Optimizing a structured digital self-assessment of patient anamnesis service for the elderly to be used before the first doctor's appointment

Development and usability evaluation of a prototypical user interface

Master Thesis

For attainment of the academic degree of
Master of Science in Engineering (MSc)

in the Master Programme Digital Healthcare
at St. Pölten University of Applied Sciences

by

Judith Höllebrand, MSc, BSc

01347861

First advisor: FH-Prof. Jakob Doppler, MSc

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Declaration

I declare that I have developed and written the enclosed Master Thesis completely by myself and have not used sources or means without declaration in the text. Any thoughts from others or literal quotations are clearly marked. This work was not used in the same or in a similar version to achieve an academic grading or is being published elsewhere.

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Place, Date Signature

Preface

First, I would like to thank FH-Prof. Jakob Doppler MSc. for his support during the different phases of this master thesis. Special thanks go to my family that supported me in many ways during my studies. Furthermore, I would like to thank my work colleagues as well as the test persons for testing the prototype. I am also thankful to Elisabeth for proofreading, to my fellow students and especially to Ina. Finally, I want to express my very profound gratitude to my partner Lukas for always encouraging me and supporting me with advice and proofreading.

Abstract

In recent years, numerous digital services have been developed that bring facilitation to the healthcare system. One of these is the possibility for patients to digitally fill out their medical history (anamnesis) before visiting a doctor. Such structured digital self-assessment of patient anamnesis is considered to have a lot of potential, for example to save time and resources, to shorten the admission process, to improve data quality and subsequently to increase the quality of patient care (Hayna & Schmücker, 2009). Studies show that patients generally have a positive view of this digital service, but older people and people with less technological experience often have problems with existing technologies.

The aim of this master thesis was to develop a user-friendly first-level prototype especially for older people to collect medical history data while following the user-centred design approach. First, the context of use and functional and non-functional requirements were specified. 41 design recommendations for mobile device accessibility for the elderly were summarized and were used to develop the prototype. The prototype includes the functions of entering core data, answering anamnesis questions, uploading reports and signing data protection forms. It was tested on an Android tablet by 5 people older than 60 years. Time-on-task and task-completion rate were measured. After the test the participants answered a questionnaire.

The five participants rated the usability of the prototype overall as good according to the SUS Score. Two people even rated it as excellent. All participants could successfully complete every task. People with technological experience did not have any problems using the prototype, whereas participants with very little or no technological experience revealed uncertainties especially at the beginning of the user test and needed to get to know the basic functions of entering data digitally. While using the prototype, participants showed that the functions are intuitive and the handling could be learned using the prototype. In a next step, the improvement possibilities identified during the conducted usability tests should be implemented and then the prototype should be tested again. For further development, a function to share the collected data with different doctors could be considered.

Key words: anamnesis, medical history, digital questionnaire, older people, elderly, accessibility, mobile device, tablet, self-assessment

Kurzfassung

In den letzten Jahren sind zahlreiche digitale Services entwickelt worden, die zu Erleichterungen im Gesundheitssystem beitragen. Eines davon ist die Möglichkeit für Patient:innen, ihre Krankengeschichte (Anamnese) vor dem Besuch bei Ärzt:innen digital auszufüllen. Zahlreiche Vorteile werden einer strukturierten digitalen Selbsteingabe der Patient:innen-Anamnese zugeschrieben, z.B. Zeit und Ressourcen zu sparen, den Aufnahmeprozess zu verkürzen, die Datenqualität zu verbessern und in der Folge die Qualität der Patientenversorgung zu erhöhen (Hayna & Schmücker, 2009). Studien zeigen, dass Patient:innen dieser digitalen Anwendung im Allgemeinen positiv gegenüberstehen, ältere Person und Personen mit weniger technologischer Erfahrung jedoch oft Probleme mit den vorhandenen Technologien haben.

Ziel der Masterarbeit war es, einen benutzerfreundlichen First-Level-Prototypen speziell für ältere Menschen zur Erfassung von Anamnesedaten zu entwickeln, und dabei dem Ansatz des User-Centred Designs zu folgen. Zunächst wurden der Nutzungskontext sowie funktionale und nicht-funktionale Anforderungen spezifiziert. 41 Designempfehlungen für die Accessibility von mobilen Geräten für ältere Menschen wurden zusammengefasst und für die Entwicklung des Prototyps verwendet. Der Prototyp umfasst die Funktionen der Eingabe von Stammdaten, der Beantwortung von Anamnesefragen, des Hochladens von Befunden und der Unterzeichnung von Datenschutzformularen. Getestet wurde der Prototyp auf einem Android-Tablet von 5 Personen, die über als 60 Jahre alt sind. Während des Usabilitytests wurde die Time-on-task and Task-completion Rate erfasst. Nach dem Test beantworteten die Teilnehmer:innen einen Fragebogen.

Die fünf Teilnehmer:innen bewerteten die Benutzerfreundlichkeit des Prototyps nach dem SUS-Score insgesamt als gut. Zwei Personen bewerteten ihn sogar als ausgezeichnet. Alle Teilnehmer:innen konnten jede Aufgabe erfolgreich erledigen. Personen mit Technologieerfahrung hatten keinerlei Probleme bei der Nutzung des Prototyps, wohingegen Teilnehmer:innen mit sehr wenig oder gar keiner Technologieerfahrung am Beginn Unsicherheiten zeigten und sich zuerst mit den Grundfunktionen der digitalen Dateneingabe vertraut machen mussten. Während der Nutzung des Prototyps zeigte sich, dass die Funktionen intuitiv sind und innerhalb der Nutzung des Prototyps erlernt werden können. In einem nächsten Schritt sollen die in den Usability-Tests identifizierten Verbesserungsmöglichkeiten umgesetzt werden und der Prototyp erneut getestet werden. Für die weitere

Entwicklung könnte die Funktion in Betracht gezogen werden, die gesammelten Daten mit anderen Ärzt:innen teilen zu können.

Schlüsselwörter: Anamnese, Krankengeschichte, digitaler Fragebogen, ältere Menschen, Accessibility, mobiles Gerät, Tablet, Selbsteingabe

Table of Content

1 Introduction

In our ageing society, health is increasingly becoming an expensive and resource-intensive commodity, but digitalization of the healthcare system can work against this development by reducing the costs for services and increasing their quality according to a new study from Helmcke et al. (2021). More and more patients believe in the benefits of digitalization of the healthcare system (Bundesverband der Arzneimittel-Hersteller e.V., 2020). For example, 77% of the respondents in a representative population survey in Germany expect that digitalization in the healthcare system leads to greater safety for patients, 76% believe in better treatment by doctors as a result and 74% believe in cost saving (Bundesverband der Arzneimittel-Hersteller e.V., 2020).

Communication between doctor and patient is described as an essential factor in medical care and a requirement for a correct diagnosis and optimal therapy (Matusitz & Spear, 2014; Meier et al., 2018). Digital communication possibilities enable to extend the ways of communication for doctors and patients. The possibilities of digital communication are extensive. Examples are telemedicine, online appointments, digital transfer of medical reports or history, digital message exchange or apps for recording and sending relevant parameters, just to mention a few. For all digital communication options, it is essential to comply with patients' rights and data privacy. Digital communication between doctors and patients is a large subject area, therefore, the focus of this master thesis will be the anamnesis process.

The word "anamnesis" comes from the Greek and means memory (Duden, n.d.). In medicine, the term anamnesis refers to the patient's medical history and aims to gain information about patient's medical symptoms (Seiderer-Nack et al., 2012). It provides an essential basis for diagnosing and treatment decisions. The accuracy and completeness of the medical history significantly influences the quality of the diagnostic process (Kassirer, 2014; Moonen et al., 2017). The term anamnesis is also used to describe the conversation between doctor and patient to collect the patient medical history and current complaints (Blanck, 2019). Overall, the duration of the anamnesis conversation lasts between five and 50 minutes (Blanck, 2019). In some medical practices, the anamnesis is taken on a sheet of paper by the patient and during the first conversation between doctor and patient (Kopp et al., 2021). Bachman (2003) that the use of standardised questionnaires leads to obtaining a more detailed patient's medical history compared to conducting a doctor's consultation on its own. A new approach in the last years is to use structured digital self-assessment of patient anamnesis, which is considered to have a lot of potential, like saving time and resources, shortening the admission process, improving data quality and subsequently increasing the quality of patient care (Hayna & Schmücker, 2009). Patients provide positive feedback on digital anamnesis and most of them prefer the digital option to paper-pencil versions (Hess et al., 2008; Kopp et al., 2021; Melms et al., 2021; Wæhrens et al., 2015; Wong et al., 2017; Zazpe et al., 2019). Most studies examine digital anamneses tools which are used in the waiting room immediately before the appointment. Greater convenience is expected if the medical history questionnaire can be answered at home (Kopp et al., 2021). Different studies report that older people or those with less affinity for technology overall had difficulties, needed support more often and more time to answer the questions about their medical history digitally (Hess et al., 2008; Kopp et al., 2021; Melms et al., 2021; Wong et al., 2017).

The proposed benefits of this master thesis are to develop a prototype for a tool which can facilitate the first doctor's appointment through digital self-assessment of patient anamnesis, give doctors the opportunity to prepare for a patient's appointment and include the answered anamnesis questionnaire in the digital patient documentation system. It can also be advantageous for patients; they can fill out the medical history at home in peace and quiet and in systematic form. On the broader scale, the hope is that such research leads to better possibilities to collect anamneses and provides a good basis for diagnosis and treatment decisions. With focus on changes and difficulties relating to aging and using mobile technologies like barriers in colour vision, contrast detection, selective attention, hand movement, a more user-friendly prototype for the elderly should be developed.

Considering the literature two research question were defined:

RQ1: What functional and non-functional requirements are necessary for a structured digital self-assessment of patient anamnesis used by older patients before the first doctor's appointment?

RQ2: Does the first-level prototype for a structured digital self-assessment of patient anamnesis prove to be usable also for older people in the context of a first explorative pilot study?

This master thesis uses an exploratory approach to the field of research following a user-centred design (UCD) process with four stages:

1. **Understand and specify the user context**
    a. After defining the research questions, literature research was carried out to summarize results of studies of structured digital self-assessment including problems and recommendations.
    b. To get an overview of available tools and the different functions, existing structured digital self-assessment products have been analysed.
    c. Literature research on the topic of designing mobile technologies for the elderly was conducted to answer the following questions: How do the elderly use technology? What are the problems and barriers for the elderly? Which recommendations does literature give to design user-friendly technology especially for older people?
2. **Specify the user requirements**
   Based on the literature results, the requirements for users were defined, including the creation of personas.
3. **Design and prototyping**
   According to the defined requirements, the prototype was designed and developed.
4. **Evaluate design and prototype**
   The evaluation of the prototype was carried out through a usability test with five people older than 60 years.

For a better understanding, the method is summarized in Figure 1.

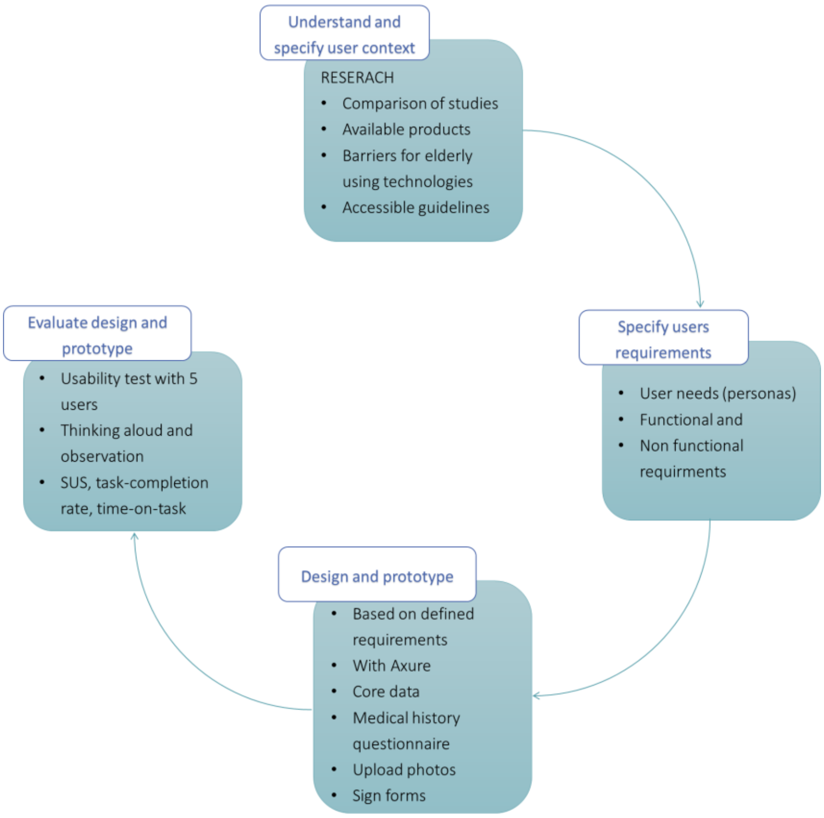


Figure 1 Four stages of user-centred design process of the master thesis

Before starting the master thesis, an ethics concept was written and approved by ethics commissioners of the study program.

Thesis Structure

- Chapter 1 Introduction: describes problems, motivation, research questions, methods of the thesis
- Chapter 2 Background of patient anamnesis and mobile device accessibility for the elderly: summarizes studies and products of structured digital self-assessment of patient anamnesis, names barriers older people have to face and guidelines for designing user-friendly technologies for older people.
- Chapter 3 Design and prototyping: covers context of use and requirements, applied guidelines as well as design and functionality of the prototype.
- Chapter 4 Usability test design and evaluation: describes the usability test, questionnaire, test user description.
- Chapter 5 Results: present the evaluation of the usability tests.
- Chapter 6 Discussion and Conclusion: which summarizes the findings.

2 Background of patient anamnesis and mobile device accessibility for the elderly

2.1 Structured digital self-assessment of patient anamnesis

In most medical practices, anamnesis is still only collected verbally in a conversation between the doctor and the patient or sometimes additionally with paper-pencil questionnaires answered by the patient in the waiting room (Denecke et al., 2018; Kopp et al., 2021). In the last years various studies have been conducted on the structured digital self-assessment of patient anamnesis. In general, most participants prefer digital questionnaires compared to paper-pencil versions (Wæhrens et al., 2015; Zazpe et al., 2019). Studies have also proved that digital medical data collection is in many cases, for example regarding completeness and correctness, of higher quality than the traditional paper pencil method (Dale & Hagen, 2007; Renggli et al., 2020; Tiplady et al., 1997).

In Pubmed, GoogleScholar and Journal of Medical Internet Research the following keywords were used to search for relevant studies: self-anamnesis, structured anamnesis, digital medical history, digital questionnaire, computer-assisted history taking, tablet, self-assessment, self-administered questionnaire. In the next part, five relevant studies will be summarized, which all tested or compared structured digital self-assessment of patient anamnesis tools.

Hess et al. (2008) tested patient administered computerized questionnaires used on a tablet in a routine clinical care by more than 11 000 patients. The patients got the tablet with a “pen” at the check-in and answered the questions in the waiting room. Answers were given with radial buttons and checkboxes, no free-text response was required. Questions were asked at the first and following visits, but the number of items varied. Items included sex, race, marital status, educational attainment, physical activity, social support, living will, comorbid medical conditions, pain rating scale, change in appetite, weight, prescription refills needed, tobacco and alcohol use. Overall, the majority of the patients reported having no problems, but 16% of the patients reported having some or a lot of difficulties. The results show that people with increasing age, Asian and African American race, less than a high school degree and with the presence of comorbid medical conditions have in general more difficulties using the self-administered tablet questionnaire. For example, 41% of the people over 65 years reported having some or a lot of difficulties and women in this age group had even more difficulties compared to men. Hess et al. (2008) did not examine the reasons why patients have difficulties.

Herrick et al. (2013) conducted a cross-sectional study at two urban Emergency Departments with 841 participants testing self-administered computer-assisted interviewing (SACAI). In general, there was a high degree of acceptability of SACAI, but there were also differences between participants. For example, participants over 65 years showed a 42% longer mean per-click time compared to younger participants. Older people also needed help more often than younger ones. Several reasons for needing help were reported: vision problems (32%), motor problems (18%), cognitive problems (26%), too sick (5%) and others (19%). Herrick et al. (2013) recommended for future studies to optimize usability for those with physicals limitations, for example design improvements like better readability through front size, colour or style customization, computer vocalization of questions and answer choices, availability of question-specific instructions or adjustment of touch screen sensitivity. The results also showed that less entry mistakes were made with a touchscreen interface compared to using a digitizer pen technology (Herrick et al., 2013).

Wong et al. (2017) evaluated the acceptability and feasibility of a tablet capture system to assess patient reported measures with 121 patients with chronic kidney diseases. The majority of the patients indicated the system as acceptable and 79% completed the questionnaire with no or very little help, but older patients (> 70 years), people with low health literacy and people with less previous computer experience needed more assistance and reported a lower level of acceptance compared to younger ones. Also, patients with physical difficulties or visual impairments needed assistance for completing the questionnaire. For further studies, special consideration should be given to the elderly or patients with little computer experience as well as to patients with visual or physical impairments and there should be individualized support for them (Wong et al., 2017).

Eldh et al. (2020) examined the experience of a digital communication system used for patient-staff encounters in primary care. In this study, 21 individual interviews with staff at five primary care centres in Sweden were conducted after a six-month trial period of the system. One part of the system was the possibility for the patient to register and answer structured questions about the reason of the appointment and anamnesis questions in form of drop-down menu options or free text alternatives. The patients could use the system anytime, but service staff was only available during daytime from Monday to Friday. Nurses in the primary care centre responded within two hours during office hours. The results showed that specific digital skills are necessary and that it was mainly beneficial for younger people to offer another quicker communication route. Concerning the chat function, patients expected synchronous communication although this could not be offered because of a lack of resources. Sometimes data was missing in the anamnesis questionnaires. Eldh et al. (2020) explained the missing data with a lack of knowledge on the patient side for the importance of a complete anamnesis. A great advantage was the possibility to upload photos. In the future, additional instructions for patients should be offered to get more detailed data, but also to support health literacy. It is recommended that the potential inequities in society are considered when developing digital communication tools and that the tools can be used as easily as possible and offer more effective alternatives than currently available means (Eldh et al., 2020).

Renggli et al. (2020) tested the usability of a web-based software tool for history taking in the emergency department and compared the anamnesis with and without a web-based software tool. Based on the patients' answers the further questions were dynamically adapted and included for example symptoms, medications, allergies, personal and family medical histories. The study compared a baseline week (junior physicians performed history-taking) and an intervention week (patients filled out their medical history electronically and junior physicians used the information for the history-taking). Afterwards, senior physicians rated the quality of different anamnesis-taking. Results show that junior physicians rated their confidence in making the diagnosis with the electronically filled anamnesis questionnaire better than just with the patient conversation. Also, the senior physicians' ratings classified the medical histories collected with the software as more complete compared to the baseline. Only one category - "medications" - was rated as less accurate during intervention compared to baseline week. This effect might be explained by the challenge to enter all medication manually in the software, while normally patients have a medication list which could be included as an electronic copy in the documentation system. However, "social history" was more complete with the software in comparison to physician's history and some patients preferred to give information about sensitive topics like high alcohol consumption or drug abuse digitally. Regarding efficiency, junior physicians describe a reduction of their workload with the software in 54% of the cases. Overall, the study reports a good usability, but one mentioned limitation is the young age of the intervention group (median = 41 years).

Kopp et al. (2021) evaluated the use of a digitized structured self-assessment (DSSA) of patient anamnesis before computed tomography on a tablet with 317 patients. In general, the patient feedback concerning the tablet usability and the comprehensibility of the questionnaire, consisting of 67 items, was positive, but with increasing age, patients reported more negative feedback and needed more time. Minor adaptation to digitalization, reduced fine motor skills, and increasing health impairments were cited as possible reasons for the negative feedback from older people. Potentially critical questions addressing CT indication were marked with a “red flag” and patients had the possibility to mark questions for further discussion during the following individual patient briefing, which helped to focus on the most relevant health issues. For further digital questionnaires Kopp et al. (2021) recommend a better preselection of questions to reduce the amount and time effort and to implement the possibility to complete the DSSA on private devices already at home, where relatives may help. This way a better convenience is expected (Kopp et al., 2021).

Jimenez et al. (2020) declared digital medical interview assistant systems based on a narrative review as a chance to enhance primary care consultation and facilitate management with chronic condition. In their study, they describe potential benefits and disadvantages of digital medical interview assistant systems compared to face-to-face consultation, which are summarized in Table 1.

Table 1 Advantages and disadvantages of structured digital self-assessment of patient anamnesis. Information is adapted from Jimenez et al. (2020)

Advantages	**Disadvantages**
Collects medical history for health screening or doctor's consultation	Technical issues may result in - Missing relevant information - Erroneous information - Collection of irrelevant information
Collects more complete and accurate information	Possible human computer interaction-related concerns: - Perceiving the digital answering as impersonal - Inability to detect nonverbal behaviour
Potential to increase diagnostic certainty	Doctor must confirm all responses
Helps to prepare patient and doctor for the consultation	Requires patient's familiarity with technology
Helps to focus on identified concerns and problems during consultation	Can require technical supervision
Promotes rapport, communication and decision making	Requires further legislative, organisational factors to allow successful implementation of an eHealth innovation
Enables triage prioritization and improves referral of patients	
Shortens spending time of history taking, dictation and documentation for doctors	
Integration with electronic medical records	

Overall, the studies reported very positive feedback from the patients, but there are big differences between patients' groups. Especially elders and patients with physical limitations, lower education or less technical experience had more problems and needed more help. Their needs should be given special consideration for further developments, for example better usability and support possibilities (Eldh et al., 2020; Herrick et al., 2013; Hess et al., 2008; Kopp et al., 2021; Wong et al., 2017). All mentioned studies expect Eldh et al. (2020) examined tools which were used in the waiting room before the doctor's appointment. The possibility to also answer the questions at home was recommended (Kopp et al., 2021). Through the comparison of medical history taking with and without a digital questionnaire, Eldh et al. (2020) showed that, overall, medical history taking with structured digital self-assessment is more complete and in many cases poses a reduction of work. The different studies also offer many recommendations for further and better structed digital self-assessments.

Based on the described studies, the following recommendations are identified:

- focus on needs of older patients, patients with less computer experience, visual or physical impairments, less technology experience and lower education (Eldh et al., 2020; Herrick et al., 2013; Hess et al., 2008; Kopp et al., 2021; Wong et al., 2017),
- offer the possibility of individual customization like font size, colour or style and adjustment of touch screen sensitivity (Herrick et al., 2013),
- computer vocalization of questions and answer choices (Herrick et al., 2013),
- offer more instructions, also question-specific (Eldh et al., 2020; Herrick et al., 2013),
- implement a possibility to upload photos (Eldh et al., 2020),
- reduce to the most important questions and adapt questions automatically based on the given answers (Renggli et al., 2020),
- explain the importance of a complete anamnesis for correct diagnosis (Eldh et al., 2020),
- offer the possibility to answer the questions at home or in the waiting room at the doctor's office (Kopp et al., 2021),
- give special consideration for medication acquisition, which was sometimes less accurate with the digital version compared to the conversation (Eldh et al., 2020; Renggli et al., 2020) and
- in general, touchscreen was more effective and less entry mistakes were made compared to using a digitizer pen technology (Herrick et al., 2013)

2.2 Examples of structured digital self-assessment of patient anamnesis in Europe

In this chapter the market research of tools to collect structured digital self-assessment of patient anamnesis is summarized. Two questions should be answered: which digital anamnesis tools are currently available on the market and which different functions do they have? In the market research, the focus was on European suppliers and the larger ones were selected. Although, unfortunately, no claim can be made to unambiguous correctness, as a comparison of sizes was not always possible. The search also showed that there is no consistent wording of the offered services. For example, the following search terms were used: medical history tool, anamnesis tools, medical history digital forms, patient intake form, medical history questionnaire, medical form, anamnesis form. Next, four service providers are described.

2.2.1 Idana

Idana is a software for digital patient admissions with the possibility of digital anamnesis, digital forms, contact free self-check-in for patients, digital patient information, legal documentation, and digital patient scheduling.[1]

Prefabricated anamnesis questionnaires are offered for a wide range of specialties, e.g. general medicine, orthopaedics, psychiatry and psychotherapy, gynaecology, paediatrics and adolescent medicine. The practice team selects the appropriate questionnaire, which can be answered with a tablet in the practice. Optionally, the patient can do it with a specific link and a login code at home. Idana is device-independent, collects data through end-to-end encryption, is DSGVO compliant and with a GPD interface it can be connected to the practice program. For the doctor, answers are transferred into a structured report with highlighting as well as warnings of important answers. Scores are calculated automatically. The price starts at 99€ per month with a one-year commitment.

A study conducted on behalf of Idana shows that a digital anamnesis tool can save labour and material costs (Tomes GmbH, 2021).The costs that can be saved are estimated at almost 1600 euros a year for a doctor’s office with 200 patients per month. Idana asked more than 160.000 patients about their opinion after filling out the questionnaire. 93,5% of the asked people would use Idana again (Idana, 2020).

[1] Idana software https://idana.com/ (Access on 2022-01-20)

A quote from an Idana client, Dr. Rainer Paus, also reports positive feedback from most of the patients. However, older patients need help more often. The quote has been translated from German into English by the author to the best of her ability.

The feedback from patients is mostly positive. Dealing with Idana is unproblematic for young patients. But not only young, but also older patients appreciate the offer, the flexibility and they associate this with a positive and innovative image of the practice. Of course, there are always patients, especially older patients, who are overwhelmed. We have to help them individually and personally.

Figure 2 provides an example of the Idana software.

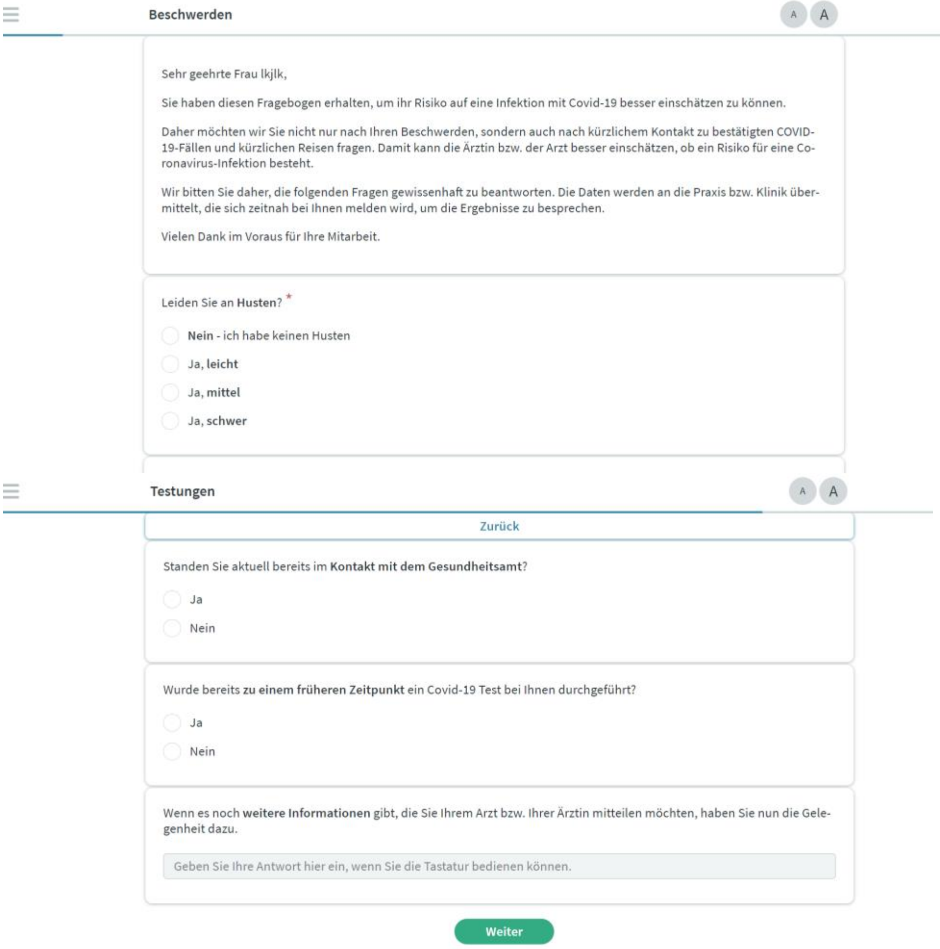


Figure 2 Example of Idana software [2]

[2] Idana software https://idana.app/questionnaire/questions (Access on 2022-03-12)

2.2.2 Doctrin

Doctrin is a platform for e-health to help providers to digitalize the patient journey. Patients can initiate an online healthcare contact anytime, login to the save platform and fill in their medical history digitally. The platform should help with the lack of resources in the healthcare system, support healthcare providers and simplify communication as well as collaboration. In order to achieve that, the care provider automatically gets a compiled and clear medical report after the patients have answered the medical history questionnaire. On this basis, each patient case is triaged quickly and is sent to the most appropriate team or medical professional. In a next step, flexible healthcare contact via video or chat is offered. With Doctrin, messages can also be sent to patients or to colleagues, for example, to schedule upcoming contacts. Doctrin has the overall goal to improve medical quality, increase efficiency and improve satisfaction.[3]

The medical catalogue consists of many forms for different subject areas, which can be individually adapted to the situation. The completed forms are automatically compiled into a report enabling accurate and efficient medical decisions to be made. Forms are offered for the following usage areas: administration, consultation, protocol, scales, triage and follow-up. Doctrin has standard forms for many medical specialties, for example: cardiology, dermatology, gynaecology, neurology, orthopaedics, psychiatry, surgery, urology, dental.

Doctrin is a certified medical device with CE label and all transmitted data is encrypted in accordance with the European Union's General Data Protection Regulation and the Swedish Patient Data Act.

270 healthcare units have implemented Doctrin (status on 27.01.2022). In 2021, Doctrin was active in Sweden, Norway, the Czech Republic, Poland and the United Kingdom.

Figure 3 demonstrates an example of the Doctrin questionnaire.

[3] Doctrin software https://doctrin.com (Access on 2022-01-27)

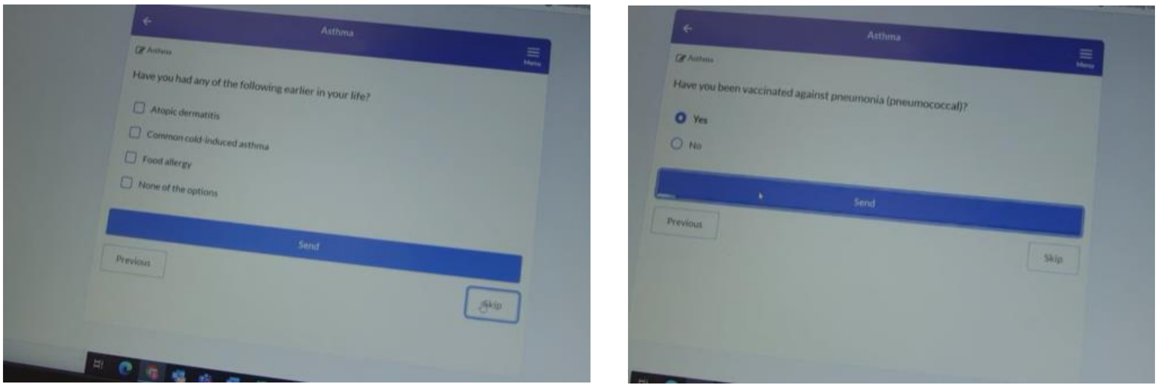


Figure 3 Example of Doctrin software

2.2.3 Aidminutes

Aidminutes is a medical communication tool with the aim to overcome language barriers and give all people access to the healthcare system regardless of their language skills. They offer two products aidminutes.rescue and aidminutes.anamnesis.[4]

Aidminutes.rescue helps paramedics to get vital information in emergencies and overcome language barriers. The app includes 250 situation- and symptom-related questions and comments in more than 40 languages and dialects.

Aidminutes.anamnesis focuses on optimal treatment preparation and collects medical history from patients in a structured way before they visit the doctor. The structured survey includes patients' current symptoms, medical history, known diagnoses and current medication as well as psychosomatic aspects. The questionnaire can be answered in more than 20 languages and is dynamically generated to shorten the procedure to the most relevant questions. The patients can use aidminutes.anamnesis on their own mobile device or on a tablet in the doctor's office. Doctors get the answers in a translated and structed way and they can be integrated into electronic health records.

Customers of aidminutes.anamesis are hospitals or health insurance companies. For example, in hospitals, the answers can be shared with multiple stations. Health insurance institutions can offer aidminutes to their insures. Their answering of the anamnesis can strengthen health literacy and be used as a basis for doctor's visits and telemedical consultations.

[4] Aidminutes software https://www.aidminutes.com/en/ (Access on 2022-03-20)

According to aidminutes, the communication time for taking medical history between doctor and patient can be reduced from 8-20 to 3-7 minutes with the help of the aidminutes tablet. The time saving can lead to less personnel deployment and costs.

In Figure 4 an example of aidminutes.anamnesis is shown.

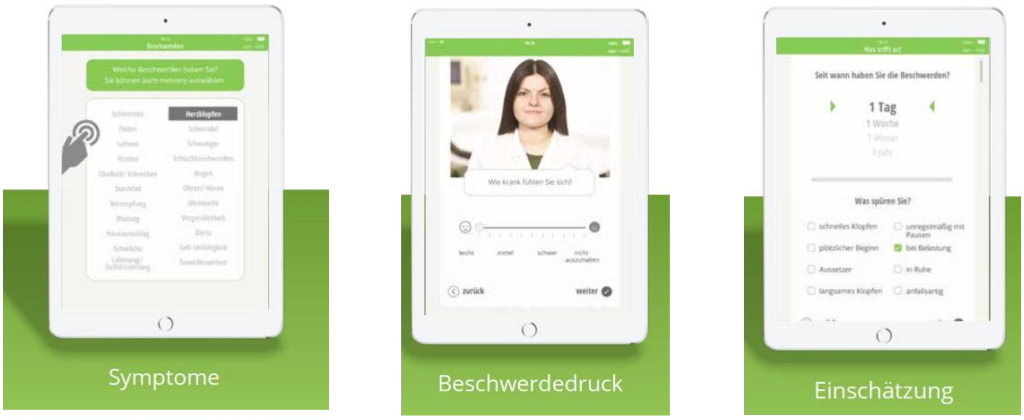


Figure 4 Example of aidminutes software[5]

2.2.4 Latido

Latido is an Austrian software provider for so-called “Wahlärzt:innen” (doctors who do not have a contract with the state health insurance) with over 1000 customers since March 2022. It offers a documentation function for patient visits with additional letter- and forms-generation, financial functions, calendar function with online appointment booking option, telemedicine video consultation and digital, encrypted doctor-patient-communication, including the possibility to send a simple questionnaire.[6] The questionnaire can be sent individually by the doctor or automatically when a certain type of appointment is scheduled in the calendar. The patient gets an e-mail with the link to the Latido patient portal, can register with a token sent by SMS, login and answer the questionnaire. In chapter 3 the questionnaire is described in more detail, because the Latido questionnaire is used as a basis for this master thesis. At the moment, the questionnaire consists of questions listed on one side, which lack good usability, and further functions are necessary, like to get help or sign a form. Functions will be extended and the usability will be improved. From conversation with Latido staff, it is known that

[5] Aidminutes software https://www.aidminutes.com/static/6bf96aeb627c1a75e02c24c78479a271/aidminutes_anamnesis_flyer.pdf (Access on 2022-07-20)

[6] Latido Software https://latido.at (Access on 2022-03-29)

younger people usually complete the questionnaire well, but older people frequently have problems. Figure 12 illustrates a Latido questionnaire.

2.2.5 Market research summary

The market research showed that there are in general two types of providers: e-health providers with an additional function to collect the medical history (like Doctrin and Latido) and firms that specialize in medical history taking (like Idana and aidminutes). The customers of the described tools vary: Aidminutes is used by hospitals or health insurance companies, Doctrin by healthcare units, Latido by "Wahlärzt:innen" and Idana by doctors. All providers promise a significant time saving and consequently a cost saving. The process is quite similar for all providers mentioned above. Most of them offer a link (within an e-mail or on a website) or a code to start the questionnaire. The patient fills out the questionnaire and the doctor gets the answers in the form of a report.

For structured digital self-assessment of patient anamnesis, it is important to:

- reduce the questions to a minimum and dynamically adapt to relevant questions
- be easy to use and understand for all patients
- offer different languages if needed
- offer different examples of questions with standard questionnaires based on medical speciality
- transfer the answers into a structed digital report for the doctor, which can be implemented into a digital documentation system and optimally also be shared with other doctors or medical personnel
- be aware of the sensible health data which are collected and protect them in a legally and technically necessary way.

For a comprehensive and more detailed comparison of providers, trial versions would be helpful, because the information on the websites is partly brief and superficial. Unfortunately, this was not possible within the context of the master thesis, but it would definitely be interesting and could provide further relevant insights. Some providers only offer test accounts for doctors, in other cases, e-mails were not answered.

Overall, the market research shows that there are some tools already available, but they are mostly focused on single or few countries and have different customer groups. More possibilities in other countries, including Austria, are needed. Some tools are also quite expensive, so cheaper possibilities would be helpful for a broader use. No tool offers help or instructional material, things older people often wish especially if they do something for the first time (Darvishy et al., 2021). Also, the accessibility could be improved, for example only Idana had implemented the function to enlarge or reduce font size. No one mentioned the possibility to use their tool with assistive technologies like screen readers, therefore it can be assumed that the tools have not been optimized for this purpose.

It is not surprising that only positive information can be found on the providers' websites. But one user of Idana also mentioned more difficulties and need of help for older people. The Latido inside view also shows there is a need for considering the needs of the elderly or people with little technological experience. As the literature research demonstrates, these problems were mentioned by multiple studies, which confirms the urgency to create technological improvements that include the needs of the mentioned groups. Therefore, in the next chapter the needs and requirements of older people are summarized.

2.3 Mobile device accessibility for the elderly

We are living in an aging world. According to current estimates, the worldwide population over 60 years is expected to increase from 12% of the world's population in 2015 to 22% by 2050 (World Health Organization, 2021). This demographic change leads to various challenges for us as a society, like financial issues a social state has to face due to the decrease of working population and the increase of pensioners, or the increase of the need for health and care services. It is particularly important to strive for the inclusion of this population group in the various areas of society, including the use of technology. Unlike adolescents and young adults, today's older people have hardly grown up with computers and even less with smartphones or tablets. They have only become involved with these technologies in the course of their lives, more or less on their own free will (Darvishy et al., 2021).

In a survey in Switzerland with over 1000 people aged 65 and older, the technology and media use of older people was investigated. The results show that 40% of the interviewed people are very interested in new technologies, 39% find the operation of modern technological devices difficult or rather difficult, and 57% can no longer imagine a life without modern technological devices (Seifert et al., 2020). Overall, this study shows that the majority of older people is interested in new technologies and willing to learn how to use them. This study revealed that most of the older people want to use technology, but some technologies are designed in ways that are really difficult for the elderly to use, e.g. because of too small buttons or text size. Accessible designs try to change this. Accessibility describes the amount to which information on the web is accessible to all human beings, no matter if the human is disabled, able-bodied, old or young, etc. (Al-Badi et al., 2012). It follows the goal of a universal access to information on the internet for all people and especially people with disabilities. It refers to designs which intend to maximize the number of potential users and which consider the functional needs of all consumers including people with limitations as a result of disabling or aging conditions (Al-Badi et al., 2012). Accessible web design refers to layout, colour choices, readability, browser-independence and deals with adaptive or alternative technologies like screen readers (Al-Badi et al., 2012). In general, accessible web design ensures that the web is “user-friendly” and follows similar goals as usability. Both improve satisfaction, efficiency and effectiveness of the users. While accessibility tries to make websites open to a larger user audience, usability focuses on making the users happier and the technology more efficient as well as effective (Al-Badi et al., 2012). Design guidelines have been established to ensure accessibility as an orientation for development. In this master thesis, the focus is accessibility for older people.

For more than 20 years it is known that older people use technologies in a different way compared to younger people and that aging barriers using technologies do exist (Wildenbos et al., 2018). Already in 2001, for example, guidelines for making a website senior friendly were published by the National Institute on Aging and the National Library of Medicine. Since then, a lot of research has been done to identify barriers for the elderly using technologies and recommendations have been given to design user-friendly technologies especially for the elderly. To understand specific usability guidelines and design useable technologies for older people, it is essential to be aware of how aging can affect thinking, acting, moving and using technologies (Blendinger, 2015; Caprani et al., 2012). Therefore, in the next chapter changes and barriers older people are facing while using technologies will be summarized.

2.3.1 Barriers for the elderly using mobile devices

The word elderly is used to describe “older people” and both words can be used in exchange. There is no clear age cut off, but being old is often related to retirement and in a lot of literature people older than 60 or 65 years are defined as the elderly. “Older people” describes a group with great heterogeneity – it refers to people whose age span may cover more than 40 years (Petrie & Darzentas, 2017). The World Health Organization explains aging in the following terms:

> *At the biological level, ageing results from the impact of the accumulation of a wide variety of molecular and cellular damage over time. This leads to a*

> *gradual decrease in physical and mental capacity, a growing risk of disease and ultimately death. These changes are neither linear nor consistent, and they are only loosely associated with a person's age in years.* (World Health Organization, 2021, Ageing explained)

This definition implies that aging is not the same process for everyone. Instead, it is individual and different in many ways, like the starting age for function deficits or the severity of limitations. Overall, it shows that it is not easy to define needs and barriers for the elderly, because they are so diverse. Moreover, not everyone will face these possible barriers, and they can be varying.

Age in general is associated with normal physical decline, which, for example can make it harder to click small buttons on a smartphone, but age is also associated with developing multiple chronic diseases and related impairments (Dexter et al., 2010). It needs to be considered that most health technologies will be used to a large amount by older people, because they are ill more often than younger people (Wildenbos et al., 2018). Also, structured digital self-assessment of patient anamnesis tools are used by many older people, because they need to see doctors more often than younger ones.

In a scoping review of existing literature on aging barriers with focus of mHealth usability, Wildenbos et al. (2018) identified four aging barrier categories: cognition, physical abilities, perception and motivation, all of which will be described below.

1. **Cognition**: Aging is related to a reduction of attention and capacity of working, prospective, semantic and procedural memory (Farage et al., 2012). Older people compared to younger ones can process fewer discrete information and the process of recalling information is getting slower (Farage et al., 2012). The absorption of new knowledge or the learning of new skills also slows down with age (Darvishy et al., 2021; Farage et al., 2012). In addition, the ability to concentrate decreases with time, e.g. it often becomes difficult to ignore irrelevant stimuli (e.g. pop-ups, animation) (Darvishy et al., 2021).
   Singh-Manoux et al. (2012) observed certain cognitive abilities of five baseline age groups in ten year follow-ups in a longitudinal study. The results show declination across all age groups of all tested cognitive functions (including inductive reasoning, memory, phonemic fluency, semantic fluency) except vocabulary.
   All these reductions may negatively influence technical use (Wildenbos et al., 2018). Harte et al. (2014) mention some difficulties for older adults due to these changes in cognitive functionality when using health devices:

  - *The display and interface is [sic] cluttered or overly complex.*
  - *Feedback is not presented clearly or intuitively.*
  - *There is no adequate labelling or instructional support.*
  - *Manipulating controls gives unexpected results.*
  - *They are asked to remember difficult or complex operational routines.* (p. 261)

2. **Physical abilities**: There are many different physical impairments due to aging like slower movements and reflexes, tremor (in hands), stiffer muscles and joints as well as a reduced balance (Wildenbos et al., 2018). Physical changes are also often associated to common age-related illnesses, like rheumatoid arthritis, which leads to diminished motor skills and can make it difficult to click on small buttons or hold a device in one hand (Wildenbos et al., 2018). These diminishing physical abilities can influence learning time, error rate, speed of performance, retention of time and subjective satisfaction (Wildenbos et al., 2018).
   Harte et al. (2014) give some examples of possible difficulties regarding technology use:
   - *Attempting to press buttons which are close together or are small in surface area.*
   - *Gripping heavy or cumbersome objects, particularly in one hand.*
   - *Attempting to reach with the thumb across an interface to manipulate controls when holding a device in one hand.*
   - *Making certain gestures when interacting with touchscreens (i.e., pinches and swipes).* (p. 261)

3. **Perception**
   With increasing age, visual perception is decreasing, often due to diseases. For example, 20% of people between 65 and 74 years are suffering from macular degeneration, between 75 and 85 years it is even 35% (Berufsverband der Augenärzte Deutschlands e.V., 2022). Visual abilities like focusing on close objects, differentiating colours, detecting contrast or adapting to darker conditions decrease with aging and susceptibility to glare (Holzinger et al., 2007; Wildenbos et al., 2018). Furthermore, hearing ability declines over the years. While it is rarely fundamental for software use, it can be relevant for video tutorials (Wildenbos et al., 2018).

   The loss of visual abilities can lead to difficulties for older adults during the use of technologies when
   - *Discriminating colours and contrast on a screen, particularly in low luminance settings.*

- *Reading small, decorative or poorly weighted fonts.*
- *Distinguishing between similarly shaped software icons on screens or icons on labels.*
- *Coping with glare on a screen or maintaining concentration when glare from external sources are [sic] present in the environment.*
- *Reading scrolling text.*
- *Taking in information from a large field of vision, lack of peripheral vision could have implications for flashing warnings.* (Harte et al., 2014, p. 257)

4. **Motivation**

   Motivational issues can be a barrier to technology acceptance for older people (Wildenbos et al., 2018). Especially important for the motivation of older people is that the benefits of technology can be experienced easily and quickly during its use (Holzinger et al., 2007; Rogers & Fisk, 2010).

Harte et al. (2014) summarizes four psychosocial aspects that can lead to older people not or just party accepting digital health devices:

1. Previous Technology Experience: Lack of experience with similar technologies may cause older adults to reject the technology or be unaware of its potential use.
2. Complexity: Technology is perceived to be too complex for older people.
3. Trialability: Older people often do not have many opportunities to use technologies experimentally and lack of exposure to new technologies in their daily lives.
4. User context: For older people, the use of technologies does not fit in with personal goals or lifestyles.

Darvishy et al. (2021) mention further age-correlated limitations that may have an impact on technology use and attitudes:

- Economic resources: Some older people do not have the financial resources to spend money for technology and monthly internet fees.
- Personal attitudes: Due to little technology experience, some older people experience different fears when using technologies, like the fear of “breaking” something or of not getting ahead.

For a summary of age-related changes which influence the life of older people and the use of technology adults see Figure 5. The information is adapted from Wildenbos et al. (2018).

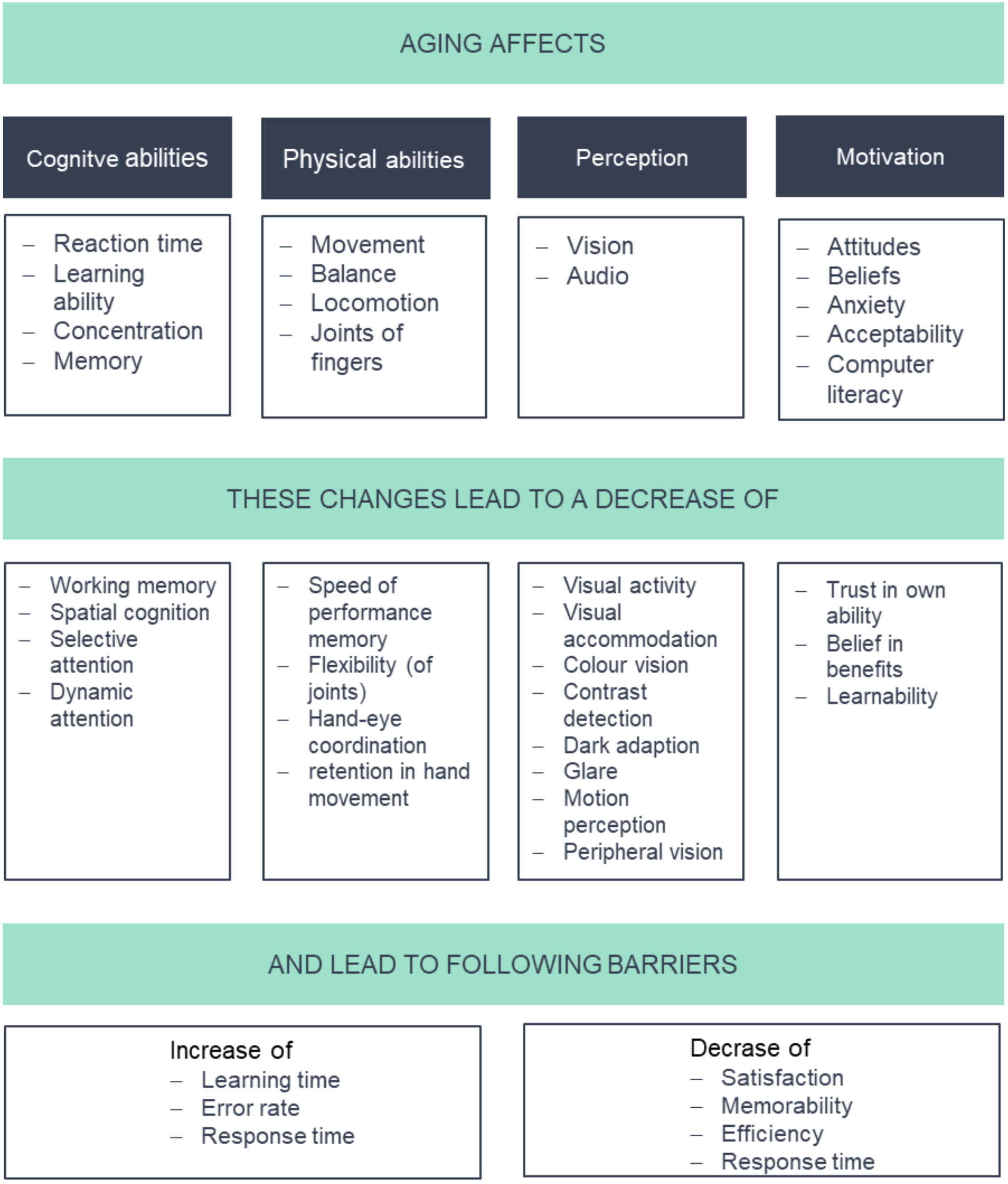


Figure 5 Characteristics of aging and following barriers using technologies. Information is adapted from Wildenbos et al. (2018)

2.3.2 Guidelines for designing accessible mobile devices for the elderly

The use of mobile devices (smartphones and tablets) has increased significantly in recent years (Darvishy et al., 2021). This trend is also evident in Austria (Statistik Austria, 2021). A survey about the use of Information and Communications Technologies (ICT) in households conducted by Statistik Austria (2021) shows an increase of internet use on mobile devices. According to Statistik Austria in 2021

88% of 16- to 74-year-olds used a smartphone to access the Internet, 41% used a desktop computer, 57% a laptop and 32% a tablet.

There are fundamental differences between the operation of applications on mobile devices compared to the use of applications on computers. For example, mobile devices are often used on the way, with many external distractions and little time (Darvishy et al., 2021). In addition, the handling of mobile devices is different. For example, instead of a mouse and keyboard, a touch screen, a screen keyboard, gesture and voice controls are available. Especially on smartphones, but also on tablets, the display is smaller than on a computer (Darvishy et al., 2021). Findlater et al. (2013) compared touch screens to traditional mouse input. The results show that touchscreen input reduced movement time for older people and error rates decreased as well. Touch devices in general are described as easy to learn and require less complex hand-eye coordination compared to computers with mouses (Findlater et al., 2013). Petrie and Darzentas (2017) showed in their review that when designing touchscreen applications especially for the elderly, a number of challenges have to be considered, for example navigation and text input.

Erharter and Xharo (2016) listed the following most often usability mistakes:

- Label or navigation do not conform to expectations or even mislead users
- Buttons and font are too small
- Elements are too closely together
- Users do not understand icons
- Users have problems with gesture control, which is used exclusively or in a wrong way
- App is left by mistake

Darvishy et al. (2021) conducted a focus groups study with older users of mobile devices and found the following to be particularly worthy of consideration when designing mobile applications:

- **Support:** Many seniors would like more support in learning the applications, e.g., in the form of on-site support or training videos.
- **Clarity:** When designing an application, the content should be presented in a clear, concise and consistent way.
- **Navigation:** It is important that menu navigation and navigation within the application is logical and limited to the essentials. The majority would like to be guided to their goal with as few clicks as possible.

- **Access to technology:** It is essential to consider the individual attitudes and expectations of the target group. Older people often have uncertainties concerning new technologies.
- **Operation:** The operation of apps should be intuitive, self-explanatory and a transparent and predictable response of the system is expected.
- **Security:** An important point is security, because there are fears regarding data loss, misuse or criminally motivated attacks on the applications, especially in the case of security-critical applications like online banking or when handling sensitive data.
- **Mobile use:** Compared to computers, on smartphones and tablets it is more important that the presentation of the application is not overloaded and that interaction is simple. The reason for this is the smaller display.

For applications used by older people it is even more important to fulfil expectations and needs of the users, because when a lack of user-friendliness occurs or parts of an application are inaccessible due to age-related limitations, the elderly tend to abandon the application quickly (Darvishy et al., 2021).

The question arises how to guarantee user-friendliness and accessibility also for older people. Many guidelines for designing technologies for the elderly have been published. In the following paragraphs the most relevant recommendations are summarized. For this summary, especially the guideline from Darvishy et al. (2021) “Altersgerechte digitale Kanäle: Webseiten und mobile Apps” and „Developer-Guidelines Usability von Apps für Seniorinnen und Senioren“ from Erharter and Xharo (2016) are used. These guidelines were chosen because they were developed especially for mobile devices, based on literature findings and user tests, and include practical tips for the development of applications.

The relevant guidelines are grouped into six meaningful categories, which are

- control and interaction elements
- navigation and menu structure
- layout and design
- language and wording
- support
- data entry

At first, each category is described and then practical recommendations based on literature findings are given.

Control and interaction elements

The most important input technique on mobile devices is touch interaction (touching the screen with one or more fingers). For this, it is crucial that the elements such as buttons and text fields are large enough and that there are sufficiently large distances between the elements so that there are as few elements selected by mistake as possible (Darvishy et al., 2021). This is especially relevant for older people with limited motor and/or cognitive abilities.

Consistency is particularly important for less experienced users, both in terms of interaction and display patterns (Erharter & Xharo, 2016).

- **CI 1:** The interaction element should be at least 12 mm high and wide. The distance between individual interaction elements should be at least 6 mm (Darvishy et al., 2021).
- **CI 2:** Clear indications are required so that elements are immediately recognizable as touch targets (Darvishy et al., 2021).
- **CI 3:** Users should be able to cancel unwanted actions, e.g. move their finger out of the element to prevent an action from being executed, and destructive actions must be explicitly confirmed by the user (Darvishy et al., 2021).
- **CI 4:** All elements should be provided with appropriate meta-information so that for users with limitations (e.g., visual or auditory) the information can be displayed correctly using assistive technologies (Darvishy et al., 2021).
- **CI 5:** Feedback should be given immediately for each action, so that the user can see the effect of their actions (Darvishy et al., 2021).

Buttons which are outlined or highlighted are much easier to find than those that are displayed in flat design (Erharter & Xharo, 2016). Flat design uses flat instead of spatial elements, which was often used in the 10s of the 21st century (Erharter & Xharo, 2016). There are studies which show that the search time is significantly longer for flat icons than for spatially designed ones, sometimes even twice as long (e.g. Burmistrov et al. (2015)). In Figure 6 you can see the difference between flat and spatial design.

Figure 6 Example of flat and spatial button

Icons can greatly improve usability and clarity, but they need to be understood also by inexperienced users (Erharter & Xharo, 2016).

> **CI 6:** Used interaction and display patterns as well as icons need to be known by the target group (Erharter & Xharo, 2016)

> **CI 7:** Buttons should always be outlined or highlighted/shaded and have sufficient contrast (Erharter & Xharo, 2016).

Besides touch interaction, there are numerous gestures to control touch devices. In Figure 7 an overview of the most important gestures is shown. When using gestures, for older people two factors have to be considered: the complexity of the gesture, which can be difficult to execute with motoric impairments, and memorizing, including knowing what the gesture is for (Blendinger, 2015). According to Stößel et al. (2010) older people report mainly good use of gesture control, but there are differences between various gestures and learning opportunities need to be offered for unknown gestures.

> **CI 8:** Different gesture controls should be used cautiously. When unknown gestures are implemented, learning opportunities should be offered (Stößel et al., 2010).

Figure 7 Common Gestures on Touch Devices ("Touch gesture icons: Freepik.com". This cover has been designed using images from Freepik.com https://www.freepik.com/free-vector/touch-gestures-icons_1537226.htm#query=touch%20gestures&position=2&from_view=keyword)

Navigation and menu structure

Many mistakes made by seniors are related to navigation. One example of an unfortunate design is a navigation bar which can only be seen after opening with a swiping gesture (Erharter & Xharo, 2016). Darvishy et al. (2021) define clarity and logical structure of applications as the most important requirements for user-friendliness. Older people want a self-explanatory guidance, a clear information hierarchy and a reduction to the essentials (Darvishy et al., 2021). Overall, a consistent, logical user guidance that offers self-explanatory step sequences makes it possible to learn the application quickly (Darvishy et al., 2021). Common navigation elements like the back button should be used consistently across multiple applications and according to the usual standards (Darvishy et al., 2021). For a convenient navigation, users should always know where they are in the application and where they have come from (Darvishy et al., 2021).

NMS 1: Elements required for navigation (like menu, forward, back, etc.) should not be accessible exclusively by swipe gestures. Additionally, common buttons are needed (Erharter & Xharo, 2016).

NMS 2: Navigation elements and user guidance should be self-explanatory, consistent and recognizable as such. Therefore, they need to be distinguished from the rest of interaction elements in several clear ways (Darvishy et al., 2021).

NMS 3: Navigation elements should always be in the same place and have the same function (Darvishy et al., 2021).

NMS 4: The number of navigation elements should be kept to a minimum and their structure should be rather broad and not deep, so that users do not get lost in the application. As a reference point, there should only be one navigation level below the main navigation (Darvishy et al., 2021).

NMS 5: Navigation elements should support assistive technologies like screen readers (Darvishy et al., 2021).

Layout and design

In the layout and design section, recommendations concerning font, size, colour and contrast are summarized.

A common difficulty for older users on mobile devices is a font that is too small, because with age, vision decreases for most people. (Erharter & Xharo, 2016) To enable good readability of texts and visibility of operating elements, sufficient contrast must be ensured.

LD 1: The font size must be set to at least 11pt, better to 12 pt (Darvishy et al., 2021; Erharter & Xharo, 2016).

LD 2: The font size should be individually adjustable (Erharter & Xharo, 2016).

LD 3: If the font is not adopted by the operating system, a sans-serif font should be used like Arial or Verdana instead of using serif fonts like Times New Roman (Darvishy et al., 2021).

LD 4: Avoid longer texts in capital letters or italics (Darvishy et al., 2021).

LD 5: For a user-friendly layout, a ragged right text is recommend (all lines begin hard at the left-hand margin and allow different endings at the right-hand margin) (Darvishy et al., 2021). An example of the difference between ragged-right and justified text can be found in *Figure **8***.

Lorem ipsum dolor sit amet, consetetur sadipscing elitr, sed diam nonumy eirmod tempor invidunt ut labore et dolore magna aliquyam erat, sed diam voluptua. At vero eos et accusam et justo duo dolores et ea rebum.

Lorem ipsum dolor sit amet, consetetur sadipscing elitr, sed diam nonumy eirmod tempor invidunt ut labore et dolore magna aliquyam erat, sed diam voluptua. At vero eos et accusam et justo duo dolores et ea rebum.

Figure 8 Ragged-right text (left image) and justified text (right image)

With increasing age, the ability to distinguish between different colours or to recognize the contrast between two colours decreases (Hegde, 2011). This is especially important to be considered when text is displayed on screens. In different design guidelines a high contrast is recommended (Darvishy et al., 2021; Erharter & Xharo, 2016; W3C, 2021). The contrast between black and white is rated as most reader-friendly (Erharter & Xharo, 2016). For the use of other colours, the contrast ratio should be calculated. For text and images of text a contrast ratio of at least 7:1 is recommend by W3C (2021). Exceptions can be made for large texts as well as texts and images that are pure decoration, then a ratio of 4.5:1 is fine (W3C, 2021). The contrast ratio can be calculated by serval free online calculation tools, for example by https://juicystudio.com/services/luminositycontrastratio.php#specify. Based on the hex colour code of the background and foreground colour, the contrast ratio is calculated.

LD 6: To ensure readability, a contrast ratio of at least 7:1 should be selected for text smaller than 18 pt and for larger text or decorative text at least 4.5:1 (W3C, 2021).

Colour is an important design aspect, because it is used, for example, to get users attention, increase usability and convey brand recognition (Nielsen Norman Group, 2021). It is especially relevant to avoid complementary colours like red-green, because many people have difficulties to distinguish colours like these (Erharter & Xharo, 2016). About 1 in 12 men (8%) and 1 in 200 women, approximately 4.5% of the world population suffer from colour blindness (Colorblind guide, 2021). In addition, colours should not be used as the sole distinguishing feature. If colours are used to distinguish text from interaction elements, e.g. for a link, there must be at least one further distinguishing feature, for example underlining (Darvishy et al., 2021).

LD 7: Complementary colour combinations like red/green, blue/orange, yellow/violet directly next to each other should be avoided (Darvishy et al., 2021; Erharter & Xharo, 2016).

LD 8: Do not use colour as the sole distinguishing feature (Darvishy et al., 2021).

Language and wording

Special attention must be paid to the comprehensibility of used terms and text. Non-user-native languages and very specialized terms should be avoided (Erharter & Xharo, 2016). If specialized terms are necessary, they need to be explained (Erharter & Xharo, 2016). This is especially relevant for menu structure, navigation, and names of buttons.

LW 1: Use short sentences, active language, generally understandable terms and avoid foreign words and specialised terms (Darvishy et al., 2021; Erharter & Xharo, 2016).

LW 2: Longer information must be provided in a well-structured manner and in manageable text sections (Erharter & Xharo, 2016).

LW 3: Use a pyramid-shaped layout, which means put overviews or summaries at the top. Headings and appropriate bullet points help to structure the text and make it easier to read (Darvishy et al., 2021).

Support

Applications should be designed in such a way that as little support as possible is required and the application can be used intuitively. Nevertheless, sometimes questions arise and then support and answers should be easy to get. Supporting information can be presented in different ways. For example, a manual, tutorials, and online help could be offered or users could be supported in person (Blendinger, 2015). Older people often have less experience with mobile devices, therefore, they wish assistance to guide and support them especially during the first few steps (Erharter & Xharo, 2016).

Applications should provide supportive material for their users which is available at any time and prevents users from getting lost within the application (Blendinger, 2015). For example, a “help”-button which is displayed at the same position within the application wherever users navigate can be implemented. Concerning support, however, care must also be taken that the user is not flooded with it, so help must neither annoy the user nor restrict functionality (Darvishy et al., 2021).

Erharter and Xharo (2016) recommend operation aids like the possibility to adjust font, zoom function for text magnification, invert colour and grayscale for a better contrast as well as visual and vibration alerts.

S 1: Support must be available at any time and any view of the application (Blendinger, 2015).

S 2: A direct contact possibility like a contact formular or forwarding to the e-mail program to quickly contact the developer should be offered (Darvishy et al., 2021).

S 3: Help must be clearly recognizable as such, e.g. the background of the help elements should be distinguishable from the background of the application (Darvishy et al., 2021).

S 4: Help and tutorials should be able to be skipped or turned off by the user (Darvishy et al., 2021).

S 5: Applications need clear descriptions of how they work, as well as help texts and instructions in sufficient font size (Erharter & Xharo, 2016).

S 6: If an error occurs, there should be clear error descriptions and easy and understandable instructions of what do to next (Erharter & Xharo, 2016).

Data entry

Self-explanatory and supportive design is essential for registration and input forms (Darvishy et al., 2021). The purpose and benefit of data entry must be immediately clear to the user and, with regard to data protection, it must be explained when data is used, archived or accessed by third parties. The limitations of the sensory organs and slower reaction times of older users must also be considered (Darvishy et al., 2021).

Generally, the alphabetic or numeric data entry should be kept to a minimum, because with the opening of the keyboard or keypad a part of the display is obscured and especially for older people with physical impairments it can be exhausting, error-prone and take a long time (Caprani et al., 2012). Therefore, other options should be offered, like clicking on predefined values, buttons or sliders (Caprani et al., 2012).

Many seniors have difficulties entering text, because the keys on the screen are often too small and thus poorly hit (Erharter & Xharo, 2016). A recommended way to help people fill out text fields is an automatic typing error correction. Older people sometimes are looking for arrow keys like on a PC and have problems navigating the cursor in the text (e.g. to correct errors in words) (Erharter & Xharo, 2016).

DE 1: Text or numeric input tasks should be kept to a minimum. Instead, other possibilities should be offered (Caprani et al., 2012).

DE 2: The input mask must be sufficiently large and easy to understand (Darvishy et al., 2021).

DE 3: Mandatory fields should be marked clearly (Darvishy et al., 2021).

DE 4: The current input field needs to be clearly identifiable (Darvishy et al., 2021).

DE 5: Care must be taken to display the correct keyboard layout, for example, a numeric keypad when numeric input is requested (Darvishy et al., 2021; Erharter & Xharo, 2016).

DE 6: Text fields should be error tolerant, there should be support for text entry with typing errors or autocompletion for words (Erharter & Xharo, 2016).

DE 7: Incorrect or missing entries in forms should be clearly marked and the option to correct should be offered easily and without loss of previously entered data (Darvishy et al., 2021).

DE 8: Do not ask for information that is already known or can be inferred from previous entries, e.g. social-security-number and birthday. Also repetitions like e-mail or password entry should be avoided. If necessary, the values can be shown to the user again to confirm (Darvishy et al., 2021).

DE 9: In the case of more extensive forms, the possibility to take a break and continue entering data should be possible without losing data (Darvishy et al., 2021).

DE 10: If the maximum input length is known in advance, the text field should be designed accordingly to avoid vertical scrolling (Darvishy et al., 2021).

DE 11: Label elements should be placed above and not next to form elements to avoid horizontal scrolling. The label should not be inside form elements either, because they disappear immediately when the input begins (Darvishy et al., 2021).

Darvishy et al. (2021) established an example of a user-friendly form for a mobile application, which is adapted and shown in Figure 9.

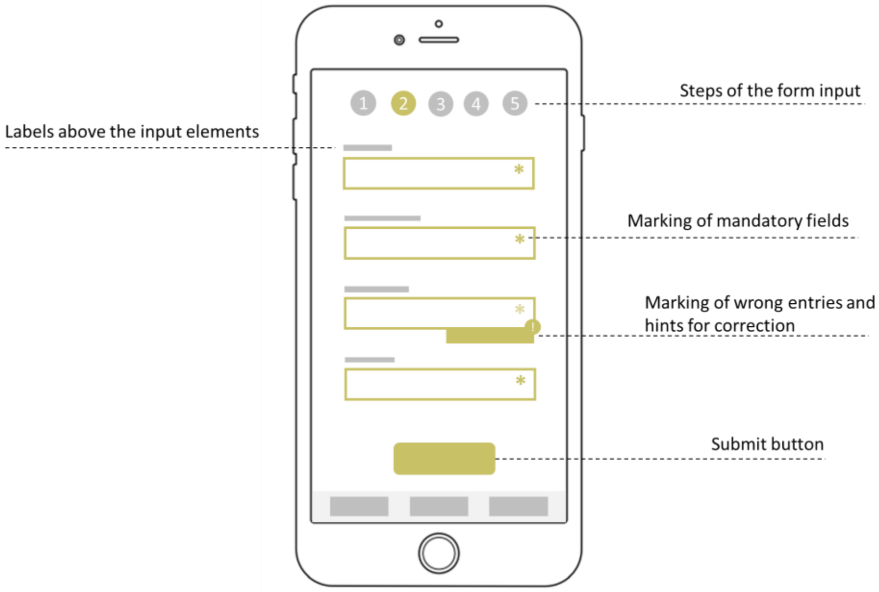


Figure 9 Design example for a user-friendly mobile form input adapted and translated from Darvishy et al. (2021, p.79)

In this subchapter, 41 recommendations for designing mobile devices for elder people based on literature results were summarized and grouped into six different categories. The recommendations listed do not claim to be exhaustive and can be regarded as a summary of the most important guidelines.

As Blendinger (2015) declares, when developing applications it is nearly impossible to realize every single guideline. Instead, based on the use case and core functions, focus should be given to the most relevant guidelines and brought into practice to achieve a better usability (Blendinger, 2015). In addition, the implemented design and functionality of an application should also be regularly checked and optimized with the help of usability tests with real users (Darvishy et al., 2021).

Not only older people have usability problems, but also younger people report difficulties and frustrations using technologies. In general, improving design and usability for older adults leads to a better usability for other user groups as well (Darvishy et al., 2021; Rogers & Fisk, 2010). It is worthy to implement seniors in design processes, because with their experience and needs they can improve the product for every future user (Östlund, 2015). Nielsen Norman Group (2013) even goes that far: “If you redesigned your website to give seniors the same user experience quality as younger users, you could expect to get 35% more business from them, based purely on the higher success rate.” (Nielsen Norman Group, 2013).

3 Design and prototyping

The master thesis follows the user- or also called human-centred design process, which consists of four steps (International Organization for Standardization, 2010):

- Understand and specify the context
- Specify the users' requirements
- Design and prototyping
- Evaluate design/prototype

The specification of the context of use and requirement elicitation are essential parts of the user-centred design (UCD) process. To give an understanding of the context of use, information was collected and summarized in the theoretical background chapter. Before starting the design process, the context of use and the primary users need to be specified as well as the requirements analysed and specified. The elicitation of requirements is a key factor in the success or failure of the product (Maguire, 2001). Maguire (2001) emphasizes the importance of identifying the future user group and recommends to develop personas, which illustrate an example of a future user group. Two personas were created and in a next step, based on the personas and literature findings, functional and non-functional requirements were defined. The acquired knowledge was considered for the design process. First, paper-pencil mock-ups were developed and followed by a low-level click prototype. The last step of the UCD process is the prototype testing and evaluating, which is summarized in chapter 4 and 59.

3.1 Context of use and specification of the users' requirements

For representing users' needs and case scenarios, an often recommended way is to create personas (Maguire, 2001). They illustrate samples of future user groups, their needs and motivation. A persona is a fictive user, with a name and a use scenario and should help to generate ideas for designs and functions of the planned product (Maguire, 2001).

Based on the literature research and characteristics of family members and friends, two personas were created. In Figure 10, a patient persona is described and in Figure 11, a doctor's persona. Although the prototype only focuses on the interface for patients, it is relevant to also consider the needs of doctors. For the persona, an elder person is chosen, because this age group is the focus of the prototype. Nevertheless, the designed service should be used in the future by all age groups.

Josef Huber

Background: Josef Huber is 81 years old and a pensioner. He lives on his own in a small house in Lower Austria since his wife died 8 years ago. He has three children and six grandchildren, who come and visit him sometimes. Josef likes to work in his garden and to drive with his car. His senior smartphone is important for him because it offers him the possibility to stay in touch with his family and be up to date. During the first corona lockdown, his children bought him a tablet so that he can surf on the internet or watch videos of missed TV broadcasts on demand and make video calls.

Problems & Challenges: Josef has already had several illnesses in his lifetime. For example, he suffers from high blood pressure, type 2 diabetes, five years ago he had a pulmonary embolism and ten years ago he had gallstones surgically removed. In 3 months, he will get an artificial knee joint. Four weeks ago, he fell ill with Corona and he has had breathing problems since then. His family doctor recommends visiting a pulmonary specialist. Josef does not like to go to new doctors, it is always difficult for him to communicate all the important information to the doctors in a short time. Sometimes one of his children accompanies him to a doctor's visit, but they are all working full time and appointments are difficult to arrange. Josef also likes to be independent. At the last appointment he had to answer a paper-pencil questionnaire in the doctor’s office. It helped him to focus on the relevant information, but there was not enough time to answer everything and it was stressful for him.

Wishes: Josef wishes there was an easy way to communicate the relevant information to doctors, which can be done at any time, at home, in quiet and if necessary, with the help of his family.

Figure 10 Persona patient - „Josef Huber“ (Photo is a royalty-free image from Microsoft library)

Dr. Susanne Maier

Background: Susanne is 42 years old and lives with her husband and two children in Lower Austria. She studied medicine and completed her residency in internal medicine. Last year, she fulfilled a long dream, founding her own practice, where she is available for her patients four days a week. Before that, she had worked in a hospital and as a substitute in various practices and thus she has already gained a lot of experience.

Problems & Challenges: She consciously decided to digitalize many processes in her practice, because she sees the future in it and experiences time savings and simplifications in her daily routine. One process that is still done with pen and paper is the anamnesis questionnaire for new patients. Susanne would like to digitize this process as well, so that patients can fill out this information at home. She doesn't have to decipher handwritings, she can prepare for the patient in the best way and have a structured and more complete patients anamnesis compared to paper-pencil version.

Wishes: Susanne would like to have a simple way to have the patient answer digital anamnesis questionnaires before the doctor's consultation and maybe also other questionnaires. This way she can receive information in a structured way. It is important for her that the data collection is safe from misuse and complies with the legal framework. Many of her patients are already older, so she needs a simple user interface which can be used by everyone. She is also willing to purchase tablets so that they can be offered to patients if they have no other possibility.

Figure 11 Persona doctor – „Dr. Susanne Maier" (Photo is a royalty-free image from Microsoft library)

For the successful design and development process of a software it is essential to define requirements first (Sommerville, 2011). Therefore, a distinction is often made between functional and non-functional requirements.

Functional requirements describe what the product will do, what it should provide and how it should react to particular inputs or in particular situations (Robertson, 2013; Sommerville, 2011). A non-functional requirement is a "software requirement that describes not what the software will do, but how the software will do it, for example, software performance requirements, software external interface requirements, design constraints, and software quality attributes" (Institute of Electrical and Electronics Engineers, 1994) (as citated in Folinas et al., 2021, Non-functional requirements of the Cometech eHMIS). There are no consistent standards for non-functional requirements, the recommendations all differ from each other (Meulendijkal et al., 2014). For this master thesis, as a basis the recommended non-functional requirements of Meulendijkal et al. (2014) are used, because they are specialized for medical apps: Accessibility, certifiability, portability, privacy, safety, security, stability, trustability and usability. First the functional and afterwards the non-functional requirements are described.

The structed digital self-assessment of patient anamnesis should collect data, encrypt it, present it to the doctor in a structured way, store it and offer the possibility to export it. In a more detailed way, the following functional requirements are expected:

1. Core data like address, birthday, insurance, and family doctor should be collected digitally and be integrated in the doctor's electronic patient record system.
2. Information concerning the patient's medical history should be collected in advance. Different anamnesis questionnaires have been compared to identify the most important questions for an anamnesis before an internist visit (Lohse & Neurath, 2015; Poschenrieder & Korzenietz, n.d.; Rauch, n.d.; Scheibner & Perz, n.d.; Unger, n.d.):
    - pre-existing conditions
    - surgeries
    - family history
    - allergies
    - nicotine, alcohol, and other drugs
    - exercise
    - stress level
    - body height, weight, and related changes
    - medication
    - current complaints
    - questions concerning the visit like requests for clarification and expectations/fears
3. The collected data should be presented in a clear form, so that the doctor can prepare for the appointment and have a structed overview of the patient's medical history to start the consultation.

4. The possibility to get documents from patients like laboratory results, radiology results or medical reports from another doctor in a digital, secure way and following medical data protection laws.
5. Patients should be able to sign forms like data protection digitally.
6. The answering of the questions and the information gathering should be location independent.
7. Patients should get a good support and instruction, so they can use it as independently as possible.
8. Overall, it is especially important to ensure data security and data protection, because medicine and sensitive data is collected.

Requirements number 3 and 8 will not be implemented in the prototype, but they are important for a future real-world implementation of the structured digital self-assessment of patient anamnesis.

For defining the non-functional requirements, the recommended requirements from Meulendijkal et al. (2014) are used as a starting point. The non-functional requirements are summarized in Table 2.

Table 2 Non-functional requirements for a structured digital self-assessment of patient anamnesis

Non-functional requirement	Description	Detailed non-functional requirement for a structured digital self-assessment of patient anamnesis
Accessibility	Accessibility describes the degree to which the application is available to all users, also considering people with disabilities (Meulendijkal et al., 2014).	A structured digital self-assessment of patient anamnesis should be usable by all people. Thus, different needs must be considered. For this prototype, the special needs of older people will be the focus. Therefore, the findings and recommendations from the literature research will be considered (see chapter 2.3). In a next step it should also be optimized for screen readers for blind people.

		Also, the accessibility of technology must be considered, as not everyone has a device and internet at home. Therefore, doctors should offer a tablet with internet, which can be used in the waiting room or can even be borrowed. Accessibility should also consider language barriers. Therefore, translation should be possible for speakers of other languages, for whom an inclusion and active participation in the healthcare system is often difficult (Sozial Versicherung, 2015).
Certifiability	Certifiability refers to approvement of the software's behaviour by official authorities (Meulendijkal et al., 2014).	Certifiability will not be relevant for the prototype development. Before the service is used by patients, certifications need to be considered, like medical device approval and storing data in an ISO-certified data centre.
Portability	Portability relates to the amount of operation systems and devices that the software supports (Meulendijkal et al., 2014).	A structured digital self-assessment of patient anamnesis should be supported by different devices (tablets, smartphones and computers) and by all common operation systems. The prototype will be designed for and tested on a tablet, because tablets seem most appropriate for this use case and have also been proved to be useful in some studies with structured digital self-assessment of patient anamnesis (Herrick et al., 2013; Kopp et al., 2021; Wong et al., 2017).

Privacy, safety and security	Privacy, safety, and security are quite similar and are therefore combined to one requirement. They “relate to safeguarding users’ well-being when using the application” (Meulendijkal et al., 2014, p. 7).	The collected data is highly sensitive, so the data must be encrypted and processed according to the EU Data Protection Regulation. It is important that the users understand that their data is being protected, know that it is safe to enter personal data as well as that only the doctor or medical personnel have access to it. For the prototype developed with Axure it is not possible to control if and how the data is stored, therefore, for testing the prototype no real data is used.
Stability	Stability refers to the technical robustness and dependability (Meulendijkal et al., 2014)	A structured digital self-assessment of patient anamnesis needs to be robust and available 24/7, whenever the patient wants to answer the medical anamnesis or the doctor wants to look at the report. It also needs to be possible to start the questionnaire and make a break and continue the next day without any data loss. This requirement is relevant for the practical use, for the prototype it will not be implemented.
Trustability	Trustability means the ability of the software to convince the individual user of dependability and responsibility (Meulendijkal et al., 2014).	Users should be convinced that it is a serious and reliable service, which offers additional value to the healthcare system, facilitates the medical history conversation and can lead to more accurate diagnoses and better therapies. A professional appearance and design can contribute to this, as

		well as clear information and explanations.
Usability	Usability describes the ease of use and learnability (Meulendijkal et al., 2014). Nielsen (2012) defined usability by five components: - Learnability: How easy is it for users to use the software and accomplish basic tasks the first time? - Efficiency: After learning the design, how quickly can the user perform the task? - Memorability: If users return to the design after a period of non-use, how easily can they restore their knowledge? - Errors: How many errors do users make and how quickly do they recover from them? - Satisfaction: How pleasant is the use?	A structured digital self-assessment of patient anamnesis needs to be easily learned and used. It must be sufficiently intuitive to allow a successful use the first time, because it will not be used regularly by the patients. Thus, already the first use must be successful. Consequently, a helpful instruction will be given. The risk of making mistakes should be minimized in advance and in case of an error, assistance should be provided. Users should have a pleasant experience. To guarantee usability, good learnability, efficiency, satisfaction, and less errors, the design guidelines described in 2.3.2 will be used. At the end of this table there is a summary of the guidelines.
Additional requirements	Further non-functional requirements based on the literature review and market research are listed.	- Overall, the questions need to be reduced to the most relevant and they should adapt automatically based on the given answers, so that no

	irrelevant questions are asked (Renggli et al., 2020). - The application should be intuitive and self-explanatory (Darvishy et al., 2021). - Further information and explanations should be offered as well as question-specific instructions (Darvishy et al., 2021; Eldh et al., 2020; Herrick et al., 2013). - Offer the possibility of individual customization like font size (Herrick et al., 2013). - Give special consideration for medication acquisition, which was sometimes less accurate with the digital version compared to the conversation (Eldh et al., 2020; Renggli et al., 2020) - Offer the possibility of voice input (Herrick et al., 2013).

Next follows the summary of the guidelines for designing for older people, which can also be considered as non-functional requirements.

Control and interaction elements

CI 1: The interaction element should be at least 12 mm high and wide. The distance between individual interaction elements should be at least 6 mm (Darvishy et al., 2021).

CI 2: Clear indications are required so that elements are immediately recognizable as touch targets (Darvishy et al., 2021).

CI 3: Users should be able to cancel unwanted actions, e.g. move their finger out of the element to prevent an action from being executed, and destructive actions must be explicitly confirmed by the user (Darvishy et al., 2021).

CI 4: All elements should be provided with appropriate meta-information so that for users with limitations (e.g., visual or auditory) the information can be displayed correctly using assistive technologies (Darvishy et al., 2021).

CI 5: Feedback should be given immediately for each action, so that the user can see the effect of their actions (Darvishy et al., 2021).

CI 6: Used interaction and display patterns as well as icons need to be known by the target group (Erharter & Xharo, 2016)

CI 7: Buttons should always be outlined or highlighted/shaded and have sufficient contrast (Erharter & Xharo, 2016).

CI 8: Different gesture controls should be used cautiously. When unknown gestures are implemented, learning opportunities should be offered (Stößel et al., 2010).

Navigation and menu structure

NMS 1: Elements required for navigation (like menu, forward, back, etc.) should not be accessible exclusively by swipe gestures. Additionally, common buttons are needed (Erharter & Xharo, 2016).

NMS 2: Navigation elements and user guidance should be self-explanatory, consistent and recognizable as such. Therefore, they need to be distinguished from the rest of interaction elements in several clear ways (Darvishy et al., 2021).

NMS 3: Navigation elements should always be in the same place and have the same function (Darvishy et al., 2021).

NMS 4: The number of navigation elements should be kept to a minimum and their structure should be rather broad and not deep, so that users do not get lost in the application. As a reference point, there should only be one navigation level below the main navigation (Darvishy et al., 2021).

NMS 5: Navigation elements should support assistive technologies like screen readers (Darvishy et al., 2021).

Layout and design

LD 1: The font size must be set to at least 11pt, better to 12 pt (Darvishy et al., 2021; Erharter & Xharo, 2016).

LD 2: The font size should be individually adjustable (Erharter & Xharo, 2016).

LD 3: If the font is not adopted by the operating system, a sans-serif font should be used like Arial or Verdana instead of using serif fonts like Times New Roman (Darvishy et al., 2021).

LD 4: Avoid longer texts in capital letters or italics (Darvishy et al., 2021).

LD 5: For a user-friendly layout, a ragged right text is recommend (all lines begin hard at the left-hand margin and allow different endings at the right-hand margin) (Darvishy et al., 2021). An example of the difference between ragged-right and justified text can be found in *Figure* ***8***.

LD 6: To ensure readability, a contrast ratio of at least 7:1 should be selected for text smaller than 18 pt and for larger text or decorative text at least 4.5:1 (W3C, 2021).

LD 7: Complementary colour combinations like red/green, blue/orange, yellow/violet directly next to each other should be avoided (Darvishy et al., 2021; Erharter & Xharo, 2016).

LD 8: Do not use colour as the sole distinguishing feature (Darvishy et al., 2021).

Language and wording

LW 1: Use short sentences, active language, generally understandable terms and avoid foreign words and specialised terms (Darvishy et al., 2021; Erharter & Xharo, 2016).

LW 2: Longer information must be provided in a well-structured manner and in manageable text sections (Erharter & Xharo, 2016).

LW 3: Use a pyramid-shaped layout, which means put overviews or summaries at the top. Headings and appropriate bullet points help to structure the text and make it easier to read (Darvishy et al., 2021).

Support

S 1: Support must be available at any time and any view of the application (Blendinger, 2015).

S 2: A direct contact possibility like a contact formular or forwarding to the e-mail program to quickly contact the developer should be offered (Darvishy et al., 2021).

S 3: Help must be clearly recognizable as such, e.g. the background of the help elements should be distinguishable from the background of the application (Darvishy et al., 2021).

S 4: Help and tutorials should be able to be skipped or turned off by the user (Darvishy et al., 2021).

S 5: Applications need clear descriptions of how they work, as well as help texts and instructions in sufficient font size (Erharter & Xharo, 2016).

S 6: If an error occurs, there should be clear error descriptions and easy and understandable instructions of what do to next (Erharter & Xharo, 2016).

Data entry

DE 1: Text or numeric input tasks should be kept to a minimum. Instead, other possibilities should be offered (Caprani et al., 2012).

DE 2: The input mask must be sufficiently large and easy to understand (Darvishy et al., 2021).

DE 3: Mandatory fields should be marked clearly (Darvishy et al., 2021).

DE 4: The current input field needs to be clearly identifiable (Darvishy et al., 2021).

DE 5: Care must be taken to display the correct keyboard layout, for example, a numeric keypad when numeric input is requested (Darvishy et al., 2021; Erharter & Xharo, 2016).

DE 6: Text fields should be error tolerant, there should be support for text entry with typing errors or autocompletion for words (Erharter & Xharo, 2016).

DE 7: Incorrect or missing entries in forms should be clearly marked and the option to correct should be offered easily and without loss of previously entered data (Darvishy et al., 2021).

DE 8: Do not ask for information that is already known or can be inferred from previous entries, e.g. social-security-number and birthday. Also repetitions like e-mail or password entry should be avoided. If necessary, the values can be shown to the user again to confirm (Darvishy et al., 2021).

DE 9: In the case of more extensive forms, the possibility to take a break and continue entering data should be possible without losing data (Darvishy et al., 2021).

DE 10: If the maximum input length is known in advance, the text field should be designed accordingly to avoid vertical scrolling (Darvishy et al., 2021).

DE 11: Label elements should be placed above and not next to form elements to avoid horizontal scrolling. The label should not be inside form elements either, because they disappear immediately when the input begins (Darvishy et al., 2021).

3.2 Design ideas and applied guidelines for designing the prototype

The current Latido questionnaire is used as a template for designing the prototype, because this master thesis is written in cooperation with Latido. The cooperation included support such as access to the software and information like experiences and preferences of doctors and patients and in return the collected results of the master thesis can be used for further development of the Latido functions. The Latido firm and software is described in subchapter 2.2.4. The digital Latido questionnaire can be sent by doctors who use Latido as a documentation software to patients via the Latido patient portal. The patient gets an e-mail and can log in to the account with any computer, smartphone or tablet and answer the questionnaire. The Latido questionnaire only consists of the possibilities to ask patients questions and upload a document. The prototype developed as part of this master thesis is intended to significantly expand the functions, increase the information gain, improve the structure and design, enable improved usability for patients and offer instructions. In Figure 12, an example of a Latido questionnaire is shown.

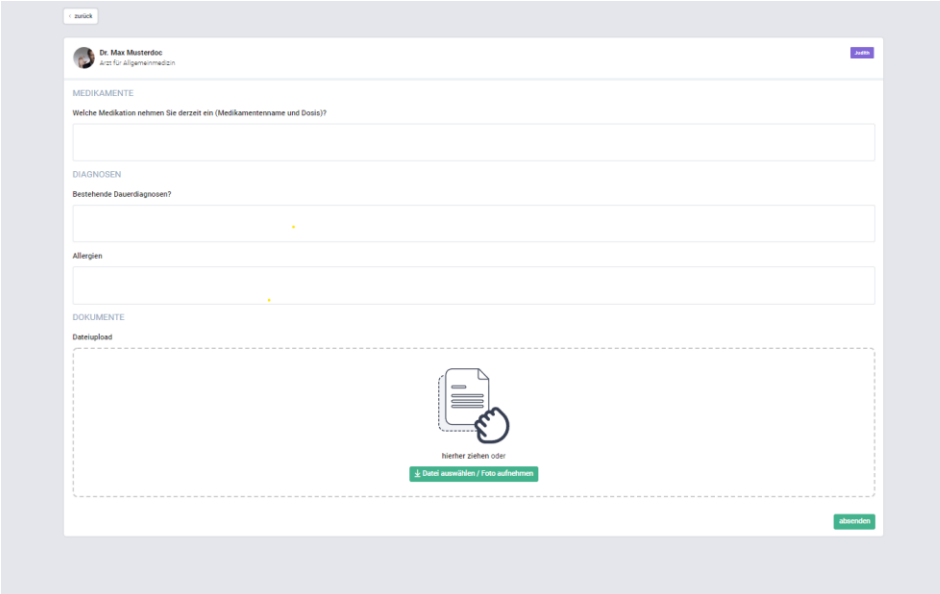


Figure 12 Example of a Latido questionnaire

The used design was evaluated and possibilities for improvement were found. For example, the buttons are too small and the used contrast is too low according to the Web Content Accessibility Guidelines (W3C, 2021).

In a first step a mock-up with paper-pencil was designed to visualize the first design ideas for the prototype. The prototype is designed for be used on a tablet and enter data with the virtual keyboard or selecting predefined options with touch input. It will be tested by German speaking participants, therefore, the used language is German. Figure 13 shows the first drafts of the user interface for patients. At the top the navigation bar with the individual steps is illustrated. The first screen draft represents the welcome page with an overview of the next steps and the further explanations button, which can be seen on the second screen draft. On the third draft the beginning of the core data entry is shown. Draft four illustrates the help for entering the core data. The first part of the anamnesis questions is sketched on draft five. Number six shows the upload function and number seven the signing of the privacy policy. The last draft illustrates the overview page after all steps are done and the button “Jetzt abschließen” (“complete now”) to send the data to the doctor.

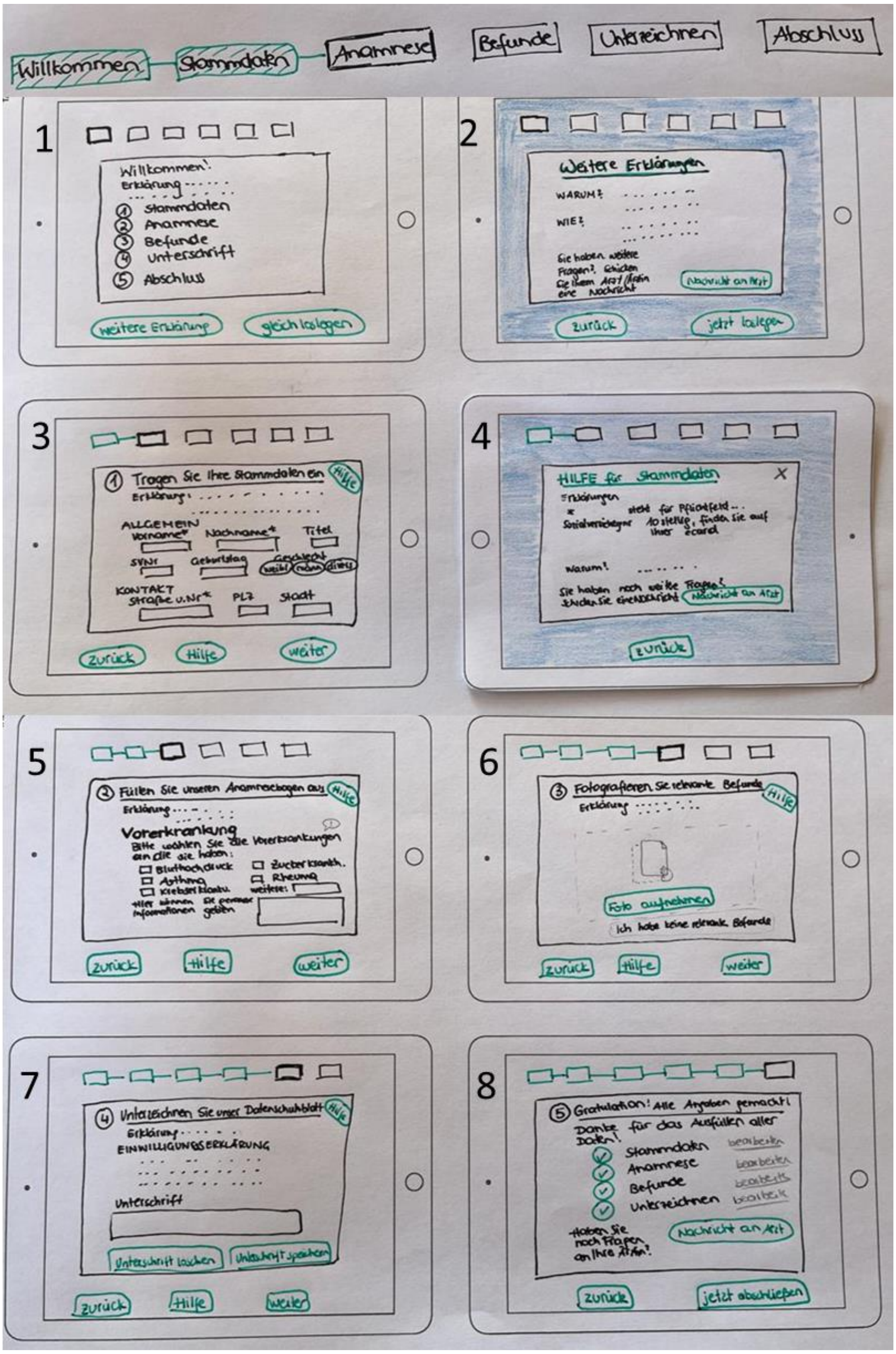


Figure 13 Mock-up of first design idea for the prototype of the structured digital self-assessment of patient anamnesis service

To provide the functional requirements described in section 0 in a senior-friendly way, the guidelines summarized in 2.3.2 are being considered. As already mentioned, the relevance of guidelines is bound to the context and functionality of the application. Therefore, not every guideline can be set in practice for every use case. Sometimes, there is also hardware or functionality restriction of the prototyping program. The applied guidelines and difficulties are described by the categorization from section 2.3.2.

Control and interaction elements

Most interactions on the prototype can be done by the standard touch gesture, no double click is necessary and only one finger is needed (cf. CI 8). Only for scrolling, a swipe gesture is needed. For an accurate interaction, the buttons and text fields are at least 12 mm in hight (cf. CI 1). To avoid erroneous button touches, the minimum space between them is never smaller than 6 mm. An exception is the keypad of the tablet, where the space between letter buttons is a bit smaller than 6 mm. For a clear recognition, most buttons are outlined and the shadows make them appear spatial, like seen in Figure 14 *(*cf. CI 2, CI 7).

Figure 14 Examples of buttons used for the prototype

The elements of the prototype are not provided with meta information, because no assistance technologies were used in the user test. This must be taken into consideration for further development, so that users who need assistance technologies like screen readers can also use the application well (cf. CI 4). Special attention is paid to a sufficient contrast in the button colour selection. Because seniors often are not that familiar with icons, there are not many icons used. Just the information and microphone icon (see Figure 15) are used, both are described once and especially the information icon is also used in non-technical context, so that a general understanding can be assumed (cf. CI 6). In addition, mandatory fields are marked with a little star (*), which is often used and recommended by Darvishy et al. (2021). The star icon is explained and an error message is shown if the field stays empty. For the resizing of the font size icons are consciously avoided, instead, buttons with the words “Vergrößern” ("increase") and “Verkleinern” (“decrease") were chosen.

Figure 15 Info and microphone icons used in the prototype

Moreover, feedback is given for different actions, for example when the user clicks in a text field and sets the cursor, the line colour turns green (cf. CI 5). Unwanted actions can be prevented from being executed if the finger is moved off the input element (cf. CI 3).

Navigation and menu structure

Because a logical structure and navigation bar is considered as one of the most important requirements for user-friendliness according to Darvishy et al. (2021) this is given special consideration. The steps of the form input are clear and consistent on every site, namely at the top, and the functions always stay the same (cf. NMS 3). Overall, the navigation elements are rather broad and not deep, so that it is easier for users compared to deep navigations (cf. NMS 4). Navigation elements are visible on each page at the top without requiring further action (cf. NMS 1). Sometimes, numbers are used to symbolize the progress of a process. Instead of the numbers, words are used, for a more self-explanatory way (cf. NMS 2) and they show the users at which step of the process they are and how many they have already done. The individual elements can also be used for navigation, for example to navigate back to the beginning. In Figure 16, the different steps are shown. Already finished steps are indicated by a turquoise-coloured background, which is also the case for the current site, but additionally the title of this site is written in bold. The lines between the steps symbol the journey between the different sites and after completion of a site they change from a dotted line to a continuous turquoise line. At the bottom of every step, buttons with the words “zurück” (“back”) and “weiter” (“forward”) are used to navigate between the steps. In the future, metainformation will have to be added to the navigational elements so that they will be usable with assistive technologies (cf. NMS 5).

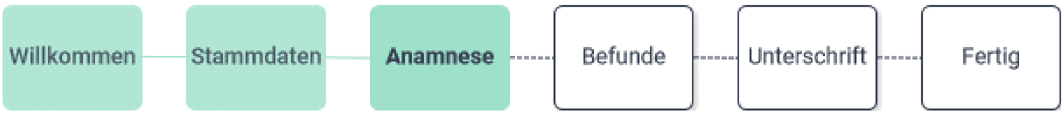


Figure 16 Navigation steps of the prototype

Layout and design

The prototype avoids using colours to transfer key information and colours are never the sole distinguishing feature of an element (cf. LD 8). No complementary colour combination is used directly next to each other (cf. LD 7). The choice of colours is based on the Latido corporate colours, but the colours were a little bit adapted to achieve at least a contrast of 7:1 according to accessibility recommendation by W3C (2021). The background colour of the prototype is kept in a light grey and the background for most of the text is white for a high contrast (colour contrast ratio:10.68:1) (cf. LD 6). Table 3 shows the used colours for the prototype.

Table 3 Colour values and usages

	Colour Value	**Colour Usage**
	#9EE0CA	Colour of main buttons, navigation and for highlighting
	#363E51	Font colour and help button colour
	#FFFFFF	Background of fields
	#575757	Line colour of further buttons
	#1D6249	Line colour of text fields when courser is in it
	#A30013	Error colour
	#FAFAFA	Background colour

To avoid one of the most common difficulties of older people using technologies - a small font - the font size is at least 15 pt (cf. LD 1). Furthermore, the sans serif font Roboto is used, and longer text is never written in special font styles, like capital letters or italics (cf. LD 3 und LD 4). Moreover, the text is always ragged right (cf. LD 5).

Language and Wording

Because the prototype was tested with German speaking persons, no English terms were used. Attention was paid to the use of short sentences and simple language (cf. LW 1). Longer information, like further explanations, is presented in a well-structured manner, for example with bullet points (cf. LW 2 und LW 3).

Support

In general, the prototype is designed in a way that not much support should be required. Nevertheless, especially older people wish clear explanations and the possibility of gaining supportive information (Erharter & Xharo, 2016). It is important to consider the necessity of help. However, designers should never flood the user with it. Therefore, a really short explanation is presented at every step and further information is available anytime on every site by providing a help button (cf. S 1). With the help button, clear descriptions of how the prototype works and support information are available in sufficient font size (cf. S 5). An example is shown in Figure 17. There is also a contact possibility for further questions implemented (cf. S 2). Additional instructions are placed near specific elements, for example next to the social insurance number. If the user clicks on “weitere Informationen” (“further information”), an instruction where to find the number and a picture of the ecard is shown. For a clear recognition, help information is marked with the info icon and the same colours and style is used throughout the whole application (cf. S 3). Moreover, error messages are shown, for example if a required field is left empty (cf. S 6).

Instructions are written for all steps of the prototype. Nevertheless, these instructions have to be adapted and improved continuously based on users’ feedback and questions in the future.

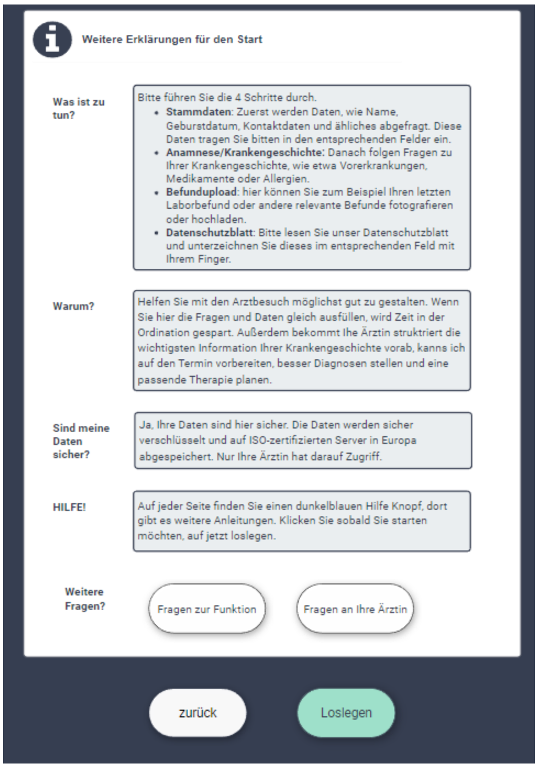


Figure 17 Screenshot of the first help text

Data entry

The main focus of this prototype is to collect data, but this is a task which is often difficult for the elderly. Therefore, many considerations have been made. Text input tasks are kept to a minimum (cf. DE 1). For example, many checkboxes or radio buttons with the option to choose are implemented instead of free text answers (like shown in Figure 18.)

Figure 18 Example of checkboxes and radio buttons used for the prototype

Nevertheless, there are still some text and numeric inputs necessary. To make it as easy as possible, the input fields are large (at least 12 mm) (cf. DE 2) and the current input field are clearly identifiable (cf. DE 3). In Figure 19, the different states of input fields are shown. As Darvishy et al. (2021) and Sherwin (2018) recommend, labels and hints are placed outside the form fields, because positioning them inside can lead to some errors (cf. DE 11). For example, users could assume that the field is already filled in or that the hint or label is no longer visible as soon as text is entered (Sherwin, 2018). In addition, the size of the input fields is also adapted to the expected maximum input length (cf. DE 10). Errors and missing text entries are marked in red and instructions for solutions are offered (cf. DE 7). Moreover, based on the required text input, the appropriate keypad layout is displayed, for example a numeric keypad for the telephone number field (cf. DE 5). To reduce the text input to a minimum, no information is asked twice (cf. DE 8). For example, when the ten-digit social security number is entered, the date of birth is automatically taken over. For the prototype some postal codes are saved, so that the name of the city is automatically filled in, e.g. when 3100 is entered, St. Pölten is automatically placed in the city field. In the future, a database of all postal codes and cities should be implemented.

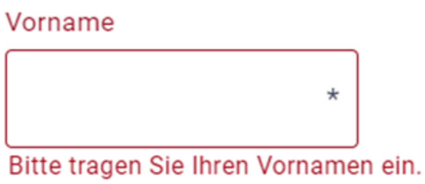
	Text field with label above the input field and little star, which symbolizes mandatory field
	Current input field
	Error, a mandatory text field is not filled out, error message under the input field suggests what to do

Figure 19 Different text input field states

The recommendation to store the data during a break could not be implemented with Axure for the prototype (cf. DE 9), but it is not relevant for the usability test, because there will be no breaks. Making text entry error tolerant could not be realized with the prototype and needs to be considered for further development (cf. DE 6).

Another possibility to enter data is tested with the prototype - speech recognition. In text areas, a microphone icon is added. If the patient prefers it, there is also the possibility to record a verbal answer and with the help of Google Speech Service it is transferred to text.

After the description of the implemented guidelines, the functionality and screenshots of the final prototype are shown.

3.3 Final prototype and functionality

The prototype was designed with Axure RP 10 and could be reached during the usability testing phase at: https://kyndiv.axshare.com. In Figure 20, an overview of the different functions is listed.

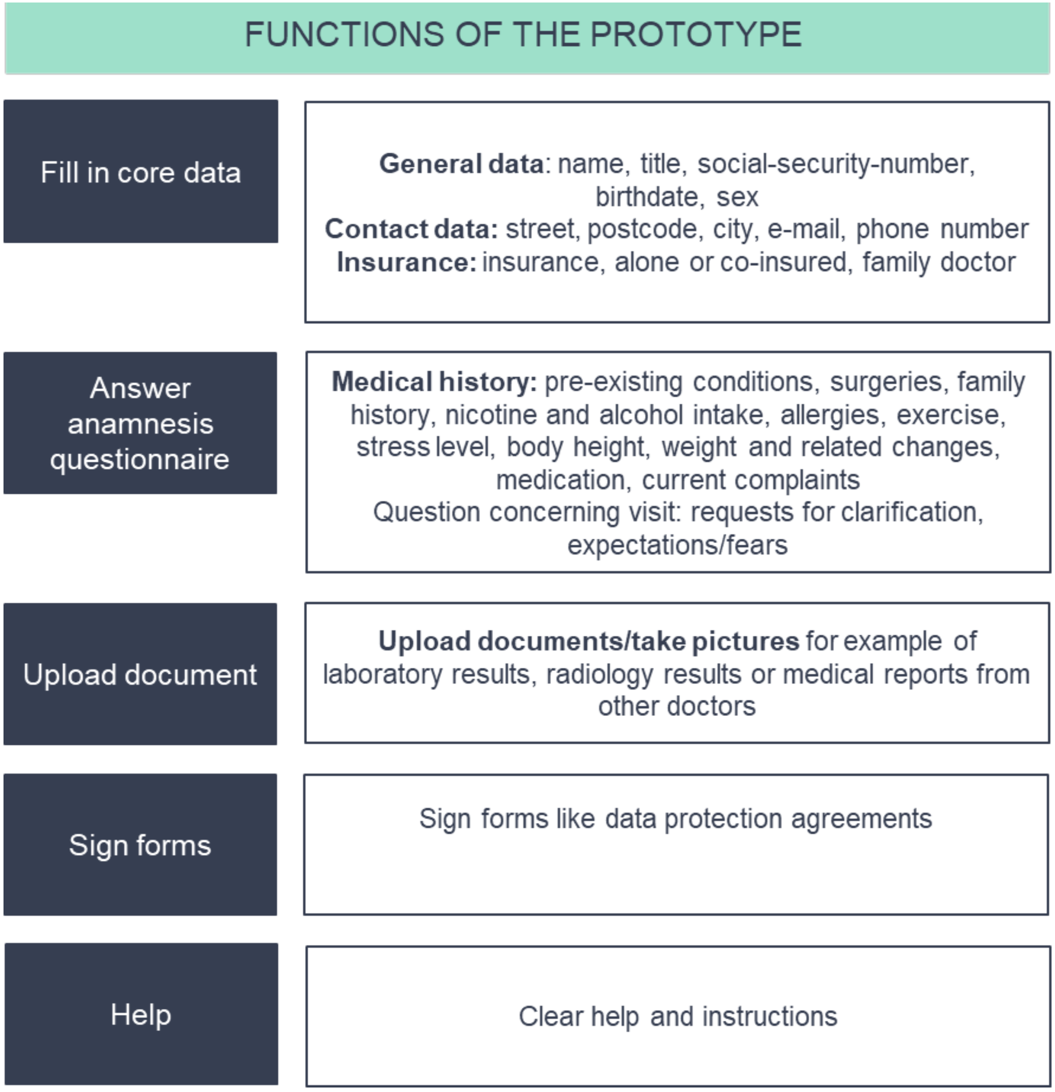


Figure 20 Overview of the functions of the prototype

The prototype starts with a welcome page and an overview of the following steps. It also mentions the importance of filling in the questionnaire conscientiously, as well as the secure data transfer. In addition, there is a help button for further information. On the second site, core data is to be entered, and there is also a help button for more information if needed. Following that is the site on which questions concerning medical history are asked. As few as possible free text fields were implemented. Instead, checkboxes and radio buttons are used. The questions also adapt based on the given answers. For example, if someone clicks “already have had surgeries”, an additional question opens saying “what operations have you already had?” Renggli et al. (2020) recommends special consideration for medication acquisition, so that the digital self-collection of data can be as accurate as when collecting data during conversation. To reduce possible errors or missing medication, the opportunity to take a photo of the medication list is provided. For the process of uploading a document like laboratory results, a short explanation video is offered to the user. The function to sign a form was not possible with Axure's offered functionalities, therefore, JavaScript code was used. The code is added in the appendix (A). Moreover, a detailed instruction is offered, in case people do not know how to sign on a tablet. At the end there is an overview of all completed steps and the theoretical possibility to check the given answers, as well as to ask a question to the doctor. With the button "jetzt abschließen" ("complete now"), the data is going to be send and a message is shown saying that the transfer of the data has been successful and the window can be closed.

In Figure 21 some screenshots of the prototype are shown. All four screenshots show the buttons for font enlargement/reduction in the upper right corner, then the navigation bar, followed by the headline and the help button, with which further information can be opened. The most important instructions are summarized in the grey box with the i-icon. Screenshot 1 illustrates most of the core data collection with various input fields, which the user fills out with the virtual keyboard of the tablet. The small star symbolizes mandatory fields and some fields are provided with additional information. Screenshot 2 shows the first anamnesis question with predefined answer options (checkboxes) and additional free text fields. The free text fields can be filled in with the virtual keyboard or by clicking on the microphone icon and use speech to text. Screenshot 3 illustrates the upload function. By clicking the "Befund hochladen" ("upload") button, the camera can be opened to take a picture of a document or an already taken photo can be uploaded. With the button continue the next page opens. Screenshot 4 shows the data protection agreement and below the field to sign. By clicking on "Unterschrift löschen" ("delete signature"), the written signature is deleted and can be signed again. If someone does not agree with the data protection agreement, the checkbox I do not agree can be selected.

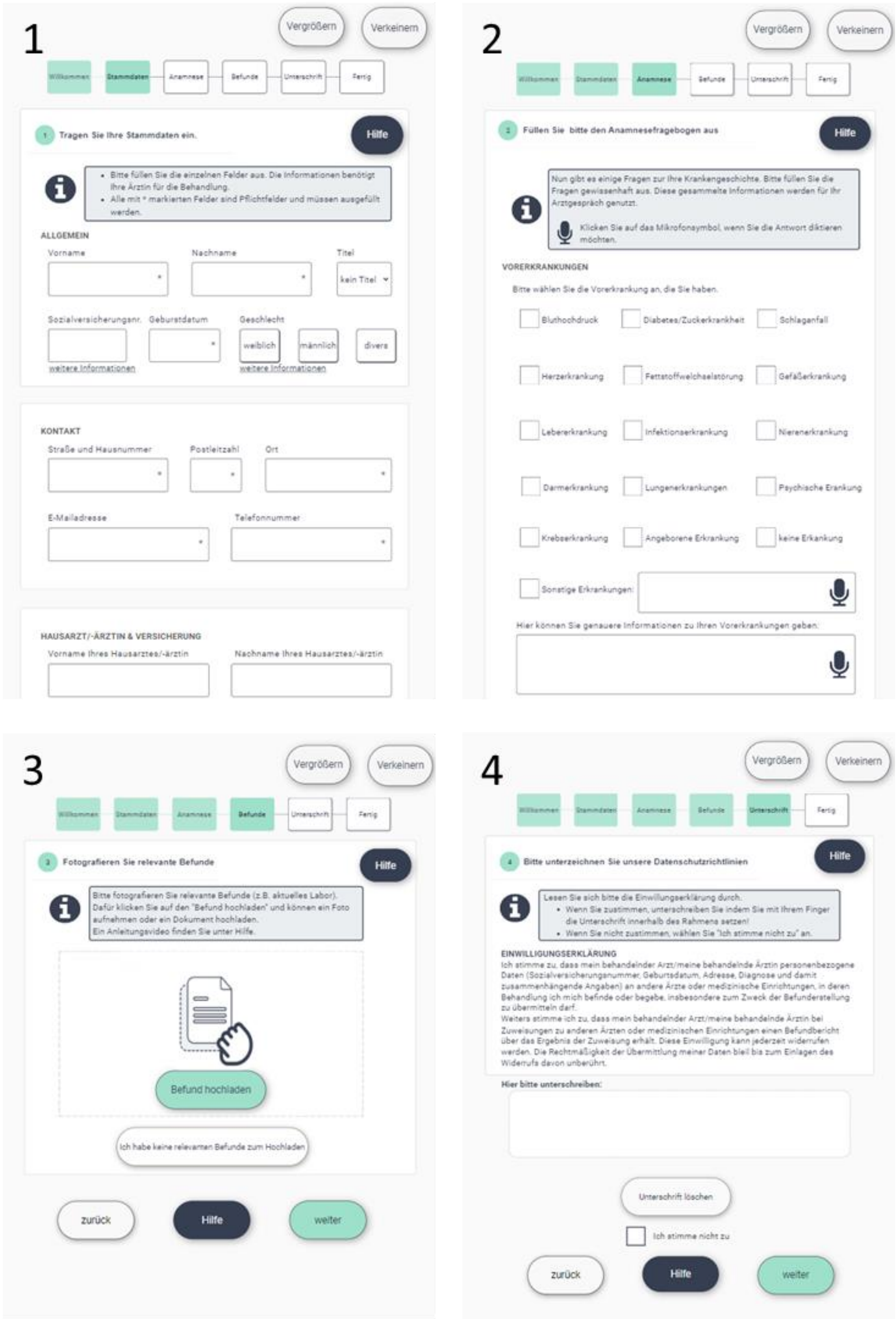


Figure 21 Screenshots of core data, anamnesis questions, upload and signing site of the prototype (own illustration)

4 Usability test design and evaluation

The best way to achieve a user-friendly design is to test it multiple times with the target group (Harte et al., 2014). To verify whether the development and implementation of the guidelines support the usability of the digital anamnesis questionnaire, a user test with five people has been conducted. In the next chapter, the usability test including participants, set up, methods and questionnaires will be described. An overview of the usability test is shown in Figure 22.

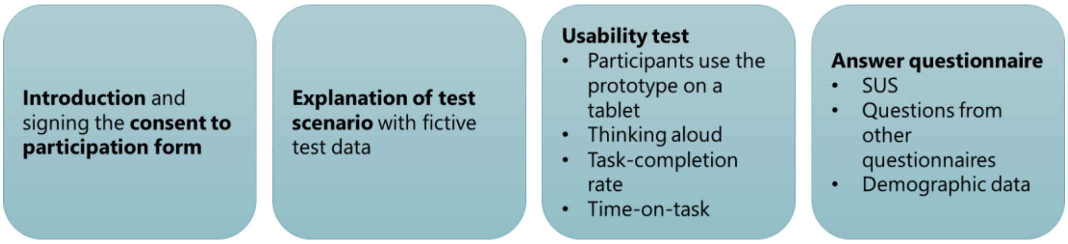


Figure 22 Overview of the usability test

The usability test took place in July of 2022 in Lower Austria. Before the test, the consent to participation document was discussed with each person, including description and purpose of the usability test and informed consent. By signing, participants agreed to participate voluntarily and to allow the use of the data in anonymized form for this master's thesis. In appendix B, a blank version of this document is attached.

4.1 Participants of the usability test

The following inclusion criteria were defined:

- People older than 60 years
- Native language German or at least B2 level and
- Internet access at home.

No real patient was included, meaning no patient actually waiting for a doctor's appointment. Every person occasionally is a patient and can be a possible future user of this prototype, but due to ethical reasons, no participant should enter their real data.

Based on these criteria, five participants were chosen for the usability test. Nielsen and Landauer (1993) state that five testers is the optimal sample for a usability test size considering cost/benefit ratio. In addition, most usability problems can be detected with 5 testers and more testers do not provide more appreciable insight (Nielsen & Landauer, 1993).

Five people joined the usability test, three female and two male participants. In the following chapters, the participants are abbreviated with p1-p5. Their age ranges from 62 to 85 years (M = 71.4, SD = 9.71). Three participants use the internet daily (p1, p3, and p4), one several times a week (p5) and one does not use the internet actively (p2). Four people have a smartphone (p1, p2, p4 and p5), three a computer (p1, p3 and p4), two a tablet (p1 and p4) and no one has a smartwatch.

4.2 Setup of the usability test of the prototype

After the informed consent was signed, the participants received an introduction to the usability test. The participants got a test scenario and were asked to imagine that they have been suffering from high blood pressure for eight weeks. Their family doctor recommends a visit to an internist. The appointment has already been scheduled with the internist Dr. Maier. Before the first appointment, the doctor requests relevant medical data and contact details to be sent to her, to upload relevant medical reports and to sign the data protection agreement via an encrypted, digital service. The prototype represents this service. Therefore, fictive test data, laboratory results and a medication list were prepared. This information was written in German and can be found in appendix C.

Participants had the possibility to asks questions for further clarification. Then the participants received the tablet with the opened prototype. All participants used the same Android tablet. They tested the prototype on their own and were encouraged to think aloud and share their thoughts. The test was comprised of four tasks (Table 4), which will be abbreviated as t1-4.

Table 4 Description of the tasks for the usability test

Tasks	Description of the tasks
Task 1 (t1): Fill in all mandatory core data	The following data fields are mandatory to be filled in: first name, last name, date of birth, street, house number, postal code, city, e-mail address, telephone number
Task 2 (t2): Answer all anamnesis questions	First, pre-existing diseases and diseases in the family are to be selected from predefined diseases (checkboxes). Surgeries, allergies, nicotine, alcohol and drug intake and level of exercise are to be answered with yes-no options. If yes is selected, more detailed explanation should be entered as free text. Height and weight are to be entered as numbers, weight change is selected from three options and stress frequency from five options. The current medication (name, dosage, time of taking) could be entered by text input or by taking a photo of the medication list. As free text, current complaints/reason for the doctor's visit and expectations or fears could be added.
Task 3 (t3): Upload a document	The latest laboratory result is to be uploaded by taking a photo.
Task 4 (t4): Sign the form	The data protection agreement is signed with a finger or a touch pen.

4.3 Task-completion rate

During the usability test, the success rate, also called task-completion rate, was collected. It is a common metric used in user experience tests and reports the number of people who successfully complete tasks (Budiu & Nielsen, 2021). The task-completion rate is an easy to collect statistic and shows if users are able to accomplish a task (Budiu & Nielsen, 2021). Different tasks are defined and typically, each task is rated as task success (coded as 1) and task failure (coded as 0) (Sauro & Lewis, 2016). It is also possible to rate partial task success (Sauro & Lewis, 2016).

When testing the prototype for usability, four stages of success, as suggested by Budiu and Nielsen (2021), were used. Each task performed by the participants was rated according to the following stages:

- Complete success (coded as 3)
- Success with minor issues (coded as 2)
- Success with major issues (coded as 1)
- Failure (coded as 0)

4.4 Time-to-task

Another easy and quantitative usability metric is time-to-task. It describes the time for each task which is needed by the users to finish it (Nielsen, 2001). All time-to-task measurements per person can be summed up to a total time-to-tasks measurement or be analysed for each task individually. When using a mean over all participants, it is recommended to use the geometric mean instead of the arithmetic mean. The reason is that the geometric mean is less affected by statistical outliers than the arithmetic mean and the geometric mean is recommend to be used to measure the average of percentage change (Nielsen, 2001). This is relevant, because time-to-task measurement is often used to compare different designs and to represent the difference in a number. The geometric mean is calculated as the n^{th} root of the product of *n* numbers (Weiß, 2018). Nielsen (2001) recommends to test with 20 users to get a tight confidence interval. This is not possible within this master thesis, but the time-to-task measure can reveal which tasks took longest and show differences between participants. In this thesis, every single time-to-task per person, the overall time and the geometric mean is reported.

4.5 SUS questionnaire

After testing the prototype, every participant answered the paper-pencil questionnaire. The questionnaire consists of the System Usability Scale (SUS) (Brooke, 1996) and some further questions.

The SUS questionnaire represents the overall usability of the tested system and is considered to be reliable and low-cost (Brooke, 1996). It is freely available and contains ten items. The participants can agree or disagree with every statement on a five-point Likert scale (Brooke, 1996).

In Table 5, the ten items of the SUS questionnaire are listed. When calculating the SUS score, first the answers get transformed into point equivalents, which range from zero to four (Brooke, 1996). For this, every odd item is counted minus one and every even item is subtracted from five. Then the sum of the points is calculated and multiplied by 2.5 to obtain the SUS score (Brooke, 1996). The SUS score ranges from 0 to 100. Scores below 50 can be interpreted as not acceptable, from 50 to 69 as marginal and 70 and above as acceptable (Bangor et al., 2008). Additional increments can be added: a score above 73 is considered as good and above 85 as excellent (Bangor et al., 2008).

4.6 Further usability questionnaire

To evaluate further areas with the usability test, like attractiveness, comprehensibility of the used terms and help instructions, ease of data entry, and use of the speech to text function, additional questions from various usability questionnaires were used and adapted. Questions of the User Experience Questionnaire (UEQ) (Laugwitz et al., 2005) as well as Questionnaire for User Interface Satisfaction (QUIS) (Chin et al., 1988) were the basis. All questions were to be answered with a five-point Likert scale between two contrary attributes.

The UEQ covers six aspects of User Experience: attractiveness, perspicuity, efficiency, dependability, stimulation and novelty, and is considered as a fast and reliable questionnaire (Schrepp, 2019). In order to answer the questionnaire, the tendency between two contrasting characteristics of 26 items is to be indicated (Schrepp, 2019). For this master thesis, just one question was used to evaluate the attraction of the prototype:

- The prototype is: unattractive – attractive.

With the QUIS, the user’s subjective satisfaction with an interface can be assessed. The QUIS consists of 21 items which cover the areas: overall reaction to the system, screen, terminology and system information, learning and system capabilities (Chin et al., 1988). Three items of the QUIS were the basis for the following questions used in the questionnaire of the usability test:

- The arrangement of information is: confusing – clear
- The used terms are understandable: never - always
- Explanation and help messages are: confusing – clear

In addition, to assess the experience of data entering, which is a large part of the prototype, and of the dictation function, two further questions were developed:

- Entering the data for me was: difficult – easy
- I would use the dictation function/language to text conversion again: certainly not – definitely

Additionally, free text questions were asked:

- What do you like about the prototype?
- What could be improved?

Moreover, general questions about age, sex and technological experience were asked. The questionnaire is attached in the appendix D.

In the next chapter, the results of the prototype are summarized.

5 Results

MS Excel (Microsoft 365) was used to analyse and present the data. First, the evaluation of the questionnaire is presented, followed by the results of the time-on-task and task-completion rate. Moreover, the observation and reflection of the tasks is described.

5.1 Evaluation of the questionnaire

As mentioned in section 4.5, the answers of the SUS questionnaire were scored and summed up to get the SUS score. Every participant answered all ten items of the SUS questionnaire. In Table 5, the SUS evaluation is summarized. In the first column, the statements which were rated by the participants are listed. The answers are presented in columns 2 to 6 and range from 1 to 5. The lower the value, the more the participant disagreed with the statement, the higher the value, the more the participant agreed with it. In the last column, the arithmetic means of the participants' answers per item is presented. The SUS score is shown in the last row and ranges from 70.0 to 87.5. According to the scores' interpretation of Bangor et al. (2008), all participants ranked the usability of the prototype as acceptable and p1 and p4 even as excellent. The average SUS score of 79.0 can be interpreted as good.

Table 5 SUS answers per participant and item, mean per item and SUS score per participants and mean

Participant ID	p1	p2	p3	p4	p5	MEAN
I think that I would like to use this system frequently.	3	5	5	3	5	4.2
I found the system unnecessarily complex.	1	1	1	2	2	1.4
I thought the system was easy to use.	4	5	4	5	4	4.4
I think that I would need the support of a technical person to be able to use this system.	1	5	4	1	3	2.8
I found the various functions in this system were well integrated.	5	5	5	5	4	4.8
I thought there was too much inconsistency in this system.	1	1	1	2	1	1.2
I would imagine that most people would learn to use this system very quickly.	3	5	4	5	4	4.2
I found the system very cumbersome to use.	1	1	2	1	2	1.4
I felt very confident using the system.	5	5	2	4	3	3.8
I needed to learn a lot of things before I could get going with this system.	1	5	4	1	4	3.0
SUS SCORE	87.5	80.0	70.0	87.5	70.0	79.0

In Figure 23, the average of the answers to the further questions are illustrated. The participants answered all questions on the five-point Likert scale (1 to 5). A lower value symbolizes a higher agreement of the first adjective in the bracket, while a higher value corresponds to a higher agreement of the second adjective. Overall, the arrangement of information as well as explanation and help instruction were rated as rather clear. The used terms were clear for all participants, everyone rated this question with 5. Three participants classified the prototype as attractive and two as rather attractive. P3 scored entering data neither as easy nor as difficult, p4 and p5 as rather easy and p1 and p2 as easy. Four participants would definitely, and one probably use the dictation function again.

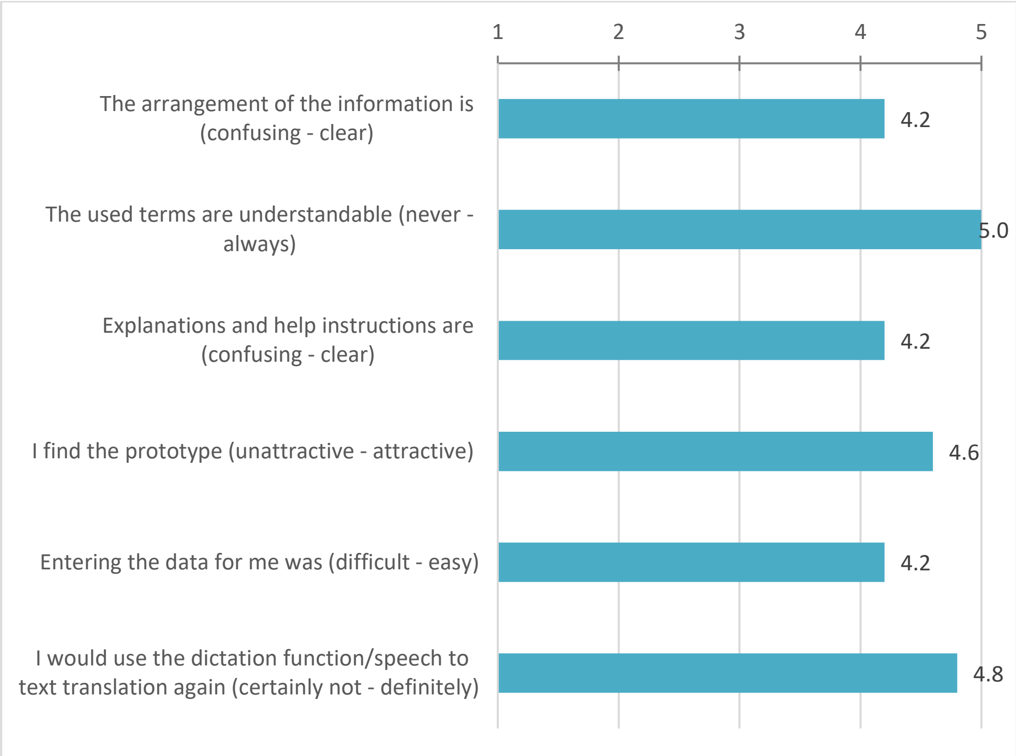


Figure 23 Average grade of the further questions

Overall, the participants gave positive feedback on the prototype. Within the questionnaire, participants could also write down what they liked about the prototype and what could be improved. The answers to the open questions are illustrated in Table 6 and have been translated from German into English by the author to the best of her ability.

Table 6 Participant's open statements about what they liked and what could be improved

Question	Participant's answer
What do you like about the prototype?	+ Simple structure (p1) + Many suggestions and selection options e.g. for diseases (p1) + Possibility of enlarging the text (p1) + Photographing the laboratory report or medication list (p1, p4) + Time saving for the doctor (p2) + Dictation function (p3, p4) + Automatic switching and correction of upper- and lower-case letters (p3) + Automatic takeover of the city from the postal code (p4)
What could be improved?	- When uploading a photo, directly provide a more detailed explanation including the individual steps (p1) - Make dictation function and font size change more conspicuous (p3) - Alphabetical order of diseases (p4) - Cursor not visible enough (p4)

5.2 Evaluation of time-to-task and task-completion

During the usability tests, the time-to-task was measured. In Figure 24, the time per task and participant is illustrated and in Table 7 the exact time per task and participant as well the overall time and the geometric mean is listed. The overall needed time ranged from about 19 minutes to 71 minutes and on average it took 37 minutes. This includes the time taken for filling out everything from the first site of the prototype, the following steps until the last site including the information that the data has been transferred safely. Participants with more technological experience were much faster than technological novices. All participants took the longest for t2 (answer all anamnesis questions), which is not surprising since this is the most comprehensive task. P2 and p5 needed much more time for t1 and t3 than the other participants. Both had less technological experience and needed more time to get used to the possibilities to enter data digitally. In addition, they had never uploaded a photo before, whereas the other participants had used such a function already for the medication list, so they needed time to read the instructions and try it out.

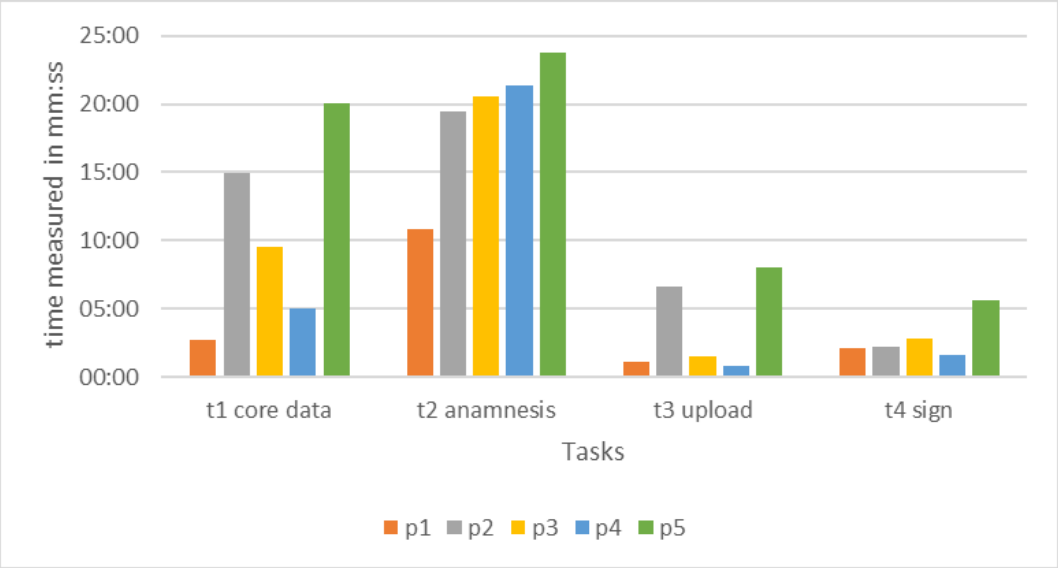


Figure 24 Time-to-task per task and participant

Table 7 Time-to-task per task and overall time per participant measured in mm:ss

	t1 core data	t2 anamnesis	t3 upload	t4 sign	overall
p1	02:45	10:50	01:05	02:05	19:17
p2	14:54	19:25	06:38	02:15	46:25
p3	09:31	20:33	01:29	02:47	36:41
p4	05:00	21:21	00:47	01:38	32:30
p5	20:05	23:45	08:04	05:37	01:11:14
geometric mean	08:17	18:33	02:19	02:36	37:41

In Table 8, an overview of the task completion is shown. 3 means complete success, 2 success with minor issues, 1 success with major issues and 0 failure. All participants could successfully finish all tasks. P1 and p4 could complete all tasks without issues, whereas p2, p3 and p5 showed some issues. The faced issues and possible improvements are described in subchapter 705.3.

Table 8 Task-completion rate

Participant ID	t1 core data	t2 anamnesis	t3 upload	t4 sign
p1	3	3	3	3
p2	2	2	2	2
p3	2	2	2	3
p4	3	3	3	3
p5	2	1	1	1

5.3 Observation and reflection of tasks

All participants were interested and motivated to explore the prototype. Overall, the usability test confirmed the variability of older people. The two youngest and most experienced people concerning technology were confident and could complete all tasks with no problems (p1 and p4). The other three do not use a tablet regularly and in general have less technology experience. P2 even used a tablet for the first time during the usability test. At the beginning, p2 and p5 mentioned that they do not know how to use such a device and are not sure if they can do it on their own. P2, p3 and p5 needed more time, showed more trial and error than p1 and p4 and sometimes asked questions. In the next part, the observation of the usability test, problems and possible improvements including the results of time-on-task and task-completion rate are described based on the four tasks.

T1: Fill in all mandatory core data

All participants could fill in the mandatory core data. P1 and p4 were confident and could enter all core data without any problems, whereas p2, p3 and p5 were not that confident and sometimes needed more time or asked questions. For example, one question at the beginning was: “How can I write something in the field, do I need a pen to be able to write?”. The test leader encouraged people to try it and attempted to not answer the question directly. In this case, the person clicked on the box and when the keyboard opened, they knew that they could type words by clicking on the keyboard. P3 did not scroll at the beginning, because they thought it was already the end of the site. Therefore, an always visible scrolling bar with a downward and upward pointing arrow is recommended. The academic title field defaults to "no title" as this is the most common response. During the usability test, this turned out to be disadvantageous, because test people mistakenly believed that no title was to be filled in here. P5 wrote the whole address in the text field for street and house number. Especially for p2 it was difficult at the beginning to navigate back to a field and correct something. To set the cursor at the right position was not easy and was not always successful. Sometimes the cursor was still in the last field and p2 already entered the next text, although the line of the current field was green and the other dark blue/black. Thus, a clearer distinction between active and other fields could be supportive. Some participants were confused about the blue dot of the cursor, shown in Figure 25. This is the standard cursor of android devices.

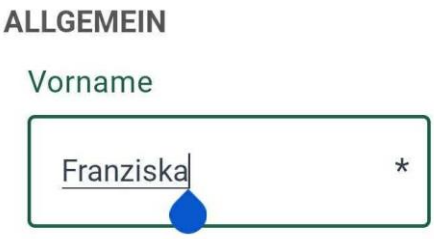


Figure 25 Cursor with blue point

Helpful for some participants were the automatic word suggestions of the keyboard and the autocorrection. For example, p2 and p3 had difficulties to find special German letters like ä, ü, ö, ß, but the autocorrection automatically corrected Mueller to Müller. Especially p1 and p4 sometimes used the automatic word suggestions so they did not need to enter every letter.

It was positively noted that, based on the postal code, the city was taken over automatically. The same is true for the date of birth based on the social security number. The duration of entering all data varied from 2:45 to 20:05 minutes.

T2: Answer all anamnesis questions

All anamnesis questions were answered by all participants. Three participants expressed a desire for alphabetical order of the disease’s options. One participant wished for options for entering the amount of alcohol. Three participants took a photo of the medication list, the other two entered the medication manually. Here, p5 wrote some information in the wrong column. 0.125 mg was entered next to Flixotide Dosaer in the name field, even though there is an extra dosage field. P2 asked how she could unselect a checkbox. After encouragement from the test instructor to try it, she found out for herself that she simply had to click the checkbox again. A problem for p5 was that she sometimes clicked too long to select a checkbox or radio button, so that further setting options of the tablet opened. For further development, a hint to click more briefly could be added.

P4 used the microphone function frequently and although he spoke in dialect the speech to text conversion worked relatively well. In case it was not completely correct, he corrected the errors manually. The other participants only tried it after the hint of the test leader. All participants liked it and seemed to be well able to handle the function and to be quicker than using the keyboard. All participants said they would use it again. P3, for example, said he would have used it more often if he had known earlier about this function and wished for a more conspicuous way of presenting the microphone function.

The participants needed between 10:50 to 23:45 minutes for this task. The slowest participant needed only about twice as long for this task compared to the fastest. This is a relatively small difference compared to the other tasks, for example, for T1, the time-difference between the fastest and slowest participants was more than septuple. T2 required the most information input, but there were fewer temporal differences between people with different technology experience compared to the other tasks.

T3: Upload a document

For uploading the document, four people used the help button to get more information. Nevertheless, it was still difficult for some of them to remember the steps until they needed the information. To improve the prototype, the information and the task of uploading documents should be displayed simultaneously, so that the information does not need to be remembered for long and can be applied immediately. The three participants who had already taken a photo of the medication list before only needed between 0:47 and 1:29 minutes to upload the laboratory results. The other two needed 6:38 and 8:04 minutes. For them, it was a little bit difficult to hold the tablet with one hand and click on the button to take a picture. Although a small picture of the uploaded document was shown, two participants asked if the upload process was successful. For further development, a written information like “document is successfully uploaded” could be added. P3 also mentioned that if multiple documents are to be uploaded, after the 1st uploaded document the button to upload should be called "upload more documents".

T4: Sign the form

Age-related restrictions became apparent in this task. The reduced dexterity (e.g. for p2 due to arthrosis) made it difficult to sign with a finger. Signing with a finger requires a great deal of precision. The participants were not always satisfied with the signature and 3 people wanted to use a pen on their own initiative to sign. With a functioning touch pen, all participants could sign in an acceptable way. Some participants tried it several times, and an improvement of the signature could be noticed. Also, a larger and especially higher field for signing could enhance the usability and should be considered for further development. Currently, the field is about 8 cm wide and 1,5 cm high. The participants needed between 1:38 and 5:37 minutes for this task.

In addition to the four tasks, the usability test provided other feedback areas. The button for changing the font size in the upper right corner was not noticed by all participants. Only one person tried the font enlargement. P3 preferred the name “Größere Schrift“/ „Kleinere Schrift” (“Larger font” / "Smaller font") instead of “Vergrößern”/ ”Verkleinern" („Enlarge" / "Reduce"). For further development, the button could be made more prominent. The navigation bar seemed to be clear for all participants, no questions were asked about it and P2 even used it to navigate. On the first site with the list of the following steps, two participants wanted to start the core data entry with a click on that step instead of clicking the button “Get started right away”. On the last site, two participants wanted an additional button to close the window instead of closing the browser window with the standard closing “x” button provided by the tablet’s browser.

6 Discussion and Conclusion

The aim of this thesis was to develop and evaluate a simple prototype to collect medical data before a doctor’s appointment. In this chapter, the results are discussed as well as limitations and future work are presented.

The usability test showed that people who use a tablet for the first time for the specific functions tested in the usability test have questions about the most basic things, like how to write in a text field or how to scroll or to unselect a checkbox. Nevertheless, with time all participants could complete the tasks successfully and showed a significant performance improvement over time. P3 even asked if he could try the prototype again to see if he could do it faster and more efficiently. For the two participants with more technology experience the prototype was easy to use and they rated an excellent usability (SUS = 87.5) according to Bangor et al. (2008).

The master thesis showed the importance of a usability test, just as many studies before reported e.g. González-Palau et al. (2013), Niranjanamurthy et al. (2014) and Zapata et al. (2015). Guidelines are a good basis for designing a prototype to best knowledge, but not everything can be considered. Therefore, it needs to be tested with the potential users. With a usability test, problems and improvement opportunities which should be considered in the further development can be found and thereby the usability can be improved significantly. In the previous chapter, many improvement possibilities are listed. The following three were rated as the most important findings of the prototype usability test:

- Help and instructions need to be closer to the interaction and more simultaneous, especially for the uploading task, so that the information does not have to be remembered for a long time.
- An always visible scrolling bar should be added, so that it is clear that there is more information on that side.
- The signing field should be enlarged, especially the height. It should be larger than 1.5 cm.

Except for the signature field, there were hardly any difficulties that could be attributed to age-related physical limitations. Even p2 with arthrosis and reduced dexterity could use the prototype satisfactorily. Some difficulties resulted from a lack of knowledge due to less technology use.

For further development, an idea is to include more voice control because this worked well and seems to be easy to use for people with no technology experience (Smith & Chaparro, 2015). This would need to be tested with a usability test again and it needs to be considered that this use case is only applicable at home. In the doctor's office it is not usable because multiple people are sitting in a waiting room and with voice control data protection could not be guaranteed. In the future, the technology experience of older people will increase, thus the initial difficulties due to lack of knowledge on how to use a tablet and enter forms digitally could be significantly reduced.

According to the user-centred design process, the prototype should be adapted based on the usability test feedback and be tested again. One limitation of the conducted test is that the sample was homogeneous, because all people live in one small city in lower Austria. The prototype was only tested with fictive data and the participants answered the questions based on the given test-scenario. The time-to-task values may be slightly affected by the additional task of thinking aloud, because some test participants expressed more thoughts and thus needed longer time. As a further limitation it can be mentioned that the author of the thesis is also the examiner of the usability test and works for a doctor's software provider.

Optimally, in the future the information gained should be made available to other doctors and the information should be possible to be reused and adopted by the patients before another doctor's visit. P4 even expressed the wish that if he would have to enter the data for another doctor again, he would like the core data, like name, address, telephone number, to be automatically transferred. The possibility of storing such a comprehensive medical anamnesis for example in ELGA and making it available to relevant doctors via the e-card could also be considered.

To conclude, within this master thesis a prototype could be developed which can be used by the elderly and less technology experienced people. The work was oriented towards the user-centred design. First, a detailed literature research and marked analysis took place. Results of other studies testing a structured digital self-assessment of patient anamnesis demonstrated the importance to focus on barriers and needs of older people (Hess et al., 2008; Kopp et al., 2021; Melms et al., 2021; Wong et al., 2017). In a next step, the first research question was answered. Functional requirements and non-functional requirements, which were grouped to accessibility; certifiability; portability; privacy, safety and security; stability; trustability, usability and additional requirements, have been defined and a list of 41 design recommendations for mobile devices used by the elderly were generated. Based on these requirement and design guidelines the prototype was developed.

The five participants of the usability test rated the usability of the prototype from acceptable to excellent according to the SUS Score. For people with very little or no technology experience, at the beginning it was a bit challenging to get to know the basic functions, but it showed that most functions are intuitive and can be learned within using the prototype. People with technology experience could use the prototype without any problems. Because all participants could complete all tasks of the usability test and according the SUS Score the average usability was rated as good, the second research question can be answered as followed: the first-level prototype of a self-assessment of patient anamnesis is usable for older people. The usability test showed some improvement possibilities which should be implemented in a next step and tested with other users again.

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Appendix

A. JavaScript code for signing

Adapted from https://codepen.io/yguo/pen/OyYGxQ (Access on 2022-05-01)

```
<!-- Content -->
<div class="container">
    <div class="row">
        <div class="col-md-12">
            <br>
        </div>
        <center>
            <div class="row">
                <div class="col-md-12">
<canvas id="sig-canvas" width="620" height="120">
                    </canvas>
                </div>
            </div>
            <div class="row">
                <div class="col-md-12">
                    <button  class="btn  btn-default"  id="sig-
clearBtn">Unterschrift löschen</button>
                </div>
            </div>
        </center>
        <br />
    </div>
    <br />
    <div class="row">

        <div class="col-md-12">

        </div>
    </div>
</div>
```

```
<script>
    (function () {
        window.requestAnimFrame = (function (callback) {
            return window.requestAnimationFrame ||
                window.webkitRequestAnimationFrame ||
                window.mozRequestAnimationFrame ||
                window.oRequestAnimationFrame ||
                window.msRequestAnimaitonFrame ||
                function (callback) {
                    window.setTimeout(callback, 1000 / 60);
                };
        })();

        var canvas = document.getElementById("sig-canvas");
        var ctx = canvas.getContext("2d");
        ctx.strokeStyle = "#222222";
        ctx.lineWidth = 4;

        var drawing = false;
        var mousePos = {
            x: 0,
            y: 0
        };
        var lastPos = mousePos;

        canvas.addEventListener("mousedown", function (e) {
            drawing = true;
            lastPos = getMousePos(canvas, e);
        }, false);

        canvas.addEventListener("mouseup", function (e) {
            drawing = false;
        }, false);

        canvas.addEventListener("mousemove", function (e) {
            mousePos = getMousePos(canvas, e);
        }, false);

        // Add touch event support for mobile
```

```
canvas.addEventListener("touchstart", function (e) {

}, false);

canvas.addEventListener("touchmove", function (e) {
    var touch = e.touches[0];
    var me = new MouseEvent("mousemove", {
        clientX: touch.clientX,
        clientY: touch.clientY
    });
    canvas.dispatchEvent(me);
}, false);

canvas.addEventListener("touchstart", function (e) {
    mousePos = getTouchPos(canvas, e);
    var touch = e.touches[0];
    var me = new MouseEvent("mousedown", {
        clientX: touch.clientX,
        clientY: touch.clientY
    });
    canvas.dispatchEvent(me);
}, false);

canvas.addEventListener("touchend", function (e) {
    var me = new MouseEvent("mouseup", {});
    canvas.dispatchEvent(me);
}, false);

function getMousePos(canvasDom, mouseEvent) {
    var rect = canvasDom.getBoundingClientRect();
    return {
        x: mouseEvent.clientX - rect.left,
        y: mouseEvent.clientY - rect.top
    }
}

function getTouchPos(canvasDom, touchEvent) {
    var rect = canvasDom.getBoundingClientRect();
    return {
        x: touchEvent.touches[0].clientX - rect.left,
```

```
                y: touchEvent.touches[0].clientY - rect.top
            }
        }

        function renderCanvas() {
            if (drawing) {
                ctx.moveTo(lastPos.x, lastPos.y);
                ctx.lineTo(mousePos.x, mousePos.y);
                ctx.stroke();
                lastPos = mousePos;
            }
        }

        // Prevent scrolling when touching the canvas
        document.body.addEventListener("touchstart",    function
(e) {
            if (e.target == canvas) {
                e.preventDefault();
            }
        }, false);
        document.body.addEventListener("touchend", function (e) {
            if (e.target == canvas) {
                e.preventDefault();
            }
        }, false);
        document.body.addEventListener("touchmove", function (e)
{
            if (e.target == canvas) {
                e.preventDefault();
            }
        }, false);

        (function drawLoop() {
            requestAnimFrame(drawLoop);
            renderCanvas();
        })();

        function clearCanvas() {
            canvas.width = canvas.width;
        }
```

```
        // Set up the UI
        var sigText = document.getElementById("sig-dataUrl");
        var sigImage = document.getElementById("sig-image");
        var clearBtn = document.getElementById("sig-clearBtn");
        var submitBtn = document.getElementById("sig-submitBtn");
        clearBtn.addEventListener("click", function (e) {
            clearCanvas();
            sigText.innerHTML = "Data URL for your signature will
go here!";
            sigImage.setAttribute("src", "");
        }, false);
        submitBtn.addEventListener("click", function (e) {
            var dataUrl = canvas.toDataURL();
            sigText.innerHTML = dataUrl;
            sigImage.setAttribute("src", dataUrl);
        }, false);

    })();

</script>

<style>
    #sig-canvas {
        border: 2px dotted #CCCCCC;
        border-radius: 15px;
        cursor: crosshair;
        z-index: 10;
        background-color: #FFFFFF
    }

    #sig-clearBtn {
        border-width: 0px;
        position: absolute;
        left: 293px;
        top: 840px;
        width: 200px;
        height: 70px;
        background-color: rgba(255, 255, 255, 1);
        background: inherit;
```

```
        box-sizing: border-box;
        border-width: 1px;
        border-style: solid;
        border-color: rgba(121, 121, 121, 1);
        border-radius: 50px;
        -moz-box-shadow:   1px   3px   10px   rgba(0,   0,   0,
0.34901960784313724);
        -webkit-box-shadow: 1px 3px 10px rgb(0 0 0 / 35%);
        box-shadow: 1px 3px 10px rgb(0 0 0 / 35%);
        font-family: "Roboto", sans-serif;
        font-weight: 400;
        font-style: normal;
        font-size: 15px;
        color: rgba(54, 62, 81, 1);
    }

    #sig-clearBtn:hover {
        border-width: 2px;
        font-weight: bold;
    }
</style>
```

B. Consent to participation

Einwilligungserklärung zur Teilnahme an einem Usability Test für ein digitales Selbsterfassungstool für die Patientenanamnese

Sehr geehrte Teilnehmerinnen und Teilnehmer!

Vielen herzlichen Dank für die Teilnahme am Usability Test eines Prototyps (= Muster einer Anwendung für Testzwecke) zur Selbsterfassung von ersten relevanten medizinischen Daten vor einem Arztbesuch.

- Bitte lesen Sie sich dieses Dokument sorgfältig durch.
- Wenn für Sie etwas unklar ist oder Sie etwas wissen möchten, fragen Sie bitte nach.

1. Beschreibung

Im Rahmen dieses Tests erhalten Sie zuerst eine kurze Erklärung und anschließend eine Anleitung für die Durchführung der Aufgaben. Zuerst werden Sie den Prototypen auszuprobieren und verschiedene Aufgaben erledigen unter anderem einige Daten eingeben. Es handelt sich dabei um Kontakt- und Gesundheitsdaten. Dafür können vorbereitete Testdaten verwendet werden.

Anschließend erhalten Sie einen kurzen Fragebogen zu Ihrer Erfahrung mit dem Prototyp. Die Beantwortung wird ca. 15 Minuten in Anspruch nehmen.

Der Ort der Testung wird individuell vereinbart.

2. Zweck

Im Rahmen dieser Masterarbeit wird ein Prototyp um erste relevante Informationen bezüglich der Krankengeschichte (Anamnese) dem Arzt/der Ärztin bereits vor der Erstuntersuchung übermittelten zu können. Studien zeigen, dass eine strukturierte Anamnese einen wichtigen Beitrag bei der Diagnosestellung und Therapieplanung spielt. Beim Entwickeln des Prototyps wurden besonders Aspekte berücksichtigt, die die Bedienbarkeit für Personen mit weniger Technikerfahrung bzw. altersbedingten Einschränkungen erleichtern sollen. Mit Hilfe des Usability Test wird die NutzInnenfreundlichkeit und Nutzbarkeit des entwickelten Prototyps untersucht.

3. Einverständniserklärung

Die Teilnahme an diesem Usability Test ist völlig freiwillig und kann jederzeit ohne Angabe von Gründen abgebrochen werden.

- ☐ Ich erkläre mich damit einverstanden, dass meine personenbezogenen Daten in anonymisierter Form für die Auswertung des Usability Tests im Rahmen der Masterarbeit verwendet werden. Die im Rahmen der Masterarbeit veröffentlichen Testergebnisse erlauben keinen Rückschluss auf die teilgenommenen Personen.

- ☐ Ich erkläre mich damit einverstanden, dass Videoaufnahmen und Audioaufnahmen von mir während der Testung des Prototyps gemacht werden. Diese Aufnahmen werden nur von beteiligten Personen der Masterarbeit zur Analyse im Rahmen der Auswertung der Tests eingesehen und sind keinen fremden Personen zugänglich. Nach Abschluss der Arbeit werden die Aufnahmen gelöscht.

- ☐ Ich erkläre mich damit einverstanden, dass Fotos gegebenenfalls für Präsentationszwecke genutzt werden dürfen.

Durch meine folgende Unterschrift bestätige ich, dass ich die Einverständniserklärung gelesen habe, alle Fragen dies bezüglich beantwortet wurden und ich mit den oben angeführten Punkten einverstanden bin.

Außerdem bestätige ich, dass ich eine schriftliche Kopie der Einwilligungserklärung erhalten habe und erkläre hiermit meine freiwillige Teilnahme an diesem Masterarbeitsprojekt.

____

Name der Testperson

____________________ ____________________

Unterschrift der Testperson | Ort und Datum

C. Instruction of the usability test

Anleitung Usablity Test

Zuerst vielen Dank für Ihre Teilnahme! Bitte führen Sie die folgende Aufgabe durch und teilen Sie mir Ihre Gedanken mit (zum Beispiel was erwarten Sie, warum Sie etwas tun, was Ihrer Meinung nach als nächstes geschehen wird, was verwirrend erscheint, was hätten Sie gerne in einer andern Art, was würde Ihnen helfen,..)! Bitte erzählen Sie mir so viel wie möglich.

Szenario: Stellen Sie sich bitte vor, Ihr Blutdruck ist in der letzten Zeit erhöht und Ihr Hausarzt hat Ihnen deshalb einen Termin beim Internisten empfohlen. Sie haben soeben bei einer Internistin (Dr. Mayer) einen Ersttermin ausgemacht. Für den Ersttermin bittet die Internistin bereits vorab relevante Daten inklusive Kontaktdaten und Informationen zur Krankengeschichte über ein digitales verschlüsseltes Service auszufüllen und zu übermitteln. Das Service ist am Tablet für den Usability Test bereits aufgerufen und Sie starten jetzt.

1. Bitte gehen Sie nun die Seiten durch und füllen die Informationen aus.
2. Anbei liegt ein aktueller Laborbefund, diesen möchten Sie auch gleich vorabübermitteln.
3. Nach dem Ausprobieren des Prototypens gibt es einen kurzen Fragenbogen zur Nutzungsfreundlichkeit.

▪

Testdaten: Nutzen Sie für die Eingabe der Daten bitte die anschließend aufgelisteten Testdaten:

Stammdaten

- Herr/Frau Mag. Franz/Franziska Huber
- Sozialversicherungsnummer: 7248010550
- Geburtsdatum: 01. Mai 1950
- Straße: Praterstraße 1, 1020 Wien
- E-Mail: f.huber@gmx.at
- Mobil: 0676/5457861
- Hausarzt: Dr. Max Müller
- Versicherung: ÖGK-Wien, alleine versichert

Anamnese

- Vorerkrankungen:
    - Bluthochdruck seit 2 Monaten,
    - Lungenerkrankung Asthma seit frühem Erwachsenen Alter bekannt, bereitet bei längerer Anstrengung Beschwerden
- Operation: Meniskus Operation 2008
- Allergien: keine bekannt
- Familienanamnese: Vater an Schlaganfall gestorben, Mutter Diabetes Typ 2 (Altersdiabetes)
- Rauchen: aktuell nicht, vor 20 Jahren gelegentlich 1 Packung im Monat
- Alkohol: ca2x pro Woche 1-2 Gläser
- Drogen keine anderen
- Bewegung: 2x wöchentlich 1h walken
- Körpergröße: 175 cm
- Körpergewicht: 75kg seit Jahren stabil
- Manchmal Stress
- Medikamente:
    - Oleovit – 3 Tropfen – täglich morgens
    - Flixotide Dosaer 0,125 mg - 1x in der Früh und 1x am Abend Sprühstoß
- Vorstellungsgrund: erhöhter Blutdruck meistens über 140/90
- Erwartungen/Befürchtungen:
    - Erwartung: Tipps wie Blutdruck auch ohne Medikamente gesenkt werden kann
    - Befürchtung Herzerkrankung
- Frage an die Ärztin: Gibt es für den Termin etwas Bestimmtes zu beachten (z.B. nüchtern kommen, COVID Maßnahmen)?

D. Questionnaire

Fragebogen zur Nutzungsfreundlichkeit

Bitte füllen Sie diesen Fragebogen, nach dem Testen des Prototyps aus.

Es gibt 5 verschiedene Antwortmöglichkeiten:

1 – Ich stimme gar nicht zu.

2 – Ich stimme eher nicht zu.

3 – Ich stimme mittelmäßig zu.

4 – Ich stimme eher zu.

5 – Ich stimme voll zu.

Entscheiden Sie bitte bei jeder Frage, welche Antwort am besten passt und kreuzen Sie die Nummer an.

1. Ich denke, ich würde das Service regelmäßig nutzen.

Stimme gar nicht zu	1	2	3	4	5	Stimme voll zu

2. Das Service erscheint mir unnötig kompliziert.

Stimme gar nicht zu	1	2	3	4	5	Stimme voll zu

3. Ich finde, das Service einfach zu benutzen.

Stimme gar nicht zu	1	2	3	4	5	Stimme voll zu

4. Ich denke, dass ich technische Unterstützung brauche, um das Service nutzen zu können.

Stimme gar nicht zu	1	2	3	4	5	Stimme voll zu

5. Ich finde, dass die verschiedenen Funktionen des Services gut integriert sind.

Stimme gar nicht zu	1	2	3	4	5	Stimme voll zu

6. Das Service erscheint mir zu uneinheitlich.

Stimme gar nicht zu	1	2	3	4	5	Stimme voll zu

7. Ich glaube, dass die meisten Leute die Benutzung des Services schnell erlernen können.

Stimme gar nicht zu	1	2	3	4	5	Stimme voll zu

8. Das Service erscheint mir sehr umständlich zu benutzen.

Stimme gar nicht zu	1	2	3	4	5	Stimme voll zu

9. Ich fühle mich bei der Benutzung des Services sehr sicher.

Stimme gar nicht zu	1	2	3	4	5	Stimme voll zu

10. Ich musste einiges lernen, um mit dem Service zurecht zu kommen.

Stimme gar nicht zu	1	2	3	4	5	Stimme voll zu

Weitere Fragen zur Nutzung des Prototyps:

Im folgenden Teil geht es um die Bewertung des Prototyps anhand von Aussagen und Beantwortungen mit Gegensatzpaaren von Eigenschaften. Die Abstufungen der Eigenschaften sind als Kreise dargestellt. Bitte kreuzen Sie den entsprechenden Kreis an.

Beispiel
Das Erlernen des Service ist
schwierig o o o X o

11. Die Anordnung der Informationen ist

verwirrend	o	o	o	o	o	klar

12. Die verwendeten Begriffe sind verständlich

nie	o	o	o	o	o	immer

13. Erklärungen und Hilfestellungen

verwirrend	o	o	o	o	o	klar

14. Den Prototypen finde ich

unattraktiv	o	o	o	o	o	attraktiv

15. Das Eintragen der Daten war für mich

schwierig	o	o	o	o	o	einfach

16. Die Diktierfunktion/Sprache in Textumwandlung würde ich wieder nutzen.

Sicher nicht	o	o	o	o	o	auf jeden Fall

17. Was hat Ihnen am Prototyp gut gefallen?

18. Was könnte noch verbessert werden?

Persönliche Angaben

Alter: ________________________________

Geschlecht: ☐ weiblich ☐ männlich ☐ divers

Sind Einschränkungen in der Wahrnehmung bekannt (z.B. rot-grün Schwäche)

☐ nein ☐ ja, welche __________________________

Technische Erfahrung

Wie häufig nutzen Sie das Internet?

- ☐ Täglich
- ☐ Mehrmals pro Woche
- ☐ Mehrmals pro Monat
- ☐ Seltener
- ☐ Nichtnutzung

Welche technischen Geräte nutzen Sie regelmäßig (mehrmals pro Woche)?

- ☐ Smartphone
- ☐ Computer
- ☐ Tablet
- ☐ Smartwatch