TU/e EINDHOVEN UNIVERSITY OF TECHNOLOGY

Becoming a Soulmate: Designing a Testing Procedure of a Mobility Application for Seniors

Citation for published version (APA):
van der Waerden, J. (2020). *Becoming a Soulmate: Designing a Testing Procedure of a Mobility Application for Seniors*. Technische Universiteit Eindhoven.

Document status and date:
Published: 15/06/2020

Document Version:
Publisher's PDF, also known as Version of Record (includes final page, issue and volume numbers)

Please check the document version of this publication:

• A submitted manuscript is the version of the article upon submission and before peer-review. There can be important differences between the submitted version and the official published version of record. People interested in the research are advised to contact the author for the final version of the publication, or visit the DOI to the publisher's website.
• The final author version and the galley proof are versions of the publication after peer review.
• The final published version features the final layout of the paper including the volume, issue and page numbers.

Link to publication

General rights
Copyright and moral rights for the publications made accessible in the public portal are retained by the authors and/or other copyright owners and it is a condition of accessing publications that users recognise and abide by the legal requirements associated with these rights.

• Users may download and print one copy of any publication from the public portal for the purpose of private study or research.
• You may not further distribute the material or use it for any profit-making activity or commercial gain
• You may freely distribute the URL identifying the publication in the public portal.

If the publication is distributed under the terms of Article 25fa of the Dutch Copyright Act, indicated by the "Taverne" license above, please follow below link for the End User Agreement:

www.tue.nl/taverne

Take down policy
If you believe that this document breaches copyright please contact us at:

openaccess@tue.nl

providing details and we will investigate your claim.

Download date: 08. Feb. 2024

Becoming a SOULMATE: Designing a Testing Procedure of a Mobility Application for Seniors

Jaap van der Waerden, PDEng trainee Smart Buildings and Cities

Urban Systems and Real Estate Group, Eindhoven University of Technology

June 2020

Foreword

"These are strange times." I think I've heard this phrase more in the past two months than I've ever heard it in the 30-something years I've been on this planet. When the COVID-19 became classified as a pandemic, intelligent lock-downs and 'the new normal' became the main topic of conversation. As I am writing this foreword as one of the last parts of my PDEng report, I've not physically seen my friends, family and colleagues for several weeks. This distancing feels even stranger to me as I am writing this report about the development of a mobility application for seniors. Those same seniors are now told to stay inside their houses and senior homes, unable to meet with their friends and family. Through this SOULMATE project, I've come to understand how important mobility and independence can be for everyone, especially our seniors. I hope we can support the seniors that are our friends and families in these strange times; right now with our thoughts and attention from a safe distance, and hopefully soon with a brand new mobility application.

Many people have supported me throughout this project, and I would like to give a few words of thanks to them. First and foremost, I would like to thank Janneke for her unending support and patience, from all the klusjes you've done for me to always believing in me. I would like to thank my parents as well, especially my dad for keeping an eye out for me and always being there to discuss project matters and other things. Further, I would like to thank Floor for her cooperation with me in this project, for teaching me how to be creative and enjoy the better things in life (from cooking to Excel). Of course, this project would not have happened at all without the award-winning supervision of Astrid and Pauline, thank you both for believing in us and lending us your expertise. Further, a special thanks goes out to the rest of the SOULMATE consortium members, who have always been pleasant to work with and provided many eye opening perspectives over the years. In addition, I would like to thank the people who have tried to make a real designer out of me at Smart Buildings and Cities and all my fellow trainees. My final thanks go out to all my friends, colleagues from USRE, family members, Brad Pitt, and people I have forgotten to mention so far, for their support, wisdom, and laughs during these strange times.

I hope you enjoy reading my report! With the best of regards,

Jaap van der Waerden

Executive Summary

An aging population presents society with many challenges, which include maintaining independent mobility; everyone would like to stay independent, healthy, and happy, as long as possible. Many tools and solutions are rising to the challenge of keeping our seniors mobile and healthy, but many of these applications fail because they are not actually being used. The SOULMATE application aims to address this challenge by making seniors a vital part of its development process. The project described in this report specifies the way in which these seniors are included as co-developers of the SOULMATE application; designing testing and measurement procedures for the SOULMATE project. Three main deliverables describe how testing procedures and application development interact:

- The testing and trial methodology plan describes all testing and measurement plans and protocols in detail. This allowed the project teams to discuss main aims and tools of testing in a concrete way. These discussions have led to several adaptations to the original planning, better aligning with the scope and goals of the project.
- The digital benchmark survey with choice experiment gives a broad overview of important characteristics and preferences of the seniors that might use the SOULMATE application. The choice experiment clearly showed preferences for functionalities of finding nearby facilities and easy access to up-to-date public transport information. Additionally, three unique potential customer segments have been identified based on preferences for functionalities and price of the application.
- The initial testing and field trials describe the qualitative feedback sessions and workshops that served as direct input for the development of the SOULMATE application. In these workshops, seniors were able to clearly communicate and visualize their challenges and needs, aiming to result in an application that does what they want in the way they want it. Design and functional testing workshops results have shown that seniors enjoyed the way the SOULMATE application looked and saw the value in its functionalities. Challenges for the further development of this application are to improve performance and accuracy.

Ultimately, the testing procedure for the SOULMATE application described in this report has achieved its main goal of closely including seniors into the development process in a structured and scientifically founded way. Although some challenges are still being dealt with in the process of delivering the SOULMATE application, valuable insights have already been gained in the needs, wants, and characteristics of the seniors who would use it.

Table of Contents

Abbreviations

AAL program: Active Assisted Living program; an EU funding agency

AIC: Akaike Information Criterion; an indicator for the comparison of different Latent Class models

FH Joanneum: FachHochschule Joanneum; Joanneum University of applied sciences

LC: Latent Class model; a model for the estimation of heterogeneous groups in choice tasks.

LRS: Log-Ratio Statistic; an indicator for model performance in choice tasks.

MNL: Multinomial Logit model; a model for the estimation of choice experiments.

MVP: Minimum Viable Product

PDEng: Professional Doctorate in Engineering; a technology and innovation design traineeship

RRD: Roessingh Research and Development

SB&C: Smart Buildings & Cities; a PDEng program of the built environment at the TU/e

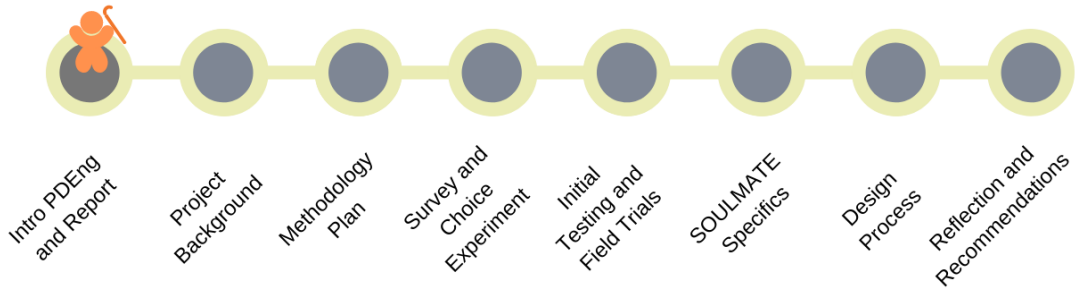
SME: Small and Medium-sized Enterprises

SOULMATE: Securing Old people's Ultimate Lifestyle Mobility through Augmented reality Training Experiences; the project discussed in this document.

TU/e: Eindhoven University of Technology

WP: Work Package

1 Intro PDEng & Report



The report before you is written as the final product of a PDEng traineeship. This post-master program offers trainees the opportunity to develop their technological design skills in a two year spanning traineeship. With a core focus on innovation, technology, and interdisciplinary design, the PDEng program encourages trainees to work together on technological innovations. During the program, PDEng trainees deal with complex and real-life problems, working on projects that deal with state of the art technology to tackle challenges in their field of industry. The program divides trainees' attention in two main components, (post-) master level education and project work. Educational activities include content specific topics and a range of more general skills that can be relevant for any designer, such as professional skills, entrepreneurship, and innovation science. Project work includes structured design projects as well as a main company project, which the current report relates to.

Stan Ackermans Institute

The PDEng program is part of the Stan Ackermans Institute 4TU School for Technological Design. The four technological universities of Delft, Eindhoven, Twente, and Wageningen form this joint initiative to stimulate innovation in technological design. By sharing knowledge with each other, these universities allow PDEng trainees to develop their skills optimally in one of the many different PDEng programs. These programs range from applied mathematics, to fluid and solid mechanics, to the built environment.

Smart Buildings and Cities

The project described in this report has been conducted as part of the Smart Buildings and Cities (SB&C) PDEng program at Eindhoven University of Technology. As the name suggests, SB&C focuses on the innovation in smart cities and the buildings therein. Transition towards intelligent, sustainable, and happy cities is thus one of the core concepts to SB&C. The program offers expertise of specializations in anything in the built environment, including architecture, building physics, information systems, and mobility. With this wide range of perspectives, trainees in the program work on a wide range of projects. Some examples include building environmentally friendly power generators for festivals, designing predictive maintenance models for elevators, or even developing an accessible mobility application for seniors.

Figure 1. Smart Buildings and Cities logo, retrieved from the SB&C website.

Report Structure

The rest of the report is structured as follows. First, a short introduction in the company project and background is provided. This includes problem statements and context for the company project as a whole and for the role this PDEng project fulfills within it. Then, the PDEng projects' deliverables are described; the testing and trial methodology plan, the benchmark survey and choice experiment, the initial testing, and field trials. The following two chapters go into more detail regarding the framework of the SOULMATE project and the PDEng design process. Concluding, results from the deliverables and design process are reflected upon in the last chapter, providing recommendations for the company project and some more general design conclusions.

Chapter Specification

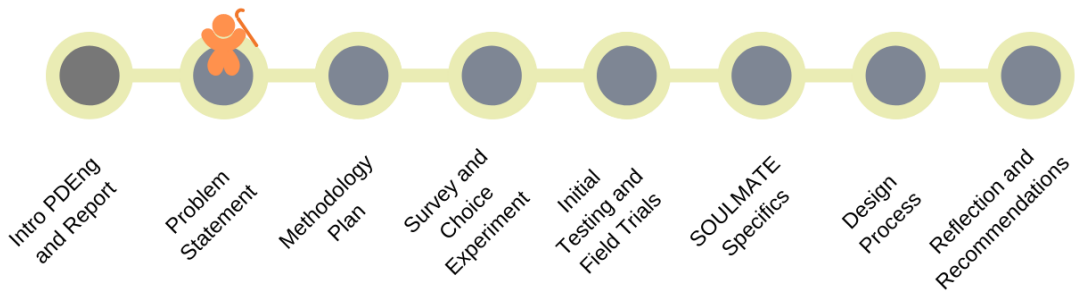
Coming chapters will reveal a duality within the project described here and thus also in this PDEng report. This duality comes from both academic (research) and professional (design) influences on the project. While many of the activities described further are some kind of research (such as measuring participant responses and doing literature research), design aspects (including a description of stakeholders and formalizing the design process) show an important aspect of how these activities were developed. As the topics of these two perspectives can be quite different, their intended audiences are different as well. While the description of the model used in the design process might be interesting to a (future) technology designer, an academic reader might find more value in the more detailed description of the choice experiment construction. In order to address this duality, icons are included to indicate the focus of each chapter of this report. While all descriptions are written to not require specific technical knowledge, these icons aim to provide some additional guidance to readers with different backgrounds. A short description

will detail why a certain part might be more suited to a particular audience and give a suggestion where to continue reading.

Passages marked with the “Gears” icon provide a more in depth look into the process behind the design of this project. They are written with a professional audience in mind and include topics that play a core role in the PDEng program, such as stakeholder analysis, design process, and communication.

Passages marked with the “Graph” icon provide more detailed background information regarding measures and results. These chapters are written mainly for an academic audience.

2 Problem Statement and Project Assignment



This chapter describes the context in which the SOULMATE project was conducted: an aging population that wishes to stay healthy and independent. It first describes the general problem the SOULMATE (short for Securing Older people's Ultimate Lifestyle Mobility through Augmented reality Training Experiences) solution aims to tackle, and then the more specific part of this problem that is addressed by the PDEng project in this report. Where SOULMATE aims to develop an accessible and useful mobility for seniors and with seniors, the role of this PDEng project is to develop testing procedures so that the feedback from these seniors can be integrated properly.

2.1 The Aging Population

The world's population is aging; across the globe, we see similar trends of people living longer, and fewer babies being born (Rosenbloom, 2001). Estimations are that in most Western countries, one third of the residents will be over the age of 65 by the year 2025 (i.e., Alsnih & Hensher, 2003). These seniors are shifting the composition of our society, by increasing the proportion of people who are no longer part of the workforce. The so-called “greying” society presents challenges around independent living and mobility. These challenges present themselves on an individual level, as well as a broader societal level.

2.2 Age and Mobility

As we become older, our physical and cognitive abilities decrease slowly (Deary et al., 2009). We may not be able to walk as far as we used to before we are tired, or sometimes we forget where we were going. While part of the natural aging process, these kinds of small issues can cause seniors to feel that they are unable to go out whenever they want. Especially in our ever increasing technologically advanced travel systems (e.g., digital passes to check in to buses, digital timetables for trains, etc.), there can be many challenges that stop seniors from traveling (Metz, 2000). When these small challenges prevent seniors from going out, they become less active and more sedentary. This can decrease their mobility even further, as physical exercise and walking are some of the most important tools to prevent disabilities (Elsawy & Higgins, 2010). This negative spiral leaves many seniors feeling like a prisoner in their own home, unhappy and unhealthy. Thankfully, many people are working hard to prevent this future for our fellow senior-citizens.

Despite the aforementioned mobility problems, we know that there are ways for seniors to remain healthy and independent throughout the aging process. Many studies show that when seniors are able to increase their mobility, they become healthier as well and they will increase their quality of life (e.g., Holley-Moore & Creighton, 2015). Interventions in mobility can take many forms: Some deal with physical training such as balance and strength exercises to strengthen the most vital muscles that prevent falling (Finlayson & Peterson, 2010). Others tackle mental challenges such as a cognitive remediation training to increase attention, which can prevent falls as well (Verghese et al., 2010). In their recommendations for research and intervention priorities, Rosenberg and colleagues (2011) suggest further exploration of not only training interventions, but also of technology based interventions that assist seniors in being active and mobile.

2.3 Problem Statement

There are many physical and mental training programs that focus on the link between mobility and health, but most technology solutions in this field are not using this connection. While there are some technologies that could help seniors stay active and independent, but they have limitations. These limitations roughly fall into two categories: applications that are too general and applications that are too specific. The largest group of technologies that could be useful are developed with a general audience in mind. Of course, these apps and technologies *can* be used by seniors, but often do not fulfill their needs (e.g., Resnik, Allen, Isenstadt, Wasserman, & Iezzoni, 2009). Since they are developed for a general audience, these apps lack functionalities that are specifically wanted or needed by seniors. Applications such as Google (or Apple) Maps can be hugely beneficial in making travel easier, but their interfaces and functionalities are not designed with seniors in mind. As a result, these kinds of general audience technologies are often not intuitive for seniors to use, or do not include functionalities that are most important to them. The other category of technologies that is currently available goes to the other end of the spectrum. These technologies serve a very specific and often single purpose. They are developed with seniors or people with mobility impairments in mind, but are too singular to benefit a large group of seniors. Applications such as the Red Panic Button (available on IOS and android) provide users with an easy to use and accessible way of alerting contacts in an emergency. An application like this can help seniors with their mobility by offering some safety and confidence while walking around, but it does not provide enough tools for them to be mobility independent. Additionally, these kinds of solutions evoke feelings of resistance in many seniors, especially when technology for impairment is involved (Charness & Boot, 2009). Because these solutions are made to address impairments, using them implies having these impairments, confronting seniors with their own limitations and mortality. To avoid these kinds of negative experiences (e.g., Hughes & Peak, 2002), seniors can be hesitant to use these kinds of specific impairment-focused technologies.

Concluding, several barriers exist that prevent seniors from using existing technologies that could help them stay mobile, independent and healthy (Figure 2). The SOULMATE project aims to dismantle these barriers by investigating the wants and needs of seniors thoroughly. Then, a mobility solution will be developed in a process of collaborative creation with these future users.

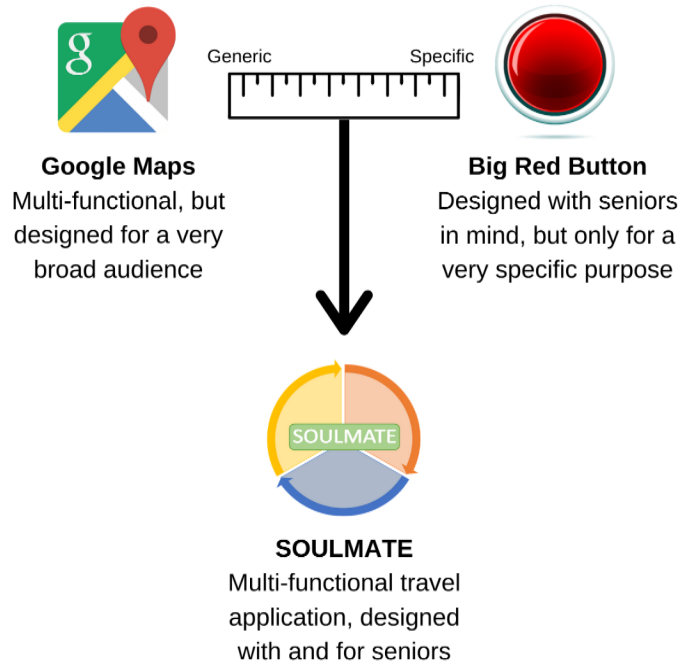


Figure 2. Problem statement addressed by SOULMATE: developing a multi-functional mobility application that is specifically aimed at a senior audience.

2.4 The SOULMATE Solution

The application that is being developed during the SOULMATE project aims to stay close to the mobility wants and needs of seniors. Additionally, it should provide mobility tools that are more than just one feature, SOULMATE aims to be a one-stop travel companion. The SOULMATE project attempts to tackle these challenges by including the end-users in every step of the way. First, application features are designed together with seniors during co-creation (see Luub, 2020). Then, focused feedback moments happen repeatedly during the development process. With these, technology partners can benefit directly from the feedback and experience of the users. Simultaneously, a large scale survey provides additional information on the characteristics of the user-group, as well as their preferences in mobility solutions. Finally when the application is ready for it, a large group of seniors will use it for an extended period of time, so that the impact on their daily lives can be measured.

Based on expert insights and feedback from the co-creation process, the SOULMATE solution will address mobility on three fronts: Exploration, Navigation, and Assistance. These three pillars are illustrated in Figure 3.

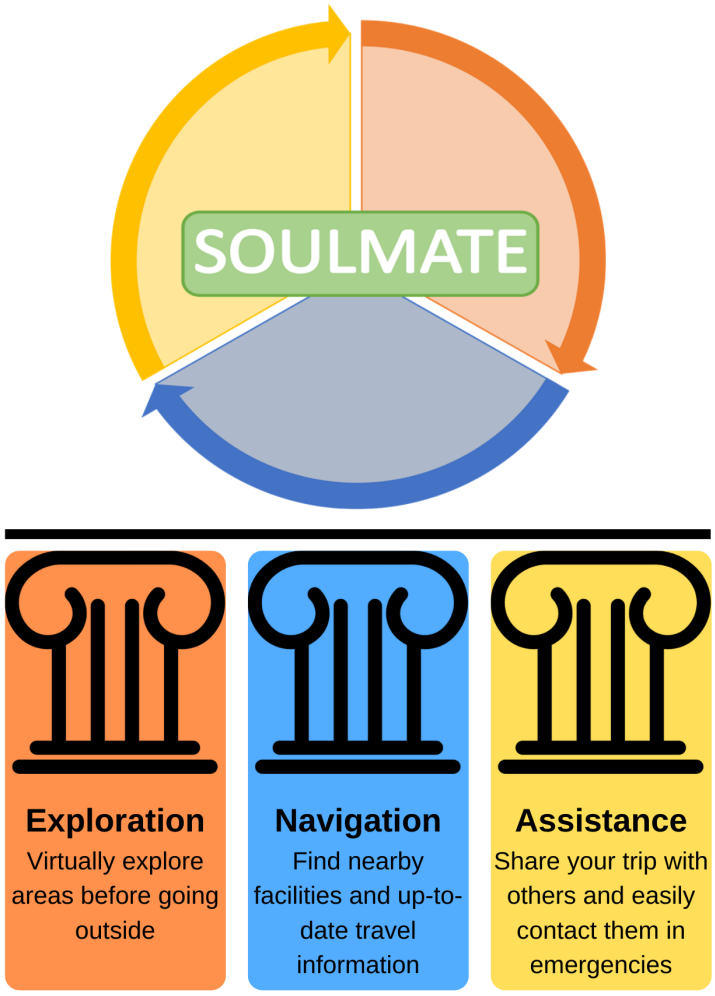


Figure 3. The three main functionality pillars of the SOULMATE application; exploration, navigation, and assistance.

Exploration allows users to look at their desired route or area from the comfort of their own home. Using images on a street-view level, users can travel a predetermined route that they plan to make in the future, or just explore around their neighborhood 'walking' through the digital environment. Exploration addresses user confidence that is often lacking when taking trips, especially to new places. By investigating the route and practicing walking it before actually going out seniors will be able to more easily recognize landmarks or streets, and build their confidence by seeing the route as many times as needed before actually leaving the house.

Navigation provides users with all information they require while they are out and about. The app provides step-by-step navigation, not only outdoors but also inside (public) buildings such as train stations. Users can obviously navigate quickest and shortest routes, but the app also provides options to go the safest route, greenest route, or make sure to stay in close proximity to benches or (public) toilets in the area. Speaking of which, the app always allows the user to switch their route to the nearest bench, toilet,

restaurant, or public transport stop. Finally, up-to-date travel information of public transport will be provided by the app. Navigation addresses some of the specific needs of seniors when on the road. Switching between different apps for navigation and transport or area information is no longer needed. Easy access is available for facilities that seniors find relevant.

Assistance provides users with a sense of security while they are travelling. For instance, the app allows seniors to share their trip data with a coach; a friend or caretaker. This allows the coach to see where the user plans to go and what route they plan to take. When on the move, the coach can follow the senior's progress remotely. Additionally, the user and coach can video-call each other to provide or ask assistance, or just to check in on how it is going. As an additional safeguard, both user and coach can set to receive a notification when the user moves too far from the designated route. In case of an emergency, the user can easily press a single button or use voice commands to call their coach, other contacts, or emergency services. Assistance addresses feelings of insecurity in users. Even if a senior can physically make a trip, insecurity about their own abilities can still prevent them from actually going out. By providing the ability to share their whereabouts and an easy connection, the application provides the feeling of security to the user.

From a technical point of view, the SOULMATE solution provides these three pillars of mobility through the integration of existing technologies. By bringing in their developers, the SOULMATE project combines Memoride by Activ84Health, Ways4All by FH Joanneum, and Viamigo by Abeona Consult. As part of the development team (see Paragraphs 2.7 and 6.2 for more detailed information on the SOULMATE consortium composition), these companies work together to create one application that services a variety of end-user needs. Thus, the SOULMATE solution does not have to be made from scratch, it builds upon parts of existing solutions. Concepts and functionalities from Memoride will be integrated to form the exploration pillar, Ways4All will be adapted into the navigation pillar, and the assistance pillar will originate from Viamigo. Together, they will form the foundation on which the SOULMATE solution's interface will be built.

On a user level, the process of using the SOULMATE application can be described as follows. First, the route to the destination can be explored virtually; streets and landmarks can be viewed and explored from the comfort of one's own home, until the route feels familiar. Now the user is ready to make the trip. Next, SOULMATE provides step-by-step navigation and up-to-date information on traffic and public transport timetables. Finally, the user can feel more secure by sharing their trip with others and ask for assistance anytime they are on the road (Figure 4). By selecting only the components that they wish to have at any given moment, the SOULMATE app provides a fitting but accessible solution for a heterogeneous group of seniors. Whether they just want easy to use navigation and up-to-date train timetables, or if they look for additional assistance in finding nearby facilities and on-road assistance.

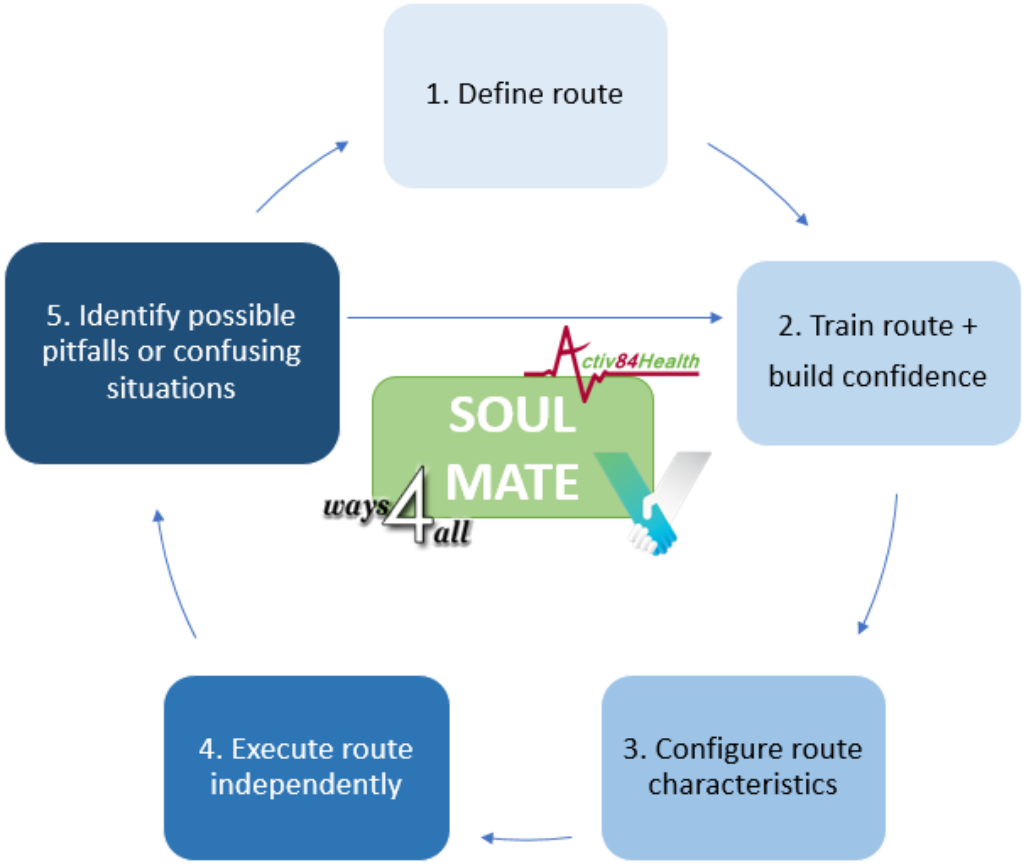


Figure 4. Envisioned user experience for SOULMATE; from virtually training a route to executing and assessing it.

To further clarify and illustrate the potential benefits of using SOULMATE, a short pitch and vision are established. These kinds of exercises can help customers and stakeholders see the importance and value of a product. The pitch focuses on convincing new stakeholders of the benefits of engaging with/investing in SOULMATE. The vision shows how SOULMATE aims to innovate, by integrating it into a future setting.

2.5 Pitching the SOULMATE Solution

A pitch is usually a short presentation of only one or two minutes. Pitches are most often used in business settings, where someone with a (business-) idea presents their most important ideas to investors. Here, a short pitch emphasizes the societal challenge SOULMATE aims to tackle, as well as what its main benefits are. The goal is not to lure investors (as it does not even touch on a business model), but to convince new stakeholders (customers, participants of the testing process) of the value SOULMATE could have for them.

> *The world population is getting older and older. UN projections estimate that by 2050 about one in 4 people is over the age of 65. Who's going to take care of all of these people? Elderly homes are packed, and seniors who live on their own have a hard time remaining independent. All this is happening while we know that seniors who can stay active and mobile are happier, healthier, and more social. So, what can we do to make sure they stay active and mobile?*

What you can do is help us develop something that can give our seniors their independence back. Our soulmate solution strives to do just that. By providing an easy to use technology that enables seniors to lead an active and healthy life. SOULMATE can be customized to fit everything they may need to get out there.

Feeling lonely? SOULMATE connects you with others for a nice day out.

Feeling uncertain? SOULMATE lets you explore environments before actually going there.

Feeling unsafe? SOULMATE lets you avoid busy and dangerous areas.

Feeling tired? SOULMATE finds you the closest resting spots; a bench or a cafe, SOULMATE could even tell you what the best thing on the menu is!

SOULMATE fulfills all travel needs a person can have, and is especially accessible for the senior among us. The solution will allow seniors to remain independent in their day-to-day activities. After all, happy and healthy seniors with an active and independent lifestyle are a vital part of our society!

2.6 Envisioning the SOULMATE Solution

To help communicate what the SOULMATE solution aims to do, it can be helpful to establish a vision. This vision should be able to explain to a broad audience how the solution would function in the future. The vision can help to set up long-term goals and direction, and can be used to help convince (new) stakeholders about the usefulness and importance of the SOULMATE solution.

In general, visioning is the practice of formulating a package of expectations that form a cohesive narrative around a potential future; a vision. Usually, this vision is far into the future, extreme, positive and uses general terms such as 'smart cities', 'internet of things', etc. (e.g., Constanza, 2000). These characteristics set visions apart from forecasts or predictions, as they are usually short-term and more limited in scope. In innovation science, visions are primarily used for mobilization of people for an innovation or movement, avoiding undesirable developments, and the formulation of long-term strategies. Wiek and Iwaniec (2014) describe three main criteria for a good (sustainability) vision. First, a vision needs to have a high construct quality; it needs to be coherent (free from contradictions), plausible (evidence based) and tangible (describe detailed goals). Secondly, the normative quality needs to be high; the vision needs to be far-sighted (visionary) and sustainable. Lastly, a vision needs to be of high transformational quality; it needs to be shared (supported by stakeholders), motivational (inspiring), nuanced (showing priorities) and relevant.

The following vision describes important future aspects of SOULMATE as part of independent assisted living in the form of a narrative, a short story.

A day in the life of Anne

Tomorrow, April 1st 2059, I will be turning 82 years old. Over the past few years, my health has started to decline a little, but I still feel healthy and able to do the things I want to do. Unlike the past, where children would put their parents in an elderly home, this dependency is not needed anymore. I live on my own, and am confident I will be able to do so for the foreseeable future. My children come visit because they enjoy my company (at least they tell me), not because they need to take care of me. In preparation for my birthday party tomorrow I am headed outside for the things I need. Of course, I could just order everything online, but I welcome the fresh air and my daily dose of physical exercise. I might even meet up with a friend to drink some coffee, I'll see if anyone is around once I get to my destination. After setting up my device with the route to all the shops, I go outside. Looking around, I notice that society is moving at a faster pace than when I was a young 32 year-old. I know that I cannot keep up with every new gizmo and program, but I know new technologies are developed with me and others like me in mind. I have a little robot to clean after me nowadays, but I still find the time and place to make my famous recipes in the kitchen. Speaking of which, I need to make sure to not forget the chocolate and check my personal device for the geographically integrated shopping list. These routing apps can do the neatest things these days! When in the future I need more guidance, my movements can be tracked on distance by my loved ones. But for now, I'm doing fine on my own. Getting supplies, finding new and interesting things to see and experience. I go on my way into the beautiful weather, it is a warm day this early in spring. My device guides me through the traffic, avoiding dangerous and busy parts of the city. Returning home, the big task of the day can begin; baking that delicious chocolate cake!

This vision shows how technology like SOULMATE is integrated in a possible future of independent assisted living. Describing a coherent chain of events, several technologies are seamlessly integrated in the day to day routine of a person. Based on existing knowledge in the field of assisted living technology (see Belbachir, Drobics, & Marschitz, 2010), this short narrative aims to create a detailed description of how the SOULMATE application would actually be useful in daily life. It shows a futuristic and overall positive image that attempts to provoke the good feelings that come with being independent and not feeling like a burden on society. This vision is shared by the senior in question, as well as their relatives. It shows that mobile technology is not dominating the space, but is integrated in the larger system of independent living, which includes things like modular housing/interior and personal support.

2.7 The SOULMATE Project

The SOULMATE solution is being developed by a multi-disciplinary team as part of the SOULMATE project, an innovation project funded by the European Union grant agency Active Assisted Living (AAL). The AAL program focuses on stimulating European innovation projects for the improvement of active, happy and healthy aging. As the SOULMATE project consists of an international consortium of partners to develop a mobility solution for seniors, it matches perfectly with the AAL objective (Table 1). A more detailed overview of all partners in the SOULMATE consortium is provided in appendix L. Summarized, the SOULMATE consortium consists of experts in the field of technology and application development, end-

user (i.e. senior) engagement, and research. These experts originate from Austria, Belgium, and the Netherlands.

Table 1. Overview of SOULMATE consortium partners, their main role in the project, and their country of origin.

Partner	Main role	Country of origin
Abeona Consult	Technology	Belgium
Activ84Health	Technology	Belgium
Happy Aging	End-user	Belgium
TU/e	Research	The Netherlands
RRD	Research	The Netherlands
Slimmer Leven	End-user	The Netherlands
FH Joanneum	Technology	Austria
C.c.com Moser	Technology	Austria
Fraiss	Technology	Austria
GEFAS	End-user	Austria

As one of the research partners, TU/e (and therefore this PDEng project) focuses on project activities related to research. These research activities focus on mobility and related concepts, including quality of life, health, and the social environment. The main goal of research as part of the project is support of the development process of the SOULMATE application. This support is provided through structured feedback moments with end-users to validate the design and function of various versions of the application. In addition, a broader overview of the target population (i.e. seniors) will be provided, through a survey and choice experiment. This survey will provide a general benchmark of various impact measures relevant for in SOULMATE project, as well as an indication of important functionalities of the SOULMATE application according to this broad audience. These validation and benchmark procedures, measures, and some outcomes are the focus of this PDEng project.

2.8 PDEng Focus Within SOULMATE

This PDEng project and accompanying report cover one part of the larger SOULMATE project. The current report focuses on testing and measurement components of the development of the SOULMATE application. The problem this PDEng project aims to tackle is that of user engagement. As described in the problem statement, technological solutions for seniors often fail to meet their diverse expectations. As a result, many potentially useful solutions end up not being used by their target audiences. The SOULMATE solution aims to address this through the implementation of different mobility components into one application (covering several needs) and including seniors heavily in the development process (covering their relevant needs).

This PDEng project designs a way of structuring, guiding and reporting of this user involvement by providing procedures and measures for testing. Thus, this PDEng project builds on earlier work in the project, such as the project proposal and co-creation phase (see Luub, 2020). The PDEng specific project shares the end-goal of the SOULMATE project; the development of a fitting mobility application for seniors. More specifically, the goal of this PDEng project is to provide tools for testing and validation within the SOULMATE project. These tools should allow the development team to share questions and product versions with end-users and gather their feedback in a structured way. This integrated co-creation is one of the core concepts of development in SOULMATE, making sure the final solution fits with the wants and needs of the seniors it aims to assist (Figure 5). Within the SOULMATE project, testing and measurements are included in work package 3 (see Paragraph 6.3 for the interactions between work packages); of which the deliverables are described in this report.

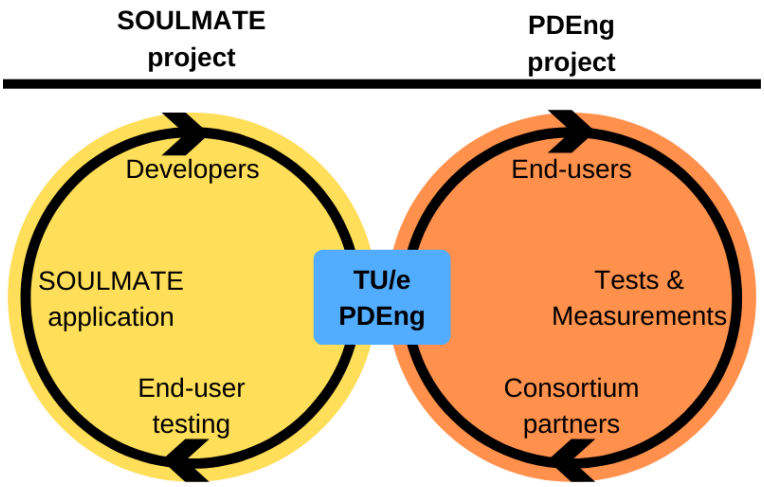


Figure 5. Congruent development loops of the SOULMATE project and the PDEng project described in this report. It shows the role of the TU/e and its PDEng trainees as a connector between end-users and developers.

These research and testing activities are beneficial to the SOULMATE project in a few ways. First, the fast iterative design allows the development team to create an application that fits well with the needs of the end-users and stays that way throughout the whole process. Additionally, feedback and insights gained

from potential end-users can be used to inform business related decisions for the eventual exploitation of the SOULMATE solution. Further, interesting data is gathered with seniors regarding, among other things, their quality of life, health, social environments, and technology preferences. Analysis of this data can provide interesting knowledge in the field of gerontechnology (the research field of technology use in seniors) and form a basis for academic papers. Finally, the procedures developed for user-engagement and gathering feedback can be useful tools for future innovations in the aging population, or even innovation in general.

The deliverables described in the next chapters are the main products of this PDEng project. These include workshop procedures, feedback forms, and questionnaires, as well as the results for some of the conducted testing activities. Chapter 7 will provide a more in depth look into the design philosophy and design process underlying these deliverables.

2.9 Deliverables

The project deliverables are reported per stage of the testing and measurement phase of the project. These deliverables are included in the current report and described in the following chapters: The Testing and Trial Methodology Plan (Chapter 3), Benchmark Survey and Choice Experiment (Chapter 4), and Initial Testing and Field Trials (Chapter 5). Of these, the methodology plan is a document describing planned activities and measures. The other deliverables include a testing set-up of protocols and measures, and (preliminary) results where possible. Set-up and results are delivered at different times (set-up before testing, results after), thus are included in different deliverables. Figure 6 shows the timeline on which these documents were delivered in the SOULMATE project.

Included with the report, appendices refer to sections of deliverables as they were originally reported and delivered to the project. Additional explanations of these deliverables are generally structured as follows. First, the goal of the deliverable is described; the “why?”. Then, the set-up of the deliverable is specified; the “how?”. Next, the deliverable document(s) are described, split up between procedure and results where applicable; the “what?”. Finally, the main results and outcomes of the deliverable are reflected upon; the “and now?”.

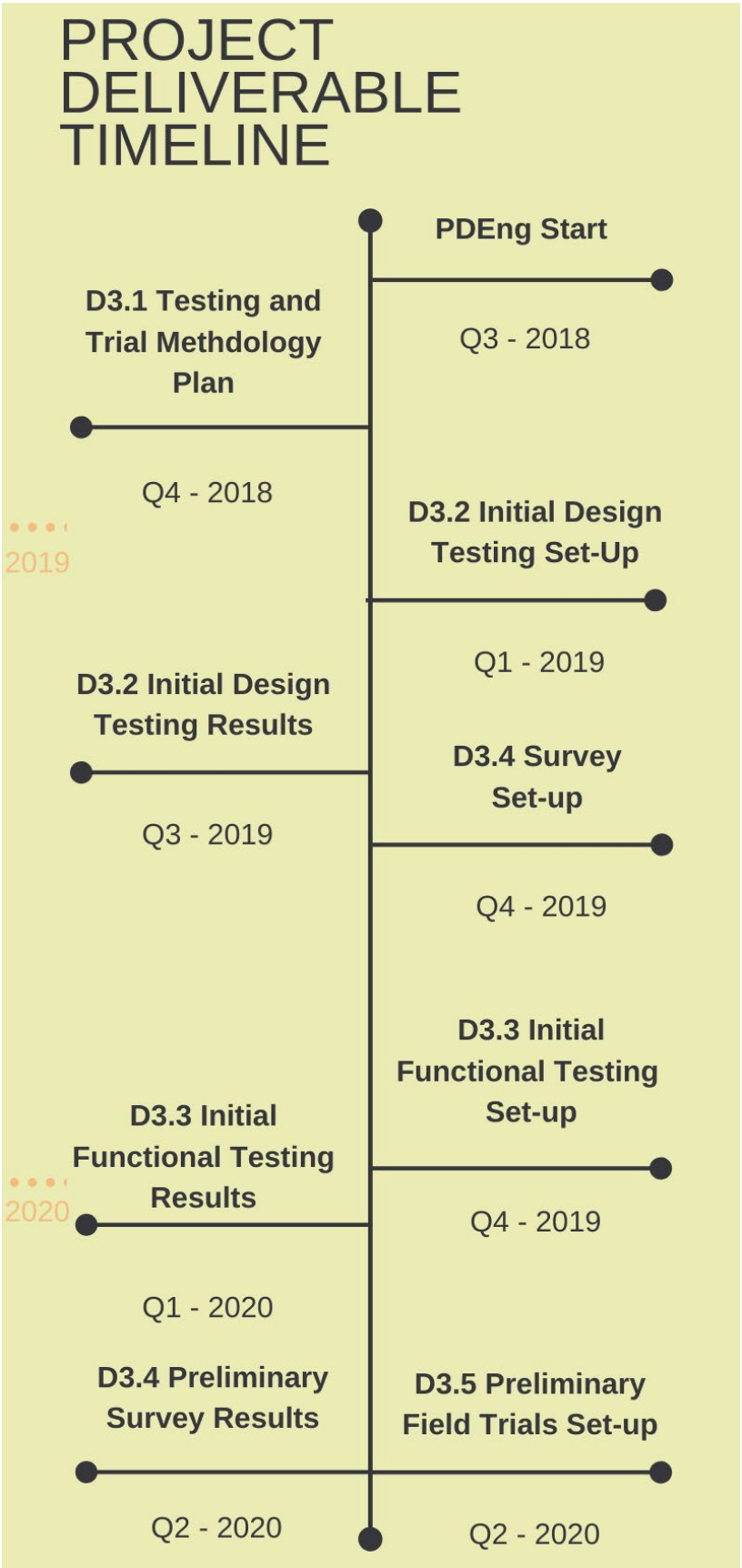
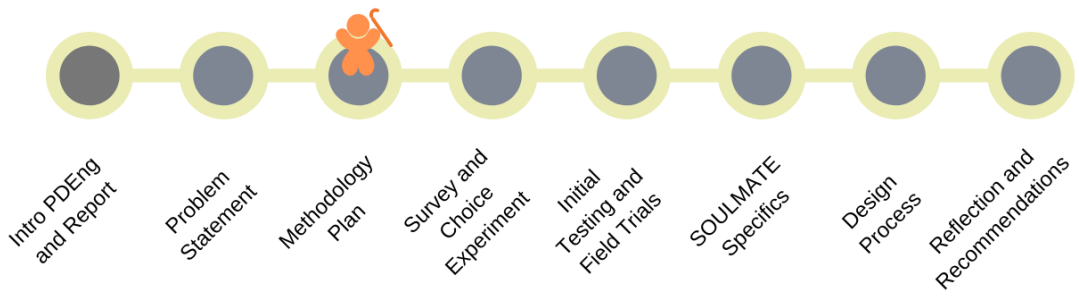


Figure 6. PDEng project deliverables timeline, spanning from Q3 of 2018 up to Q3 of 2020.

3 Testing and Trial Methodology Plan



The SOULMATE testing and trial methodology plan is a document that provides a general description of all planned activities and documentation related to the testing and measurement phase of the project. Within the project, the Testing and Trial Methodology Plan is reported in deliverable D3.1, which is included in Appendix A.1. This document was delivered to the project consortium in the end of 2018.

3.1 Testing and Trial Methodology Plan Goal

The goal of setting up a testing and trial methodology plan is to broadly outline testing and measurements for discussion with end-user group and technology partners. The document is written to ensure all project partners are on the same page regarding testing. As the starting deliverable for the testing phase of the project, the testing and trial methodology plan functions as a 'jumping off point' for discussions regarding testing that is delivered early in the project. Testing procedures and measurements are detailed enough to allow discussing feasibility and usefulness, but not too specific to avoid complexity and allow for flexibility. Procedures and measures suggested in the plan are based on the original project proposal, as well as a literature overview (see design process in Chapter 7).

3.2 Testing and Trial Methodology Plan Set-Up

The testing and trial methodology plan describes the main goals of the testing procedures in this phase of the project Initial suggestions for measures to include in this phase are added to the methodology plan. It makes a detailed distinction between testing phases: Initial testing, Field trials, and Benchmark Survey. The plan includes a preliminary version of a workflow and planning for work package 3 and more detailed descriptions of goals for initial testing, field trials, and benchmark survey. Additionally, early suggestions for measures, testing procedures, and feedback forms are included. For example for the initial testing, a workshop structure described the process of how seniors interact with a prototype application through scenarios. Another example of information in the testing and trial methodology plan includes a list of aimed measures to be included in the benchmark survey and field trials; including self-reported health, social networks, and travel behavior.

3.3 Testing and Trial Methodology Plan Results and Reflection

Making the testing and trial methodology plan proved to be a valuable start to the further development of testing and measurement procedures for the project. While some general guidelines and ideas were already established in the project proposal, their further specification in this deliverable has allowed useful discussion among the project partners. Most of the specified testing and measurement ideas have been implemented further over the course of the project; including the workshop set-up of the initial testing and the benchmark survey. Two main changes resulted from discussing the testing and trial methodology plan: the high end-user burden for seniors participating in the testing procedures and the lack of a specific testing moment for design related aspects of the SOULMATE application.

Participant Burden

With all measures detailed and combined in the testing and trial methodology plan, it became clear to the end-user organizations that there would be a very high burden for seniors who would participate. Therefore, they expected difficulties recruiting participants for the project, and retaining participation from those that would originally sign on. Especially the Field Trials (and to a lesser extent the Benchmark Survey) was subject to these concerns. As the plan for these field trials asks participants to use and test the application over an extended period of time, retaining them in the project is of fundamental to the testing goals. Thus, we discussed with the end-user organization experts how to relieve some of the participant burden while maintaining the original intent and goals of the testing phases. Two aspects were identified that could help to address the concerns of participant burden; reducing the amount of questionnaire measures that are asked from participants at each measurement point (and Benchmark Survey) and scaling back the amount of physical measurements that are conducted in the Field Trials. Most of the measures described in the testing and trial methodology plan have remained an important part of the testing and questionnaires (Appendix A.1). Measures of self-reported health, general travel behavior, social networks, loneliness, and the choice experiment remain in their originally intended forms.

First, there were a number of questionnaire measures included in the original plan that showed some overlap in terms of content. The extended version of the self-reported health scale and some of the quality of life questions, for instance, included very similar questions. Since the quality of life scale showed a very high amount of overlap, it was removed from the testing procedures. In addition, shortest validated forms of the remaining questionnaires were included, so the SF36 was replaced by the SF12 (additional background on these different versions is included in Appendix J.1).

Furthermore, the physical measurements included in the plan were not expected to add enough value to their self-report counterparts to outweigh the additional burden put on the participants. Measures for physical activity would most likely require participants to carry a separate device with them for the full duration of the Field Trials (see Appendix J.4 for some of these considerations). Additionally, the measurement for physical performance required a trained physician (or specifically trained observer) to be present for the evaluation. Both of these physical measurements were expected to place an immense burden on the participant. Instead, self-report measures of daily activities and physical health were used to cover these measurements. By using mainly self-report measures, we will potentially be giving up some validity in the testing and measurement phase (e.g., Reuben, Siu, & Kimpau, 1992). However, consortium

partners preferred this trade-off for decreasing the participant burden, and in turn increase the likelihood of recruiting and retaining participants. The most important changes and their benefits are represented in Figure 7.

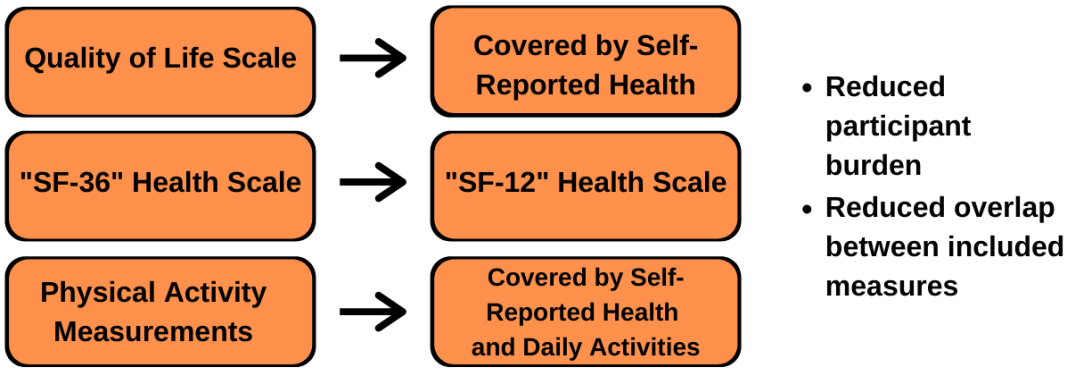


Figure 7. Updates to the measures included in the benchmark survey and field trials testing phases of SOULMATE.

Design Testing

The testing and trial methodology plan also brought out a request from the technology partners in the SOULMATE consortium. The initial testing phase initially focused on testing the application in a classical software testing way. In other words, the main point of attention of this phase was the functionality of the application; checking how well it ran and identifying crashes and bugs. However, the technology partners responsible for the development of the front-end of the application requested more feedback from users on the design of the application as well. Those design aspects include factors such as how the application looks, how intuitive the menus are, and whether buttons are the right size and in the right place. So, in discussion with these technology partners we decided to reformulate the Initial Testing phase of the project.

By splitting up the Initial Testing phase in two distinct parts, 'design' and 'functional', we create additional room for feedback moments with end-users with the specific goal of gathering their input on design aspects (Figure 8). Splitting up design and functional testing workshops also allows us to gather user-feedback in an earlier stage, before a full functional prototype is completely developed. By making the formal distinction between the two phases, we also split up the related deliverables. Thus, we focus each results report (i.e., the deliverable) on only design or functionality.

The updated version of the Initial Testing phase included in Appendix A.2 was written to formally reflect changes to the Testing and Trial Methodology Plan.

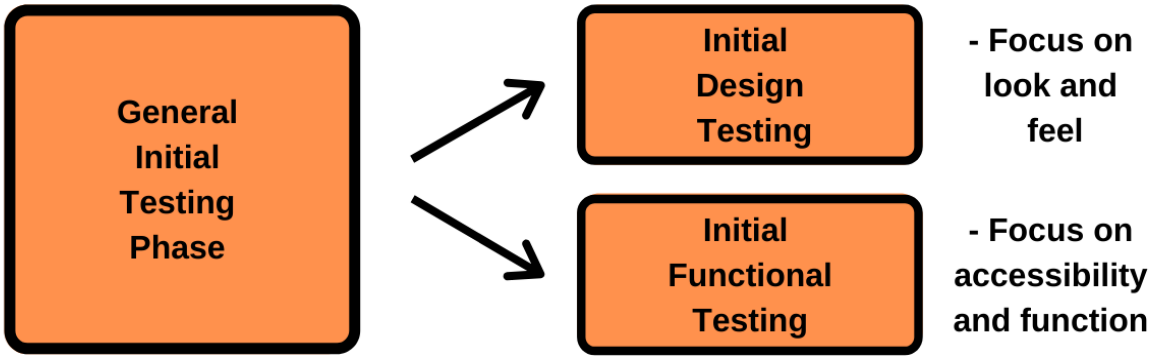
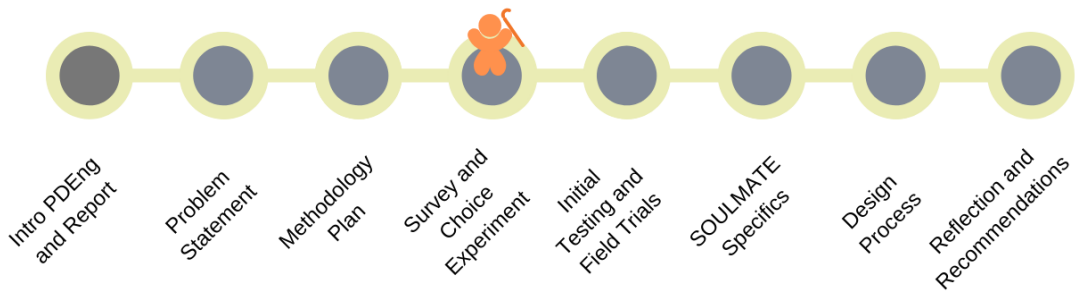


Figure 8. The division of the SOULMATE Initial Testing phase into specific Design and Functional Testing phases.

In the end, the testing and trial methodology plan turned out to be a very helpful tool for the further development and planning of the SOULMATE project. By writing more detailed specifications of each measure and procedure planned during testing, we were able to provide consortium partners with a clearer overview of the project. Presenting it at an early stage in the project, allowed us to discuss the specifics of each testing and measurement point in depth. While most testing and measurement activities already fit well with the goals and requirements of SOULMATE project partners, these early discussions allowed for a lot of flexibility in terms of the testing and measurement procedures where needed. The updates made to the project plan in order to accommodate concerns of participant burden and collecting design-related feedback, are a better reflection of the goals and needs of partners within the project.

4 Benchmark Survey and Choice Experiment



The SOULMATE benchmark survey is an online questionnaire that has been distributed among seniors who are potential customers of the SOULMATE application. Unlike the small and focused groups of participants in the workshops of the Initial Testing phase, the benchmark survey included a broad group of seniors. Within the project, the set-up and results of the benchmark survey will be reported in deliverable D3.4, parts of which are included in appendix B and C. This PDEng report mainly focuses on the choice experiment that was included in the benchmark survey; the design and results of this experiment are described in more detail (Paragraph 4.3). Other included measures and their descriptive results are described briefly, with further detail regarding their backgrounds in literature included in Appendix J. The full benchmark survey was first shared online in Q4 of 2019, but due to legal complications (see Luub, 2020) and the COVID-19 outbreak the data collection is still going at this report's time of writing. Data collection and the reporting of deliverable D3.4 is expected to wrap up in Q2 of 2020, adding data from Austrian seniors as well. The data and results included in this report are therefore preliminary and should be viewed with this restriction in mind.

4.1 Benchmark Survey General Goal

The goal of the digitally launched benchmark survey was to provide information about characteristics of the general senior audience who might be interested in the SOULMATE application. This broad form of data collection mainly deals with business and academic interests, while also providing a benchmark to which other activities in the project (mainly the field trials) could be compared. Since the survey included several health and social measures, relevant academic questions regarding the relations between age, travel behavior, and the different health outcomes can be answered. A focal point in both academic and business value of the benchmark survey is the conducted choice experiment. This choice experiment presented participating seniors with various forms of a future SOULMATE mobility application. Through their choices, the relative importance of mobility application characteristics is estimated. These estimations mainly provide value for business through the calculation of the willingness-to-pay; how much seniors are willing to pay for the addition of certain features. An additional value for the business side of the project comes through the identification of subgroups of participating seniors; which can be used for the implementation of business strategies for different segments of the potential market. Value for academic interests comes from generalizing the results regarding importance of mobility application features and segmentation; what can be inferred from seniors' preferences regarding the SOULMATE

solution? This question can be investigated further by connecting the results from the choice experiment to other demographic data or other personal characteristics. For instance, older seniors might have different preferences when it comes to a mobility application than younger seniors, or males may be willing to pay more for an application than females.

As the title of benchmark survey suggests, the broad overview of characteristics should additionally serve as a benchmark to which the data gathered in the field trials can be compared. Having this larger set of data as a benchmark, provides the research team with a broader perspective of how using the SOULMATE application impacts the daily lives of users. To this end, several measures are included in the benchmark survey, as they were expected to be impacted by the SOULMATE application.

4.2 Benchmark Survey General Set-up

The benchmark survey was set up as a digital survey. After a process of designing and discussing the survey with SOULMATE consortium partners, the included measures and choice experiment were put into a digital structure through Limesurvey (www.limesurvey.org); an open source platform for online questionnaires used by the Urban Systems and Real Estate group of the TUE. Limesurvey provides easy tools for creating, distributing and gathering online surveys (Figure 9).

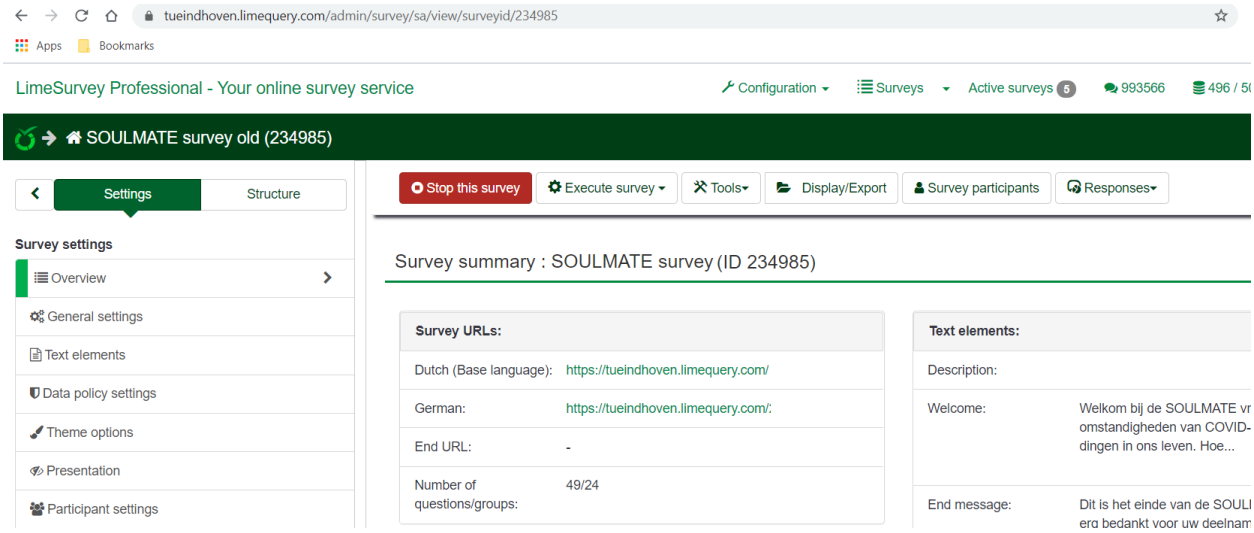


Figure 9. Screenshot of Limesurvey; the online survey tool used for the benchmark survey of the SOULMATE project.

In addition to the digital version of the benchmark survey in Limesurvey, a paper version was created as well; since some seniors might be more accessible in person than online. The Dutch version of the complete survey is included in Appendix B. Both versions of the questionnaire were first distributed through the networks of senior organizations in the consortium; they shared a link on their online platforms such as their newsletters and social media. In addition, the paper versions of the survey were shared with seniors during already planned events and meetings. However, due to COVID-19 restrictions

only a limited number of paper surveys could be distributed in the Netherlands. Therefore, additional data was gathered through the panel company Panelclix (www.panelclix.nl). At the time of writing, data collection in Belgium and the Netherlands has finished; their data is included in the results. Of these participants 41% was surveyed by participating senior organizations, while the other 59% were surveyed through (and compensated by) Panelclix.

4.3 Choice Experiment Set-Up and Results

To gather insight into the preferences of potential end-users regarding various features that could (and will) be included in the SOULMATE application, a choice experiment has been developed. In a choice experiment hypothetical scenarios are presented to respondents (Hensher, Rose, & Greene, 2005). In the case of SOULMATE, the choice experiment allows us to investigate seniors' preferences for potential future application offers. This will allow us to see which aspects of such an application are important or valuable for our audience, before it is fully developed. Since choice experiments deal with imaginary situations, their validity has been a topic of investigation in the past; how well do these experiments actually represent real-life situations? Several studies have compared experiments such as stated choice to real-life observations, and conclude that the outcomes of both approaches are comparable (e.g., Zeuwts et al., 2016; O'Hern, Oxley, & Stevenson, 2017). So, while there is still some academic debate choice experiments appear to be a more than acceptable reflection of reality, and thus a fitting choice for investigating our future application.

During the choice experiment, respondents are first explained the details of how the task is structured how all included attributes are defined, and what is expected of them. After, seniors are presented with pairs of two application offers (which look like the profile shown in Figure 11). They are then asked to indicate which of the shown alternatives they would prefer, or choose a third "neither" option. When a respondent makes several of these choices and many other respondents do the same, we can estimate which characteristics of each offer are important to our respondents. Because an orthogonal design is used to create the alternatives, the individual contribution of each attribute to a respondent's choice can be measured. In other words, we can measure how much more (or less) likely a respondent is to choose an application if (for instance) a video-calling functionality is added to it.

The following steps are generally important in the construction of a choice experiment, according to Hensher and colleagues (2005): defining a research problem and research question, selecting attributes, selecting attribute levels, and specifying the research design (see Figure 10, adapted from Hensher, Rose, & Greene, 2005). In addition to these steps, attention will be paid to the formal specification of the used models and model performance indicators.

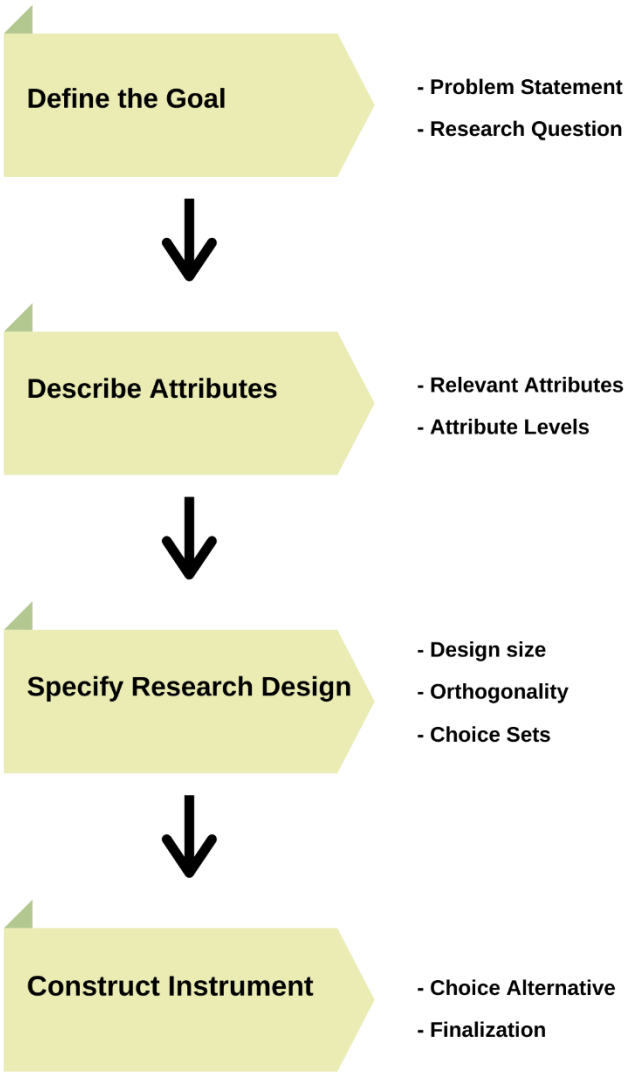


Figure 10. Steps of setting up a choice experiment. Adapted from Hensher, Rose, & Greene, 2005.

4.3.1 Research Problem and Question

The first step of setting up a choice experiment is determining what question one is trying to answer by conducting the experiment. As mentioned in the overall aim of the benchmark survey, the first aim of the current experiment was to investigate what kind of functionalities of a mobility application are important to seniors. Therefore, the experiment should reflect different functionalities that could be included in a future version of the SOULMATE application. A related goal was to assess Willingness-To-Pay (WTP)

coefficients (e.g., Louviere & Islam, 2008) for the included functionalities, so possible future price points were included in the experiment as well. The second aim of the choice experiment was to see if segments (or classes) of participants can be identified. It could, for instance, be insightful to know if a certain group of seniors loves one functionality more, while others prefer another. In this way, the segmentation of the respondents can provide a more detailed picture of seniors' preferences. Additionally, this information could provide more insight into potential business strategies (i.e., for customer segmentation).

4.3.2 Attribute Selection

Two kinds of attributes were included in the choice experiment: the main functionalities that SOULMATE aims to include at some point and a price that the consumer pays for the application. These main functionalities include the most important value propositions in the SOULMATE application, which are: street-view exploration, indoor exploration, finding facilities, public transport information, sharing routes with others, and video calling. Together, these functionalities cover the three pillars of the SOULMATE application (as described in Paragraph 2.4). Basic navigation functionalities (such as making and saving routes, receiving directions) are a fundamental part of SOULMATE on which these additional functions will be built. As basic navigation is required, it was not included as a separate attribute in the choice experiment but presented as a given for all alternatives. The resulting six main functionalities of the SOULMATE application are further specified.

Street-View Exploration

The street-view exploration functionality allows users to explore their surroundings from the comfort of their own home. By presenting a digital three-dimensional environment, users can look around on a planned route. This way, they can virtually explore their route and see what streets, buildings and other landmarks look like on the way. Users would use Street-view exploration before going on a trip, with the goal of getting familiar with surroundings before going out.

Indoor Exploration

Indoor exploration lets users virtually explore (public) buildings on the inside. This functionality adds buildings such as train stations, shopping centers, or town halls to the virtual exploration options. Indoor exploration of, for example, a train station can be useful to see in advance where to buy a ticket, where the best snacks are sold, or where toilets are. Users would generally use Indoor exploration before going on a trip, with the goal of seeing exactly where to go before going out.

Finding Facilities

Finding facilities allows users to find a route to the nearest facility of their choosing. When on a trip, a simple facilities menu allow the user to change their destination to that facility. In this menu they can look up the routes to the nearest bench, toilet, or restaurant. A simple confirmation will change the route navigation to the chosen facility. Finding facilities will be used during a trip, with the goal of providing security in knowing exactly where facilities are when needed.

Public Transport Information

Public transport information allows users to receive up-to-date information on public transport. This information includes live timetables for buses and trains, as well as information regarding stops and

routes. The application can thus tell a user at what time a bus to their destination departs, how to walk to that bus stop, and their expected time of arrival. Public transport information will be used during a trip, with the goal of providing all relevant information a user may need when using public transportation.

Sharing Routes With Others

The sharing routes with others functionality lets users share their routes and location with others. A user can designate a coach, a trusted person who they can choose to inform when and where they are making a trip. This coach can then track their location and check in on the user. When sharing a route with others a user can also set automatic boundaries around their selected route, which alerts them and/or their coach when they stray too far from the route. Sharing routes with others will be used while making a trip, with a goal of providing security to users knowing someone they trust is there to check in on them.

Video Calling

Video calling allows users to contact others during their trip. One simple press of a button allows the user to make a video call with their coach, another contact, or emergency services. A user can also instruct the application to automatically call one of their contacts in case of emergency; such as a fall or after a period of inactivity. Video calling will be used while making a trip, with the goal of providing easy access to whomever is needed in case of emergency.

Price

Price is included as a one-time payment in euros. While many applications and similar services offer subscription services with monthly payments, the point of entry to the SOULMATE application should be low (especially in this early stage). To prevent seniors from having to make a commitment to a product they do not know yet, a one-time price is included in the experiment.

4.3.3 Attribute Level Selection

A common way of specifying levels for attributes is to indicate them as low, medium, or high. This method works well for representing the levels of most attributes, such as the visibility or comfort of a biking path. Generally, respondents are able to distinguish between these levels on an intuitive level. However in the case of SOULMATE application functions, a three level representation was deemed too confusing by seniors and senior experts. Thus, these function attribute levels were simplified to have only two levels: present or absent. For the price attribute three levels were used representing one-time payments of €2, €4, and €6. These amounts were based on earlier studies of mobile applications in choice experiments (e.g., Heblij, 2012), as well as price points of similar applications on app-stores and discussion with consortium experts.

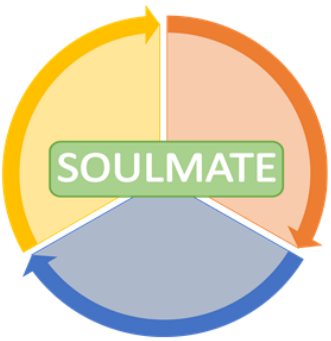
4.3.4 Design Specifications

Once attributes and their levels have been specified, they can be assembled into alternatives. These alternatives include one level of each alternative; forming a complete potential application with a certain cost. To make the process of making choices more accessible for the respondents, choice alternatives are often presented using textual and visual support. For the SOULMATE application, visuals are designed to look like examples of application offers that one would encounter in an app store (Google, 2020). Figure 11 shows what this final profile looks like in the SOULMATE survey.

In assembling these choice alternatives two main challenges present themselves: a large amount of alternatives and orthogonality. Firstly, when all combinations of attribute levels are used, respondents are looking at a total of $2^6*3^1=192$ alternatives. Even if these alternatives are presented in groups of two or three, looking at them all still takes a lot of time and effort. In order to reduce the number of alternatives that need to be presented, a fractional factorial design is used. Instead of including all possibilities, a factorial design specifies how many combinations of attribute levels are enough to represent each attribute equally. The choice between factorial designs then depends on factors such as the importance of estimating (higher order) interaction effects, the number of participants, and how many choices each participant can make. In the case of the SOULMATE survey, a total of 16 alternatives are enough to represent all attribute levels (Addelman, 1962), fitting with the aimed number of participants in the survey, the number of choices each participating senior can make, and an intended focus on main effects. The other challenge is that of orthogonality; making sure all attributes are independent of each other. Only when the attributes are independent, statistical models can estimate how much each level contributes to the choice a respondent makes. Without orthogonality, it thus becomes impossible to disentangle individual functions from a complete alternative. Fortunately, the tables designed by Addelman (1962) already account for orthogonality, including each attribute level equally across alternatives. Thus, the final 16 alternatives can be used in the experiment.

Next, the designed choice alternatives are placed into choice sets; a choice experiment requires participants to make a choice after all. For the SOULMATE survey two alternatives are presented at the same time, with an additional option to choose neither. The 16 choice alternatives are therefore randomly combined into 8 choice sets (group A). To address potential issues of order or which side the alternative was presented on, a second group of choice sets was created that swapped alternative sides and randomized the order (group B).

Thus, each participant is presented with 8 choices, randomly selected from group A or B. They are asked to choose which of the alternatives they prefer, or the “none of these” option if they neither are to their liking. Statistical models can then estimate how much each of the specified attributes has contributed to the participants’ choices.

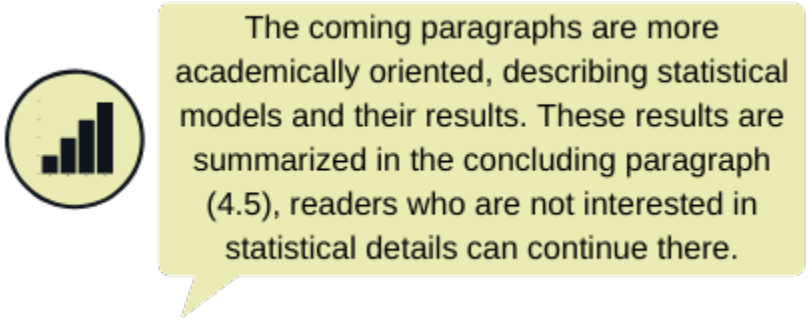


SOULMATE – Uw reispartner op de smartphone

★★★★★

Streetview 3D ontdekken	X
Gebouwen 3D ontdekken	√
Route naar dichtsbijzijnde voorzieningen	X
Actuele openbaar vervoer informatie	X
Delen van route en positie met anderen	X
Interactie met anderen (videobellen)	√
Prijs	€ 6

Figure 11. Example of a SOULMATE application offer alternative (in Dutch). The alternative visually shows the presence or absence of the main six functionalities of the SOULMATE application, as well as a price.



4.3.5 Specification of Models

As described in Paragraph 4.3.1, the choice experiment included in the SOULMATE survey aims to answer two main questions: which application functions are important to seniors and what do customer segments look like. The first question is answered with a standard multinomial logit model (MNL). This model estimates utilities for each of the included attributes; it calculates weights based on how important an attribute is in the choices of participants. The second question is answered using a Latent Class model (LC); an extension of the standard MNL model. In addition to estimating utilities for each attribute, the LC model also estimates if there are classes of respondents. In other words, the LC model allows researchers to investigate if there are groups of participants who give similar answers. Then, the model estimates utilities of the attributes for each of the classes that were identified. For example, one group of respondents could absolutely love the *Streetview Exploration* and *Video-calling* attributes, while others are more influenced by *Price* and the presence of a *Finding facilities* function. As these groups would be averaged out in a standard MNL model, the addition of using the LC model could reveal important nuances, especially in a respondent group as heterogeneous as seniors. These two models use different ways of estimating the utility for each attribute, and thus have a different formal mathematical specification. These specifications are included in Appendix H.

4.3.6 Model Performance Indicators

As a choice experiment is analyzed, it is useful to look at the measure that show how well a model performs. For the multinomial logit and latent class models, two main statistics are generally used to describe model performance: the Log-likelihood Ratio Statistics (LRS) and McFadden Pseudo R-square (Hensher, Rose, & Greene, 2005). Both indicators for performance are based on the log-likelihood, which shows the difference between observed scores and predicted scores from the model. The ratio between these log-likelihoods (the LRS) indicates how well the estimated model performs with respect to a null model, where all parameters are set to zero. To indicate significant performance, the estimated model (or optimal model) is then tested against a critical chi² value, as the LRS generally follows a chi² distribution. To provide an indication of the degree to which the model predicts the observations in the data, an R^2 is calculated as well. In the case of the comparison between null and optimal model, the McFadden Pseudo R^2 is used. Guidelines provided by Hensher and colleagues state that an R^2 of 0.3 or higher (i.e. the model predicting over 30% of observations) can be considered acceptable, Louviere (2000) specifies an R^2 between 0.2 and 0.4 to be acceptable. For latent class models, there is also an indicator to compare how the number of classes changes model performance; the minimum Akaike Information Criterion or AIC (Akaike, 1987). The AIC is calculated by subtracting (2x) the number of estimated parameters from (2x)

the log-likelihood. This indicator can thus be used for instance to decide if a model with two classes or three (or more) classes better suits the data; the model with a lower AIC better providing a better fit, given the number of parameters.

4.3.7 Choice Experiment Results

In total, 356 respondents provided complete information in the choice task and were thus included in the analyses. Together, they made 2848 choices; providing the analyses with that many observations. The information regarding model performance indicators are shown in Table 2. It appears that both models outperform their null models. This is also supported by the fact that several of the included attributes significantly contribute to the utility of a preference for an application offer. The predictive power of the models can be described as adequate to good, with the latent class models outperforming the standard MNL model by a substantial margin.

Table 2. Model goodness-of-fit information for latent class models up to four classes. Models with more classes consistently outperform previous ones, but interpretation becomes less clear at four classes.

# Classes	# Parameters	LL	LL ratio	McFadden R^2	AIC
Constants only	1	-2639.16	0	.05	5280.32
1 (MNL)	8	-2501.16	1255.37	.25	5018.32
2	17	-1868.94	1264.45	.40	3771.88
3	26	-1808.14	121.60	.42	3668.28
4	35	-1778.17	59.94	.43	3626.34

Based on these indicators and the interpretation of class distributions, a LC model with 3 classes appears to fit the data best. Although the 4 class model still shows improvements over the previous one in terms of AIC and LL ratio, these improvements are less substantial than the difference between the 2 and 3 class models. On top of this, the 4 class model identifies a class containing only a small proportion of respondents (7%), inflating the weights of included attributes. Thus, the 3 class model is performing the best, with adequately distributed groups and attributes that can be interpreted. The participants included in the 3 class model are distributed as follows: Class 1 contains 46%, Class 2 has 30%, and Class 3 contains 23% of participants.

Table 3. Coefficients of model attributes of the general MNL model and the three LC model classes. The constant is coded to represent either presented options; a negative constant indicating participants more often chose neither of the offered alternatives.

Attributes	MNL model	LC model Class 1 (Prb= .464)	LC model Class 2 (Prb= .302)	LC model Class 3 (Prb= .234)
Constant	- .553 ***	- 3.842 ***	1.491 ***	.984 ***
Streetview Exploration	.138 ***	- .145	.116 **	.409 ***
Indoor Exploration	.058 *	.156	.067	.250 **
Finding Facilities	.348 ***	.747 **	.323 ***	.673 ***
Public Transport Information	.237 ***	.286	.253 ***	.444 ***
Sharing Route With Others	.171 ***	.420 *	.118 **	.381 ***
Video Calling	.158 ***	-.084	.213 ***	.455 ***
Price	- .184 ***	- .275 *	- .103 **	- .554 ***

****, **, *, Significance at 1%, 5%, 10% level*

The coefficients and their significance of the MNL and 3- class LC model are reported in Table 3. First, the MNL model shows a negative constant, indicating that many participants preferred neither options when making one or more choices. Further, the model shows that all included functionality attributes have a positive coefficient; their inclusion adds value to the chosen alternative. From these functionalities, Finding Facilities and Public Transport Information appear to be the most important, while Indoor Exploration is the least important by a considerable margin. The coefficient for price is negative, indicating participants generally prefer lower prices over higher ones.

The LC model further details these general results by identifying groups of respondents with similar choice patterns. Based on their coefficients the three classes identified by the LC model can be characterized as follows:

Class 1 includes seniors who are generally not interested in purchasing the presented mobility application. However, they might be convinced to buy it by including the Finding Facilities function and to a lesser extent the Sharing Route With Others function. Other functionalities are not important to seniors in this class and their choices are only slightly impacted by the price of the application.

Class 2 contains seniors who are eager to purchase the presented SOULMATE application. They are mildly interested in all functionalities except Indoor Exploration; their choices being impacted most by Finding Facilities and Public Transport Information, but not with a large margin over other functionalities. These seniors do prefer a lower price over a higher one, but price is relatively unimportant to them.

Class 3 has seniors who generally prefer to purchase the one of the presented applications over turning them down, but not as much as the seniors in Class 2. For the seniors in Class 3 all functionalities are important, even Indoor Exploration. Their most valued functionality is in line with the other classes: Finding Facilities. Compared to seniors in other classes, these seniors value price the most; greatly preferring a cheaper application over more expensive alternatives.

The relative contribution of each attribute to the choice of the participant is displayed in Figure 12, with gray bars representing non-significant attribute coefficients. Across classes, the relative important of the Finding Facilities functionality stands out above the rest. On the other end, Indoor Exploration and Streetview Exploration are relatively unimportant to participating seniors.

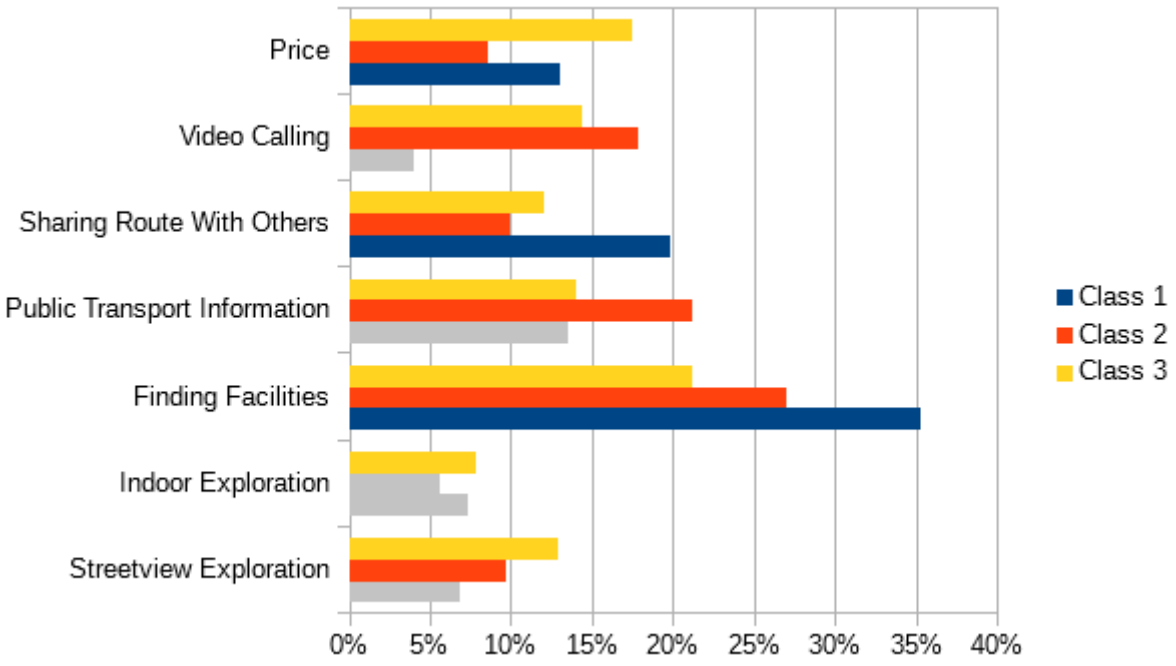


Figure 12. Relative importance of price and functionality attributes for each of the three identified latent classes (Bars in grey represent non-significant attributes).

Given these attribute weights, the Willingness-To-Pay (WTP) coefficient can be calculated to give an indication what participants are willing to pay for each SOULMATE functionality. The value of the price attribute is negative, indicating that participants generally prefer options that cost less. The WTP coefficient is calculated by dividing each significant attribute weight by the absolute (positive) weight of price. The total WTP for an application that includes all functionalities is then calculated by summing all functionality coefficients (Table 4). In general (the MNL model), seniors are willing to pay €3,04 for a SOULMATE application that includes all functionalities described in the choice experiment. In line with the descriptions of the LC model, seniors in Class 2 show the highest total willingness to purchase the presented SOULMATE application. In total, they are willing to pay €24,39 for an application that includes all the specified functionalities. The total WTP of the seniors in Class 1 is negative (- €9,70), once again

indicating that this group of seniors is not interested in the offered applications. The willingness to pay of Class 3 falls in between these extremes, with a total WTP of €6,49.

Table 4.Willingness-To-Pay coefficients per attribute for the MNL model and the three classes identified by the LC model.

Attributes	WTP MNL model	WTP Class 1 (46%)	WTP Class 2 (40%)	WTP Class 3 (23%)
Constant	- € 3,00	- € 13,95	€ 14,44	€ 1,78
Streetview Exploration	€ 0,75	€ 0	€ 1,13	€ 0,74
Indoor Exploration	€ 0,32	€ 0	€ 0	€ 0,45
Finding Facilities	€ 1,89	€ 2,72	€ 3,14	€ 1,21
Public Transport Information	€ 1,29	€ 0	€ 2,46	€ 0,80
Sharing Route With Others	€ 0,93	€ 1,53	€ 1,15	€ 0,69
Video Calling	€ 0,86	€ 0	€ 2,07	€ 0,82
Total WTP	€ 3,04	- € 9,70	€ 24,39	€ 6,49

Note: WTP coefficient for non-significant attributes is set to €0

Besides the WTP, it can also be interesting to look at the demographic data distributions of the three classes that were identified through the LC model. Since these classes have purely been estimated on the choices of participating seniors, further descriptions of these classes in terms of age, gender, and other demographics can provide interesting characterizations for business and academic purposes. Of the demographics that were included in the SOULMATE benchmark survey (Paragraph 4.4.1: age, gender, country of participation, education, migration, urban environment, living situation, car ownership, partner), only age ($chi^2 = 24.03$, $p < .05$) and country of participation ($chi^2 = 52.86$, $p < .01$) show significantly different frequency distributions per class.

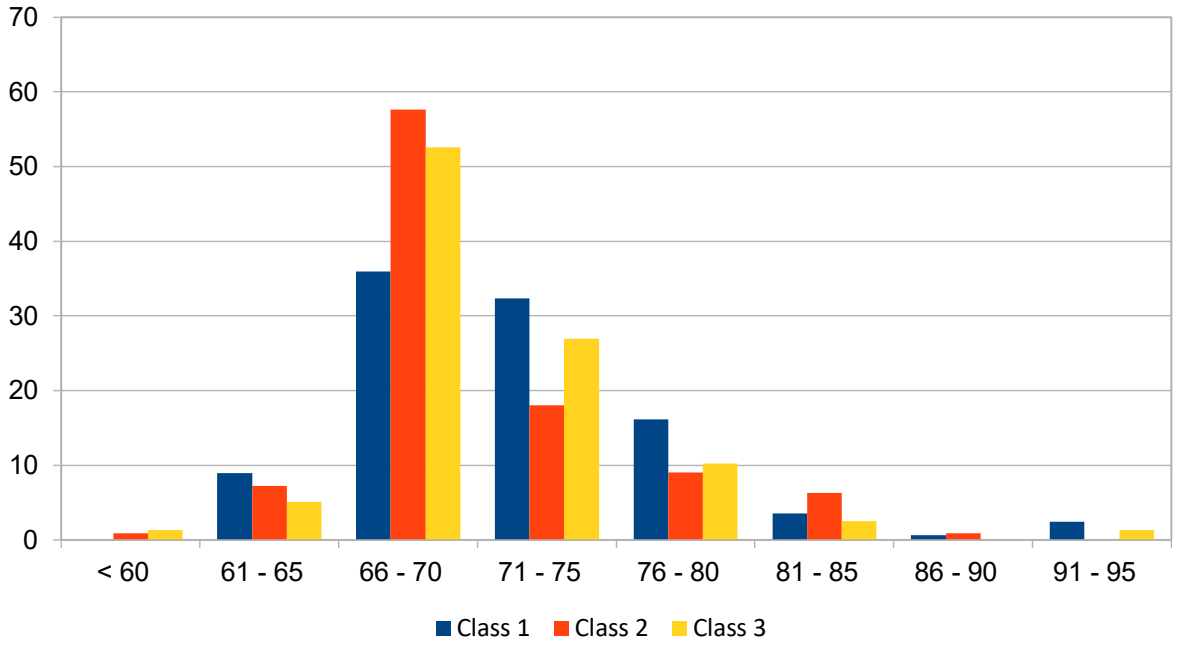


Figure 13. Proportional age distribution of participating seniors across the three classes identified by the Latent Class model.

As Figure 13 illustrates, the distribution in age of participating seniors of Class 1 differs slightly from those of Class2 and Class 3. It appears that the seniors in Class 1 are significantly older than the seniors in other the classes.

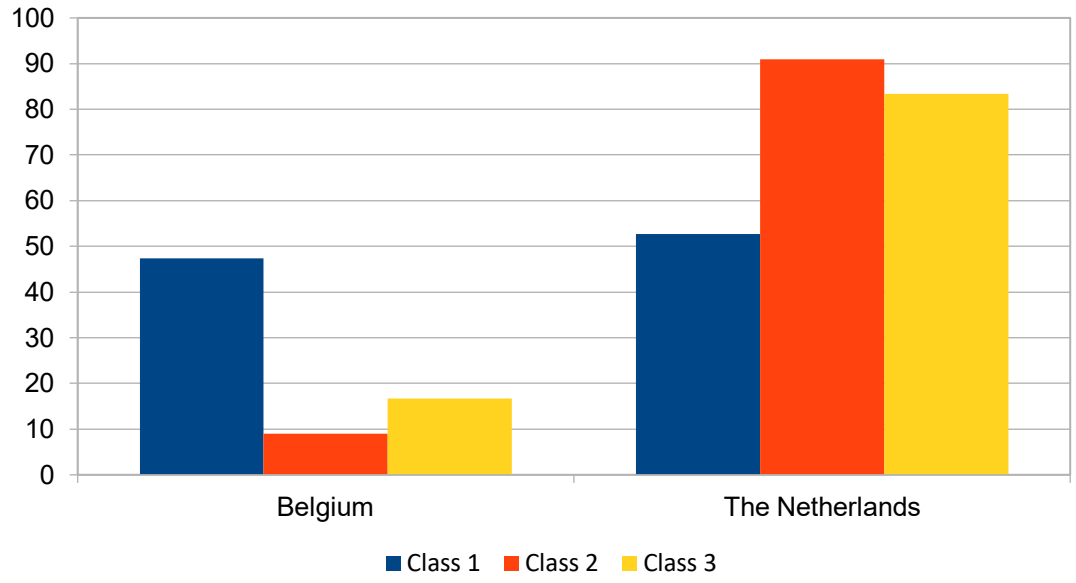


Figure 14. Proportional distribution of country of origin for participating seniors across the three classes identified by the Latent Class model.

A more pronounced difference can be seen in the distribution of classes among country of participation (Figure 14). While seniors participating from the Netherlands are distributed approximately even among the three classes, Belgian seniors are overwhelmingly attributed to Class 1. It thus appears seniors from Belgium who participated in the survey were less likely to choose for one of the SOULMATE offers than seniors from the Netherlands.

4.4 Survey Measures and Results

Several measures are included as part of the SOULMATE benchmark survey. Since it aims to provide a broad background on the seniors who form the target audience of SOULMATE, the survey contains measures the SOULMATE application aims to address: demographics, travel behavior, general health, social network, and loneliness. Short descriptions of all measures are provided, with extended literature backgrounds of some detailed in Appendix J. As mentioned, the results reported in this report are not yet complete, as data from Austrian seniors is still going to be included in the near future. However, the data that is available can already provide some preliminary insights into what the target audience of the SOULMATE application looks like. At the time of writing these results, data collection has yet to happen in Austria. Thus, only responding seniors from Belgium and the Netherlands are included in the results. In total 359 seniors participated in the survey; 146 through the original end-user organization recruitment and the remaining 213 by the Panelclix company.

4.4.1 Demographics

With any questionnaire, online or otherwise, it is important to gain some general insights into the sample of respondents who provide the answers. These demographics often cover questions such as age, gender, (educational) background, and living situation. Table 5 describes the demographic questions that were included in the SOULMATE benchmark survey. These demographic questions are included to provide an insight into the general background of seniors who might be interested in the SOULMATE application. For example, a senior who owns and drives a car to get around, might not be particularly interested in a mobility application that focuses on public transport.

Table 5. Descriptions of demographic questions included in the SOULMATE benchmark survey.

Demographic	**Description**	**Answering Options**
Country	In which country is the participant	Austria/ Belgium/ Netherlands
Gender	Gender of participant	Female/ Male/ Other
Age	Age category	Below 60/ 61-65 to 96-100/ Above 100
Education	Highest completed education	None/Lower Edu/ Low-/Medium-/High- Professional Edu/ Other

Migration	Is participant born in Country	Yes/ No
Urban	Urbanization level of home	City/ Village/ Rural
Home	Living situation	House/ Apartment/ Independent senior flat/ Senior home/ Other
Car	Car ownership	Yes/ No
Partner	Is participant living with a partner	Yes/ No

Descriptive statistics of the demographic questions are included in Appendix C; showing a well distributed sample of seniors across age and gender (Figure 15). Most participants answered the questionnaire in the Netherlands (71%; as they were surveyed through Panelclix), and were born in the country they currently live in (91%). The majority of seniors live in a house (73%) or apartment (24%) with their partner (74%), in a city (45%) or village (47%). Most respondents are have completed at least a professional education (65%) and own a car (87%).

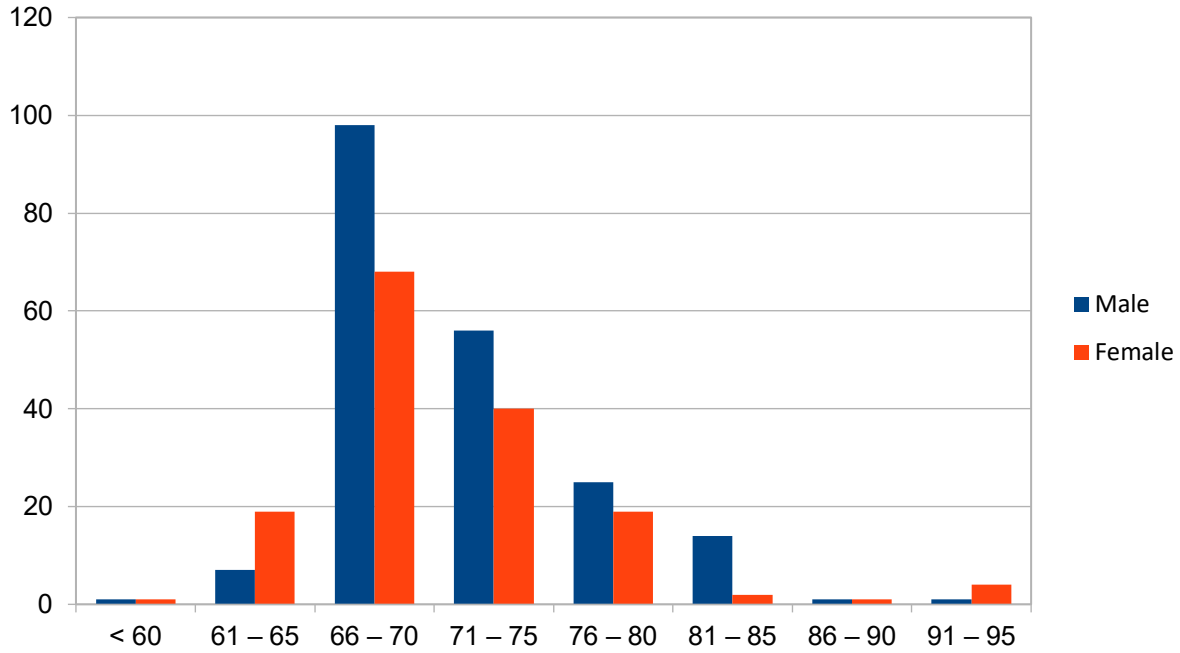


Figure 15. SOULMATE Benchmark survey sample age distribution across gender.

4.4.2 Self-Reported Health

For the development of the SOULMATE application, the health of seniors is an important factor. As described earlier in the background of the project, health can play an important role in determining if a

seniors will use a mobility application. On the other hand, health can also be an important impact factor of using the SOULMATE application. In the benchmark survey health is measured through self-report; using the 12 item Short Form health scale (SF-12; Ware, Kosinksi, & Keller, 1996). This short questionnaire covers the most important mental and physical health aspects and has proven to be as accurate as longer versions (Ware et al., 1995). The questions and statements of the SF-12 cover both current health and health across the previous four weeks; these questions are rated on different scales, ranging from two (yes/no) to six (always to never). Six of the SF-12 items combine into a summary score for physical health, while the other half summarize into a mental health score. After coding, these summary scores range from 0 to 100, a higher score indicating a better self-reported health. More information regarding the measurement of self-reported health through the SF-12 is described in Appendix J.1.

Seniors participating in the SOULMATE benchmark survey rate themselves as relatively healthy. Out of 100, seniors score an average of 76 on physical health and 79 on mental health (Table 6). The range of reported physical health scores is higher than those of mental health; indicating the group of participating seniors is slightly more heterogeneous in physical than in mental health. A bi-variate correlation analysis shows a moderately positive relation between physical and mental health ratings (r = .58, p < .01); indicating that seniors who rate their physical health as better tend to do this for mental health as well.

Table 6. Average and distribution of self-reported physical and mental health scores, out of a maximum of 100.

	Average	**Standard Deviation**	**Minimum**	**Maximum**
Physical Health	76	25	0	100
Mental Health	79	18	17	100

4.4.3 Loneliness

Social aspects are an important potential impact of the SOULMATE application. When going out independently is easier for seniors, it makes sense for them to go out and visit friends and family members more often as well; reducing loneliness and growing their social networks. These two social aspects were therefore included in the benchmark survey and described here and in Paragraph 4.4.4.

Loneliness is often categorized in two ways; social loneliness and emotional loneliness (Weiss, 1973). Where social loneliness describes a lack of a person's place in the community as a whole, emotional loneliness describes a lack of meaningful, deep relations with a best friend or partner. To illustrate, social loneliness would be reported by a person moving to a new country or town, while emotional loneliness could be caused by the passing of a spouse or a divorce. These two dimensions of loneliness are reflected in included short version of the De Jong Gierveld *Loneliness Scale* (De Jong Gierveld & van Tilburg, 2006), which contains three items for each. All six items are rated on a 3-point scale: "No", "More or Less", and

"Yes". Total scores for emotional and social loneliness can thus range from 3 to 9, with higher scores representing a person rating their situation as more lonely. Additional background on measuring loneliness is included in Appendix J.2.

Results show that the seniors who participated in the SOULMATE benchmark survey do not rate themselves as very lonely. Their majority indicates not having any feelings of loneliness whatsoever (Figure 16). Only two seniors indicated feelings of extreme social loneliness (scoring the maximum) and not a single one indicated feeling extremely emotionally lonely.

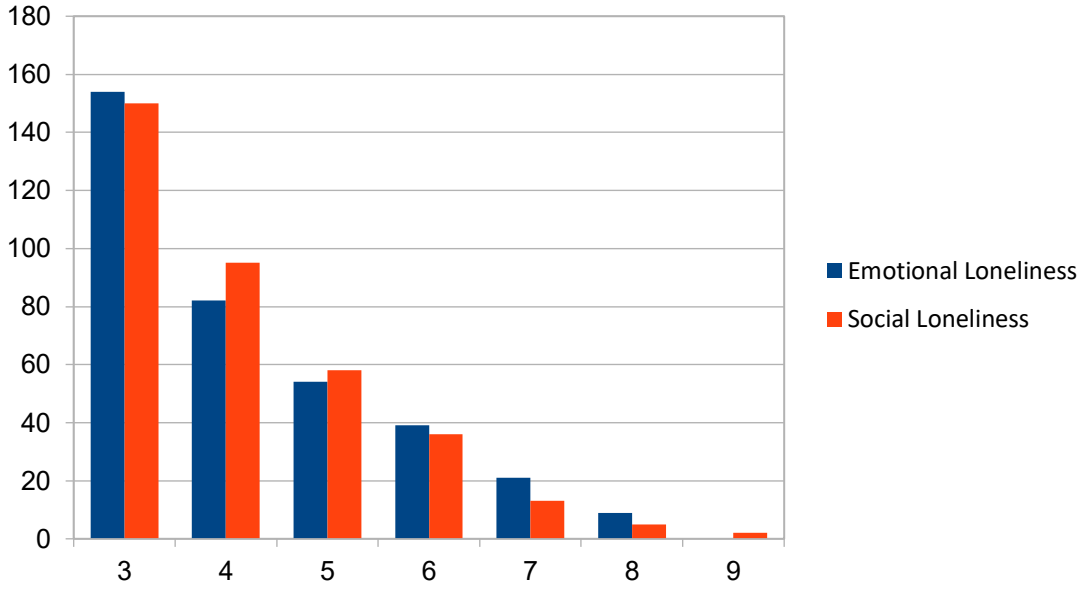


Figure 16. Distribution of ratings by participating seniors regarding emotional and social loneliness, on a scale of 3 to 9.

On average, the ratings on loneliness provided by participating seniors can be described as low as well. With mean scores of 4.21 (emotional) and 4.14 (social) on a possible range from 3 to 9, these seniors only report minor loneliness at worst, although individual differences do exist (Table 7). Ratings for emotional loneliness and social loneliness are not substantially different from each other; showing that both types of loneliness exist in approximately equal amounts. A bi-variate correlation shows that seniors who indicate having more emotional loneliness tend to experience more social loneliness as well (r = .71 , p < .01).

Table 7. Average and distribution of reported emotional and social loneliness scores, on a range from 3 to 9.

	Average	Standard Deviation	Minimum	Maximum
Emotional Loneliness	4.21	1.38	3	8
Social Loneliness	4.14	1.29	3	9

4.4.4 Social Network

As the SOULMATE application aims to make going on trips easier for seniors, they are expected to meet more people as a result; allowing them to make more (or strengthen existing) social connections and grow their social networks. Therefore, the social networks of seniors participating in the SOULMATE project can be a valuable outcome in measuring the impact of the application. For the SOULMATE benchmark survey, members of participating seniors' social networks are unknown; a single senior participates in the (online) survey, not an entire social group. Thus, an 'ego centric' approach to measuring the social network is most appropriate in the current context (Marsden, 2005). This 'ego centric' approach focuses on investigating the individual and their specific relationships within their social environment, without trying to chart all relationships present in a network. A common way of measuring the social network on the individual level is by using a name generation task (Marsden, 2005). This task relies on the simple core concept of making a list of all members of an individual's social network. Counting the names on said list would already give an indication of the social network size of that person. Additional background information about the measurement of social networks is reported in Appendix J.3.

Two adaptations have been made to the name generation task for the SOULMATE benchmark survey; additional questions regarding the nature of each social relationship and the division into social network types for easier recollection. Besides the size of a senior's social network, some characteristics about these relationships can be valuable to include as well (e.g., van den Berg, Arentze, & Timmermans, 2010). In the benchmark survey, additional questions regarding the frequency of physical contact, the frequency of non-physical contact (for example by phone or digitally), and distance were included for each name generated by a participating senior. In the online survey this meant that once the participant entered a name, these three additional questions for this name appeared below (Figure 17). Furthermore, social contacts that participating seniors were asked to mention were separated in two categories; family members, or friends, neighbors and others. The 'others' group was described to include acquaintances from (volunteering-) work or clubs. This division allowed participating seniors to keep a better overview of the names they had already mentioned, as well as provide a memory cue for a social context which should make recalling contacts easier (McCarty, Killworth, Bernard, Johnsen, & Shelley, 2001).

For each of the two categories, participants were asked to mention up to 15 names (or initial or nicknames). For each of these names, they would be asked to rate the frequency of physical and non-physical contact on a five-point scale covering: “less than once a month”, “one to three times per month”,

"once a week", "multiple times per week", and "almost daily". The distance question for each contact was answered on a three-point scale, ranging from "in the same neighborhood" through "outside of my neighborhood but in the same city" to "outside of the same city".

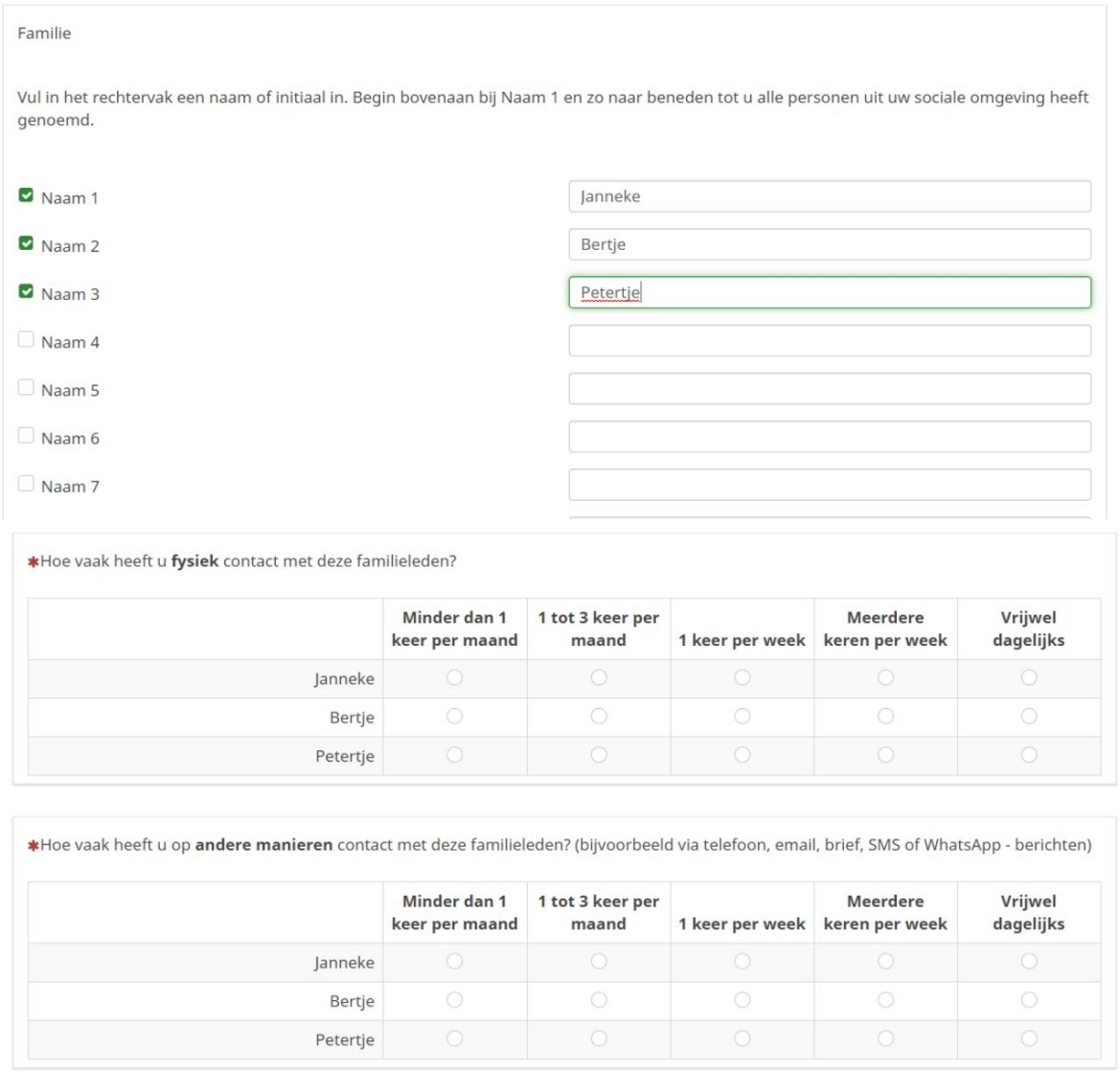


Figure 17. Screenshot of the (digital) name generation task as included in the SOULMATE benchmark survey in Limesurvey. When a contact name was entered in the list, questions regarding that relationship appeared below.

The results show that most participating seniors indicated a handful (1-6) social contacts of both family (Figure 18). There was also a considerable group of seniors who filled all 15 contacts, especially in comparison to the previous amounts. This could mean that a portion of these seniors actually had larger

social networks than they were able to mention; indicating a possible ceiling effect on total network size. On a related note, there were seniors participating in the benchmark survey who did not mention any names of contacts: 19 for the family group, 49 for the friends and neighbors group. These seniors are not included in these results, as the reason for their result is unclear; it is possible they actually have no contacts in these social categories, but it is equally likely they skipped the questions as (for time or privacy reasons, for instance).

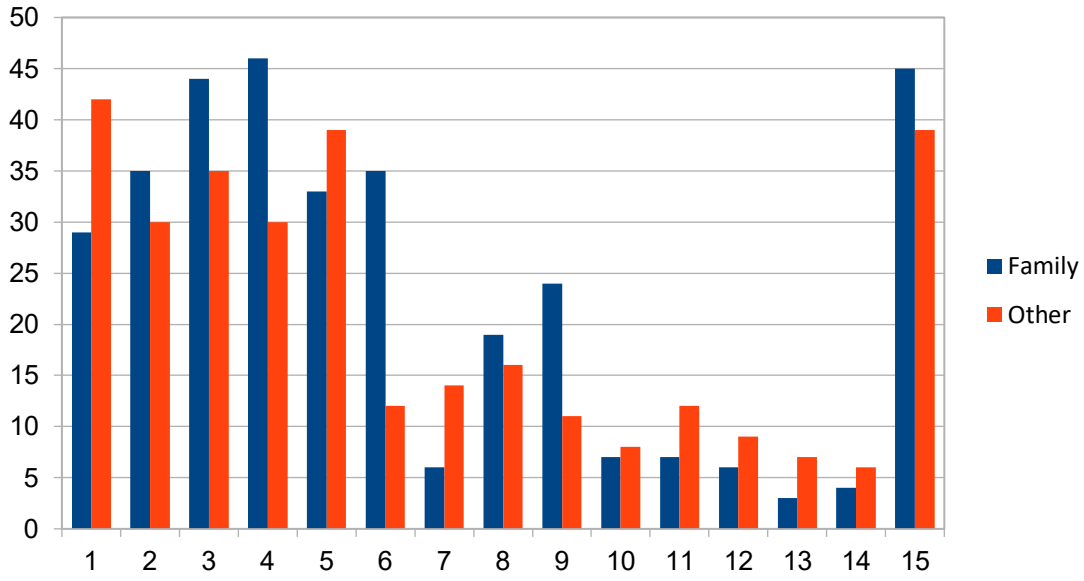


Figure 18. Social network size distribution of seniors participating in the SOULMATE benchmark survey, separately for social contacts from family or others (including friends and neighbors).

On average, participating seniors have an average total social network of 12 people; including both family members and others (Table 8). There is a high amount of individual difference, as roughly 95% of participating seniors have somewhere between 0 and 29 social connections. Social connections from family or other are comparable in terms of network size, physical contact frequency, and physical contact frequency. With frequency average scores between two and three, participating seniors interact with each of their social contacts between once a month and once a week.

Table 8. Average and distribution of social network sizes, physical interaction per contact, non-physical interaction per contact.

	Average	Standard Deviation	Minimum	Maximum
Family Network Size	6.38	4.43	1	15
Other Network Size	6.45	4.68	1	15
Total Network Size	12.14	8.30	1	30
Physical Interaction per Family Contact	2.64	1.00	1	5
Physical Interaction per Other Contact	2.72	0.99	1	5
Non-Physical Interaction per Family Contact	2.74	1.02	1	5
Non-Physical Interaction per Other Contact	2.16	1.09	1	5

Bi-variate correlations between these measures show a positive relation between the social network size of family and the size of friends and neighbors (r = .65, p <.01): seniors who mentioned more contacts from their family also mentioned more friends or neighbors as contacts. The same positive relations between family and friends exist for the frequencies of contact (physical interaction, r = .28, p <.01 and non-physical interaction, r = .42, p <.01). So, seniors who meet their family more often tend to do so with their friends as well; they are more socially active.

4.4.5 Travel Behavior and Activities of Daily Living

The results of these travel and activity measures are outside of the scope of this report. Therefore, only a brief summary of both measures is included here, more detailed descriptions and results in reported in Luub (2020). A brief summary of both is included here.

General travel behavior is measured by asking respondents to indicate their travel frequency for a list of trip purposes and travel modes. Seniors are asked to indicate how frequent they travel on a six-point scale ranging from “never or rarely” to “(almost) daily”. Trip purposes included activities such as shopping and work, travel modes include walking, biking, by car, and several forms of public transport.

Activities of daily living are investigated by asking participating seniors to indicate how easily they are able to perform daily tasks in and around the house. This ease of performing tasks is rated on a four-point scale: 1=“Yes, I can do this tasks independently without any effort”, 2= “Yes, I can do this tasks independently, but with some effort”, 3= “Yes, I can do this task independently, but only with a lot of

effort", 4= "No, I cannot do this task without the help of others". Household tasks include activities such as climbing stairs, make a short walk around the house, doing dishes, and vacuuming.

4.5 Benchmark Survey General Reflection

The two main goals of the SOULMATE benchmark survey were to investigate the preferences of seniors for mobility applications such as SOULMATE and to provide a broad benchmark of the target population to compare seniors participating in the SOULMATE testing to. Although there have been some limiting circumstances preventing Austrian seniors from participating, the SOULMATE survey has already largely served its purpose.

First, the results from the included choice experiment show clear contributions from all functionalities that would be part of the SOULMATE application. Especially the finding facilities and up-to-date public transport information functionalities appear to be important to participating seniors. When further disseminating these participating seniors, three subgroups could be identified. The first group is hesitant to use a mobility application but could be persuaded by the inclusion of finding facilities and sharing a trip with others. The second group is very interested in trying out a mobility application, is enthusiastic about most functionalities, and is willing to pay the most for the application. The third group is more hesitant but still interested in using a mobility application, prefers multiple different features, and is more sensitive to price.

Next, looking at the demographics and other measures that are included in the benchmark survey provides a good idea of the characteristics of participating seniors; the potential audience for a SOULMATE application. These seniors are distributed broadly among age categories and gender, with a majority between 65 and 75 years old. There are many individual differences in their characteristics, but most seniors rate themselves as healthy, having at least a handful of close social contacts, and not experiencing much loneliness.

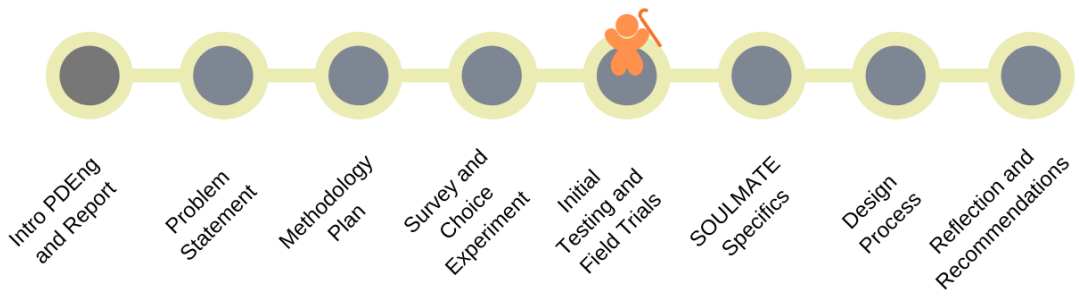
When looking at the relation between the identified classes and the included demographics, the results show that Class 1 includes older seniors who are more likely to come from the Belgian sample. In terms of their choices and WTP, these results imply that older seniors and seniors from Belgium (in comparison to Dutch seniors) are less interested in purchasing a mobility application like SOULMATE. However, these seniors might be convinced to use one of these applications if they are offered functionalities for finding nearby facilities or sharing their trips with others.

Further investigation into the data collected in the SOULMATE benchmark survey is recommended as a follow up to this report. For both academic and business related goals, the multivariate relations between the measures of the survey could be investigated. This investigation could provide more insight into the direct and indirect relations between mobility, health, and social environments in seniors. These relations can also be studied in relationship with the choice experiment results; exploring more characteristics (such as level of health or loneliness) of the classes that were identified in the analyses that have been reported here.

In conclusion, the SOULMATE benchmark survey has provided a broad overview of the seniors who are the potential audience for the SOULMATE application. Even though data from Austrian seniors should still

be included in the near future, an extensive overview could already be established in terms of seniors' mobility application preference and health, mobility, and social characteristics.

5 Initial Testing and Field Trials



This chapter details the set-up and results of all physical testing and measurements that have been done of will be done with seniors in the SOULMATE project. These physical workshops are divided into three parts; initial design testing (paragraph 5.1), initial functional testing (paragraph 5.2) and field trials (5.3). Of these workshops, design and initial testing have concluded, include results in this report, and have been delivered to the consortium (Appendices D, E, F, and G). However, due to performance challenges and the COVID-19 virus outbreak, field trials have been delayed. Therefore, an adapted set-up of the field trials is described instead, which is expected to happen in Q3 of 2020.

5.1 Initial Design Testing

The design testing workshops of the Initial Testing phase of the project were the first major feedback moments with end-users after the co-creation phase (see Luub, 2020). These workshops used a click-dummy to gather feedback from seniors on design related concepts, such as look and feel of the future application. Within the project, the set-up and results of the Initial Design Testing have been reported in deliverable D3.2A, parts of which are included in appendix D. The main deliverables for this PDEng report are the testing protocol, feedback form, and results (described in paragraphs 3.2.3 and 3.2.4 respectively). The documents related to the set-up of the design testing (protocol and feedback forms) were delivered to the project in Q1 of 2019, after which the workshops were held. The resulting feedback was reported shortly afterwards, in Q3 of 2019.

5.1.1 Initial Design Testing Goal

The goal of adding the specific design testing phase at an early stage in the project was to give the technology partners early feedback from end-users. While the functionalities that the application is going to have in the end have been generally clear to the developers throughout this process, the appearance / design of front-end of the app is not yet clear. Therefore, it was very valuable to already have some comments and direction for how the application should look and feel, early in the project, and remains valuable in the present phase. Some of these design aspects include how nice the application looks in general, how intuitive the menus (among other types of screens) feel, and how visible and accessible all individual components are (e.g., the size of buttons and text). Combined, the initial feedback of end-users on the design elements provided some early direction and a vision for how to proceed with the on-going development of the SOULMATE application.

5.1.2 Initial Design Testing Set-up

Initial Testing was done through half-day workshops with a small group of end-users. In an afternoon, the Design Testing workshops invited these seniors to interact with and provide feedback on a click-dummy. A click-dummy is a 'collage' of screens that could be part of the SOULMATE application (Figure 19). It is set-up so that tapping the appropriate button brings you to the next screen, but no actual data is accessed or recorded. The click-dummy can thus feel like a real application, but is no more than a series of static screens that were designed in advance. Using the click-dummy, end-users participating in the workshops could form a good impression of what the final application would look like. The click-dummy makes design related aspects tangible, it allows users to see the placement of buttons and size of text within the context of an application running on a phone screen.

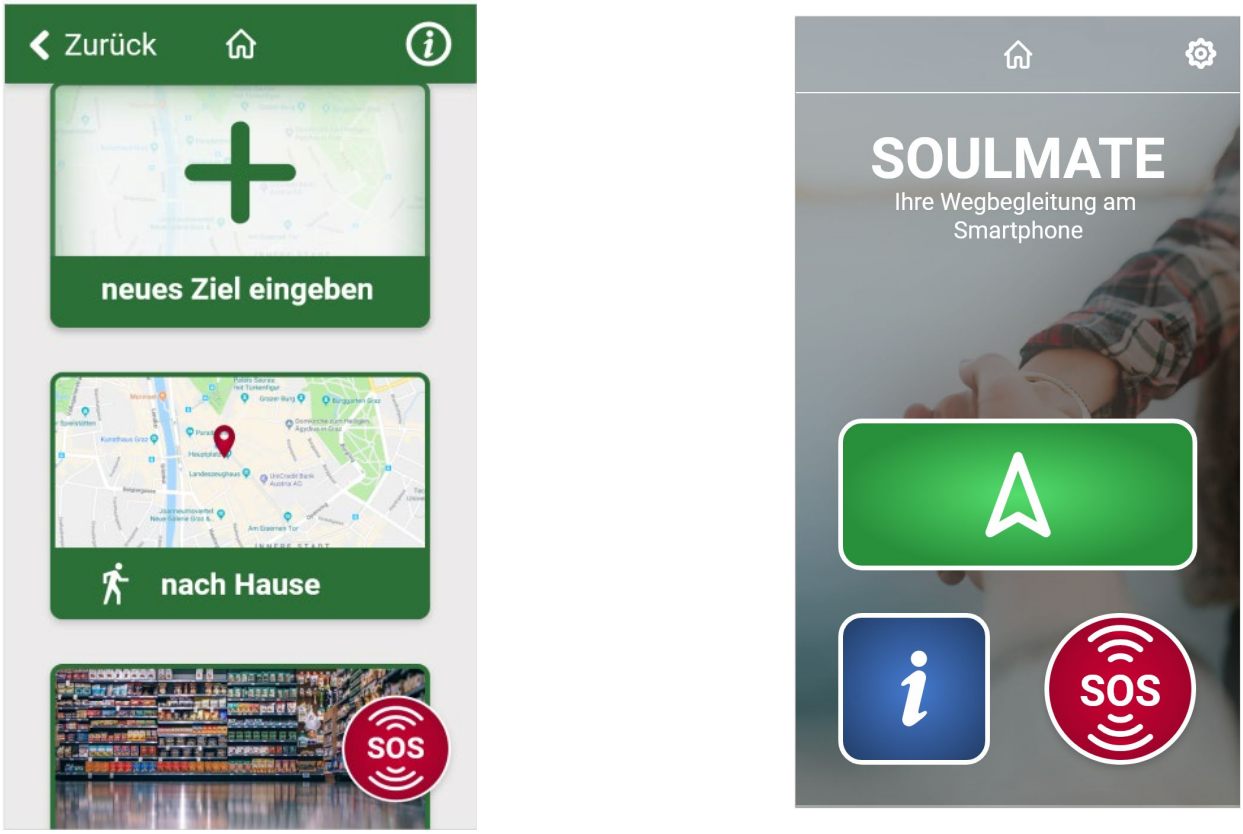


Figure 19. Examples of SOULMATE application screens used in the click-dummy (German version).

The document in Appendix D.1 is an excerpt from the deliverable document, describing the complete set-up of the design testing workshops and their place in the SOULMATE project.

5.1.3 Initial Design Testing Protocol and Measures

The format for the workshops in the Initial Design Testing phase of the SOULMATE project was a half-day meeting during which a small group of end-users interacts with a version of the SOULMATE application.

In this case, this version was a click-dummy showing sequences of static screens. In order to guide this workshop meeting, a protocol has been designed. The protocol for the design testing workshops was based on an earlier SOULMATE co-creation workshop script made with RRD, benefiting from their expertise and experience with these kinds of workshops.

Protocol

The general structure of the workshop was designed as follows. First, the participants of the workshop received an introduction to each other, the SOULMATE project, and the goal of the design testing workshop. Then, they walked through several scenarios that guided them in their interaction with the click-dummy. After interacting with the click-dummy, participants were asked to individually fill in a written feedback form, and then discuss their opinions with the group. A workshop guide was present during the workshops, helping out participants whenever needed and writing down ideas, suggestions, and discussion points made by the participants. The final testing protocol for the Initial Design Testing workshops is included in Appendix D.2.

Feedback Form

In addition to verbal feedback from participants written down by the workshop guide, a more structured way of gathering feedback was required as well. Therefore, a feedback form was set up and filled in by the end-users during the workshop. The major benefits of using a feedback form are two-fold. First, it becomes easier for the participants to discuss their opinions with others once they have written them down. They can more easily check back what they thought of specific aspects, without having to rely on their recollection alone. Second, feedback forms make it easier for the research team to gather and compare data in a structured way. Both Dutch and German versions have been designed for respective participating countries, otherwise the same answering format was used across workshops.

The feedback form in Appendix D.3 includes both closed ended questions and open ended questions. The closed questions gave the participants the opportunity to rate the click-dummy for each scenario. These questions provided general information on how well each of the screens is perceived, in terms of how intuitive and well-designed they are. The open ended questions allowed the participants to provide specific suggestions for aspects of the click-dummy that they liked and disliked. Additionally, the participants were asked to mention specific aspects that they would like to see changed in the future product.

5.1.4 Initial Design Testing Results

The workshops held in the Initial Design Testing phase had small groups of future end-users interact with the designed click-dummy through predetermined scenarios. Their feedback on the design aspects, the look and feel, of this product was recorded using the aforementioned feedback form. Seniors gave their rating of ease of use and design quality per scenario. Additionally, they provided comments on what they liked, did not like, and would have liked to see improve about the click-dummy version of the SOULMATE application. One specific question was added in the workshops discussion at the request of technology partners; what should the included “help” function look like? These results are reported in the deliverable

excerpt reported in Appendix E. Across Austria, Belgium, and the Netherlands, 19 seniors took part in the design testing workshops.

Table 9. Results for closed ended design feedback questions, averaged across all scenarios. Ratings provided by seniors on a scale of 1 to 5.

Measure	Global Average	Standard Deviation	Average Austria	Average Belgium	Average Netherlands
Design	4.2	1.0	4.2	4.3	4.1
Intuitiveness and ease of use	4.2	1.1	4.2	4.2	4.2

As the individual answers show, there were many different opinions among the participants in the workshops. This again confirms the heterogeneity of seniors as a target audience, they have many different wants and needs. In general (Table 9), the end-users were very positive about the click-dummy version of the SOULMATE application, rating it a 4.2 out of 5. The design and layout of the buttons, as well as the color scheme were especially to their liking. Most prevalent points of improvement include the intuitiveness of the “settings” and “information” functions, button size (too small), and displaying too much information on the screen at the same time. While most participants preferred a “help” function to call personal contacts, others liked this function to be more of an “SOS” function to contact emergency services. Most important results are gathered in Figure 20.

Figure 20. Main results from initial design testing workshops. Seniors are generally happy with the design of the click-dummy version of the SOULMATE application, and note they find it important to keep the amount of information on the screen manageable.

5.1.5 Initial Design Testing Reflection

Overall, the end-users really enjoyed participating in the Initial Design Testing workshops. Especially those who have been part of the SOULMATE project for a while, enjoyed seeing their earlier inputs brought to life in the form of the click-dummy. As we see repeatedly, there are a lot of varying opinions in the responses provided by the participating seniors. They did however, rate the overall look and feel of the application positively. The layout and buttons felt intuitive and easy to use to the majority of participants, which is a good indication that the design of the SOULMATE application is on the right track. Important points of feedback for further development of the application revolve around the presentation of the appropriate amount of information on the screen.

Using the click-dummy for these workshops has been a very good idea, as it allowed the participants to experience what using the application should feel like down the road. The workshop setting and procedure fit well with the intended goal of providing feedback on the design of the application, even though some of the provided feedback points included functional topics (the inclusion of speech functionality came up a couple of times, for instance). For some participants it proved difficult to separate design (how things look) and functionalities (how things work), which is understandable since these concepts often overlap. For example, how an input box looks (design) determines how big it is and thus how much text can be entered (functional). For the workshops that took place later in the project, design and functional elements were separated more clearly. The combination of feedback scales and open ended questions worked well too, as it allowed participants to put their evaluations on paper in several ways.

The points of feedback from the design testing workshops have been communicated to the technology partners of the SOULMATE consortium, who then used this information to develop their first working prototype of the SOULMATE solution. After this first working version of the application was finished, it was shared with end-users in Initial Functional Testing workshops.

5.2 Initial Functional Testing

The functional testing workshops of the Initial Testing phase of the project build upon the findings and feedback from the earlier Design testing phase (see 3.2). The feedback on the design aspects of the click-dummy has been integrated into a first working prototype of the SOULMATE application. Functional testing workshops focused on testing the functionality of the application, including the reporting of bugs, crashes, and general performance. The Initial Functional Testing has been reported in the project deliverable D3.2B, parts of which are included in Appendix F. Similarly to the Initial Testing phase, main deliverables included a testing protocol, feedback forms, and results (described in Paragraph 5.1). Final protocol and feedback form documents were delivered to the consortium in Q4 of 2019, with workshops happening in the same period. In Q1 of 2020, the results deliverable was written and shared among the partners.

5.2.1 Initial Functional Testing Goal

As the SOULMATE project has been progressing, so has the development of its application. Based on the functional requirements and the early feedback on design, the technology partners delivered a first prototype of the SOULMATE application. This prototype was not fully be polished yet, but included the core functionalities of the solution; virtually exploring surroundings, creating and following routes, sharing routes with others, and calling for assistance. With the core functions and design in place, the application has now been shared with end-users to test performance. Performance was evaluated by looking at factors such as loading speed, accessibility, and how often the application crashed. More specific kinds of bugs that might show up have been logged as well, for example navigational routes not being generated correctly, or emergency contacts not connecting. Together, feedback from end-users on these functional aspects of the SOULMATE prototype gives a clear view of how far along the development process the application was. These workshops functioned as a test of how much more development the application needed (if any), before it could be tested independently by a larger group of seniors over a longer period of time (i.e. the Field Trials).

5.2.2 Initial Functional Testing Set-up

After positively evaluating the results and feedback of participating seniors on the set-up of the previous design workshops, it was decided to use a similar approach for the functional testing workshops. Thus, a small group of seniors were invited to try out the prototype SOULMATE application in an afternoon session. The prototype was installed earlier on a set of mobile phones, so participants did not have to use their own phones and no time had to be wasted on installation during the workshop. In terms of functions, the prototype focused on creating and setting up an account, adding contacts, creating routes, walking these routes, and calling emergency contacts. The document in Appendix F.1 is an excerpt from the deliverable document for the Initial Functional Testing phase, describing the complete set-up of the workshops and their place in the SOULMATE project.

5.2.3 Initial Functional Testing Protocol and Measures

The format for the workshops in the Initial Functional Testing phase of the SOULMATE project was similar to the format of the design workshops. These workshops took about half a day, during which a focused group of seniors interacted with the then current version of the SOULMATE application. Thus, the testing protocol for the functional testing workshops was an adaptation of the one described in Paragraph 5.1.3 (Appendix D.2).

Protocol

The general structure of the functional testing workshop follows the order of the design workshops. So, participants first got to know each other, the SOULMATE project, and the goal of the functional testing workshop. Then, they walked through several scenarios that guided them in their interaction with the prototype version of the application. They were asked to create an account, create a route, walk the route they created, and call an emergency contact. After interacting with the click-dummy, participants were asked to individually fill in a written feedback form, and then discuss their opinions with the group. After this discussion, participants were given a short explanation about bugs. Then, they formed teams to go hunting for these bugs, filling in bug reports as they go. As before, a workshop guide was always there to keep track of relevant comments and points made by the participants, and offer assistance wherever needed. The final testing protocol for the Initial Functional Testing workshops is included in Appendix F.2.

Feedback Form

In a similar way as the workshop protocol, feedback forms for the functional testing workshops were based on the forms that had been developed for the earlier design testing workshops. The functional testing forms added a specific components for the reporting of bugs, an activity that had not been done before. The same benefits of using a feedback form hold here; providing participants with a concrete way of providing feedback and making it easier for the research team to analyze their response. Again, both Dutch and German versions of the feedback forms were designed, with all workshops using the same answering format.

The feedback form in Appendix F.3 included both closed ended questions and open ended questions. The closed questions gave the participants the opportunity to rate the performance of the prototype version of the SOULMATE application for each scenario. These questions provide general information on how well each functionality performed, in terms of speed and accessibility. The open ended questions allowed the participants to provide specific comments about the performance or accessibility of each functionality. Additionally, the participants were asked to mention specific aspects that they would like to see improved in the future product.

In addition to the closed ended and open ended questions, the feedback forms for the functional testing workshops included a bug catching report. This short report card (see Figure 21 for a template) allowed testers to report bugs in a structured way. These reports were used in the functional testing workshops by participating seniors, but could also be used by other (internal) testers of the application.

Bug	Info
ID number	<bug ID>
Name	<identifier for type of bug>
Reporter	<who reported the bug?>
Submit Date	<when was the bug reported?>
Summary	<what happened?>
Screenshot	<add screenshot if possible and relevant>
Operating System	<what type and version of operating system is on the phone?>
App version	<which version of the app is tested?>
Severity	<how severe is the bug? Low (something is unclear) or High (crashing, freezing, vital buttons missing)>

Figure 21. Bug catching report card template, used by testers to report bugs found in early prototype versions of SOULMATE.

5.2.4 Initial Functional Testing Results

The workshops held in the Initial Functional Testing phase had small groups of future end-users interact with an early prototype version of the SOULMATE application through predetermined scenarios. Their feedback on the functional aspects, how well the application performs, of this product was recorded using the designed feedback form. Seniors gave their general rating of usefulness and performance. Additionally, they provided comments on what they liked, did not like, and would like to see improved about the prototype. When the participants found bugs during the scenarios or during the bug hunt, they filled in bug catching reports. These results are reported in the deliverable excerpt reported in Appendix G. In total, 13 seniors took part in the functional testing workshops across Austria, Belgium, and the Netherlands.

In general (see Table 10) seniors rate the performance of the prototype of the SOULMATE application as bad to acceptable. Scoring a 2.5 out of 5 on functioning, usefulness and responsiveness combined, this version of the application scores below average. Of these scores, seniors rate the usefulness of the application the highest, with functioning and responsiveness below. Noticeable in these results are the higher scores for the group of seniors participating in Austria.

Table 10. Results for closed ended general functional feedback questions. Ratings provided by seniors on a scale of 1 to 5.

Measure	Global Average	Deviation	Average Austria	Average Belgium	Average Netherlands
Functioning	2.4	1.2	3.3	1	1.8
Usefulness	2.9	1.2	3.4	2.5	2.6
Responsiveness	2.2	0.9	2.8	1.5	1.6
Total	2.5	1.2	3.2	1.7	2.0

The open ended questions reflect the same trend as the ratings reported in Table 10. When asked which functionalities of the current application worked well, “none” is the most common response. Similarly, participants mention several points of improvement to each specific functionality. Especially the ‘creating routes’ function is stated as a major point of improvement by various comments, with user statements mentioning routes not showing up, their position not showing up on the map, and overall the functionality not working as they expected. For an example of the latter; workshop participants expected that they would be able to use the map shown in the route creation screen to directly specify their destination, but they had to fill in an address instead. The navigational functionalities show much room for improvement as well. Participants state disappointment that only walking routes can be generated with this version of the application, and the routes that are generated are often not the fastest or easiest way to the specified destination. Finally, while participants deem the SOS functionality as useful, they also state it needs more improvement. These comments range from not receiving feedback regarding whether the contact has accepted or rejected their call, to video calling at times not working at all.

While the application was expected to perform well enough to work without too much technical assistance, this did not turn out to be the case. Since no dedicated technical support was available during the functional testing workshops in Belgium and the Netherlands, participating seniors did not feel comfortable enough to do the bug hunting part of the meeting. Thus, only in Austria were bugs reported during the functional testing workshop itself, in Belgium and the Netherlands this was done later. Two examples of bug reports are included in Figure 22 and Figure 23. All bugs that were found during any testing phase have been communicated to the technical development team.

ID number	TUE004
Name	Redundant button
Reporter	TesterB100

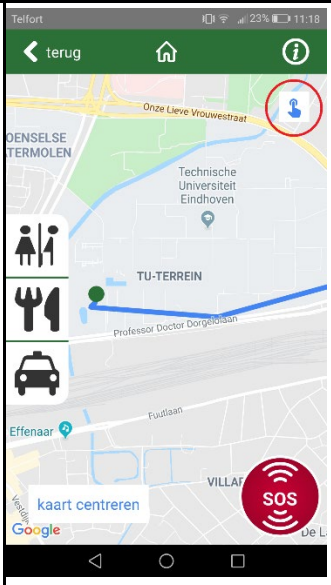
Submit Date	28/11/2019
Summary	Button on screen while navigation that does nothing.
Screenshot	
Operating System	Android 7.0
App version	V0.1.1.20191126001
Severity	Low

Figure 22. Example of a filled in bug report, tested by an internal member of the development team.

ID number	AT003
Name	App closes
Reporter	BeA
Submit Date	19/11/2019
Summary	After filling in the first information regarding the contact person and pressing “continue”, the app closed automatically.

Screenshot	N/A
Operating System	Android 7.0
App version	V0.1.1.20191119001
Severity	High

Figure 23. A second example of a filled in bug report, tested by one of the seniors participating in the functional testing workshop.

In sum, the functional testing workshops provided many points of feedback from participating seniors regarding performance of the SOULMATE application prototype. Many bugs and concrete points of improvement have been identified, which provides a clear destination going forward. The main results from these functional testing workshops are described in Figure 24.

Figure 24. Main results from the functional testing workshops. While participating seniors rate most included functionalities as useful, overall performance of the prototype is described as an important point of improvement.

5.2.5 Initial Functional Testing Reflection

Some general conclusions can be made based on the feedback forms and meeting notes that have been collected during the Functional Testing workshops. In general, participants are critical of how well the current version of the application functions. With the overall rating for the application scoring well below average, user send a clear message of needed improvement. It should be noted that the ratings in the Austrian workshops are more positive, even though they remain just above average. The presence of technology partners at this meeting is a likely reason for this, allowing for an easier back-and-forth with the end-users. The framing of workshops in Austria can have played a role in this as well. The participating

seniors there are explicitly addressed as “co-developers”, forming a more pronounced role in the whole development process. These factors could have made these participants feel more comfortable with encountering bugs and failures of the application, as these are expected parts of development. It is thus possible that in the other countries, where this co-development process was emphasized less, participating seniors expected more of a finished product than a prototype work in progress.

The current prototype version of the SOULMATE application shows a lot of room for (functional) improvement. Even though end-users were asked to evaluate the application as a work in progress, the majority shows a negative evaluation of the functionality of the app. While the application is under constant development, many improvements will need to be made to meet the expectations of end-users. In future workshops/measurements with end-users, it should be stressed that they are part of the development process and a technological expert should be present. With the current prototype, the application is not fit for further testing with end-users (in field trials). Many bugs and performance issues have already been identified through these functional testing workshops and internal testing. These issues will need to be fixed before the next phase of the project testing can be started with confidence; the version being tested in the field needs to have much better performance and stability.

5.3 Field Trials

The field trials should have been the final testing phase of the SOULMATE project. Building on previous workshops in the initial testing phase, a workable Minimum Viable Product (MVP) version of the SOULMATE application should have been tested by seniors in the field. The impact of using this MVP on their daily lives would have been measured, daily use feedback would have been gathered, and a final push to market would have been started for the SOULMATE application. However, two major challenges have thus far prevented the field trials from happening; an unexpected amount of complications in the performance of the application and the outbreak of the COVID-19 virus. As described in the conclusion and reflection on the initial functional testing workshops (Paragraph 5.2.5), the prototype version of the SOULMATE application did not perform as expected by participating seniors and other testers. Several unforeseen complications were noted, including ones regarding route generation and video-calling. While these functionalities should have been available in the prototype, their integration into the SOULMATE application apparently took more time and effort. The functional testing workshops thus clearly showed that the application needed more development time than was planned for originally. In addition to these technical developments, the project was met with an unexpected disaster; the COVID-19 virus. Where the main goal of the SOULMATE project is to help seniors stay healthy and active, the pandemic directly hinders these efforts. The SOULMATE application should make it easier for seniors to go out and take walks to stay healthy and independent, but current regulations restrict these activities as much as possible. For health and public safety reasons, people are urged to stay at home and no large gatherings of people are allowed. Especially with a vulnerable group of people such as seniors, it would currently be irresponsible to try to stimulate them to go outside of their homes.

Combined, these technological delays and COVID-19 regulations prevent the SOULMATE project from conducting the large-scale field testing as was originally planned. Merely delaying the field trials does not seem feasible at this point, since timing and severity of future regulations is still uncertain. A brief description of the original field trials and a scaled down alternative plan for the field trials are included; adapting the field trials from a large scale pre-test and post-test impact measurement to a more in depth qualitative user-experience investigation.

5.3.1 Field Trials Original Goal and Set-Up

The goal of the original field trials set-up was to measure the impact of using the SOULMATE Minimum Viable Product (MVP) on the daily lives of participating seniors. Trying out the MVP in real-life and unstructured situations, these seniors would be able to experience how using the SOULMATE application could change their mobility, health, and social lives. First, the impact measurements would provide quantitative data on several Key Performance Indicators (KPI); showing how much happier, healthier, more mobile and more independent seniors could be when using the SOULMATE application. As an 'intervention' study, the results from this impact measurement could be interesting for academic purposes as well as business purposes. Additionally, qualitative feedback would be gathered with participating seniors, through structured interviews. These interviews would provide technology partners in the SOULMATE consortium with additional feedback on the accessibility and performance of their MVP.

In the original set-up, the field trials were spanning a period of 12 weeks and two major measurement points. At the start of the 12 week period, 40 participating seniors per country would have joined introductory workshops. A week prior to these workshops, they would have been asked to keep a short travel diary; describing some characteristics of their trips. During the first workshop the SOULMATE MVP would be installed on the phones of participating seniors (or they would be provided with phones when needed), they would receive instructions and demos on how the MVP works, and fill in pre-test measures. These measures would have included many similar questionnaires as the benchmark survey (paragraph 3.4); including self-reported health, activities of daily living, social networks and loneliness. Then, the seniors would use the SOULMATE MVP on their own for a period of 12 weeks, take part in intermediate meetings with end-user organizations if needed. Prior to the second workshop, participating seniors would again be asked to keep a short travel diary over the course of that week. In the second workshop, post-test impact questionnaires would be filled in by the seniors. These measures would include the same questionnaires as in the first workshop, with the addition of technology acceptance and user enablement measures. After the questionnaires, seniors would be interviewed about their experiences with the MVP application, potentially including a plenary discussion. Finally, seniors would be assisted in de-installing the SOULMATE MVP from their phones if they would choose to do so. For an overview of originally planned respondent activities, see Appendix I.

5.3.2 Field Trials Adapted Goal and Set-Up

The main goal of the adapted field trials set-up is still to allow seniors to test the SOULMATE application in real-life situations. In the adapted field trials, more emphasis is placed on providing additional feedback regarding usability of the new SOULMATE MVP to the technology partners. As the application has been under continuous development, the MVP version is expected to perform substantially better than the prototype version used in the functional testing workshops. After the additional testing, seniors will be asked to try out the new MVP in the field. The aim of this field-tested feedback is to further clarify how (and when) seniors use the SOULMATE application, what their real-life experiences are with it, and how it impacts their travel behaviors. These experiences provide valuable information for further development of the application, as well as provide insightful user stories for future business development.

At the time of writing, the plans for the set-up of the adapted field trials contains two components; additional workshops and small scale field testing. As the first component, workshops will be an extension of the conducted initial testing phase of the project (Paragraph 5.1 and 5.2); allowing seniors to interact with the new SOULMATE MVP in a structured way. These workshops will invite small groups of seniors to see and use the MVP in guided sessions, collecting feedback on performance and accessibility of the application. For the second component of the adapted field trials, a small number of interested and motivated seniors (who were part of the workshops, for example) are asked to take the MVP home to try out over a longer period of time. During several weeks, these seniors will be in continuous contact with the project partners; sharing their experiences and feedback on the SOULMATE MVP. Figure 25 shows the general preliminary set-up of the adapted field trials. All field trials activities and their reporting are expected conclude in Q3 of 2020.

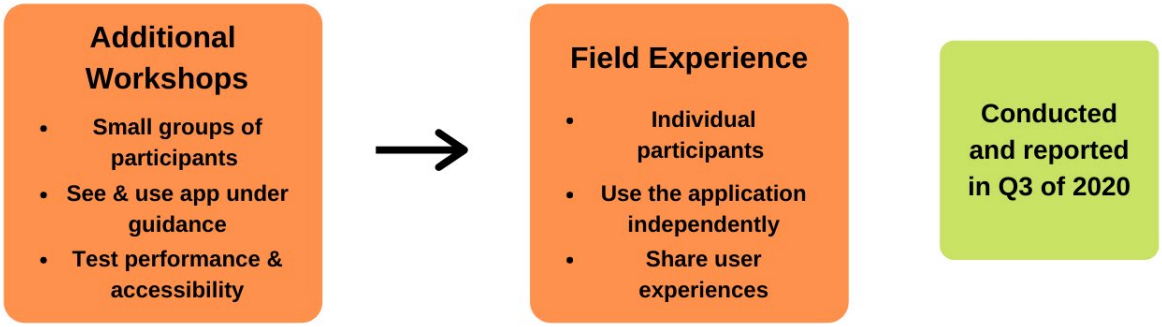
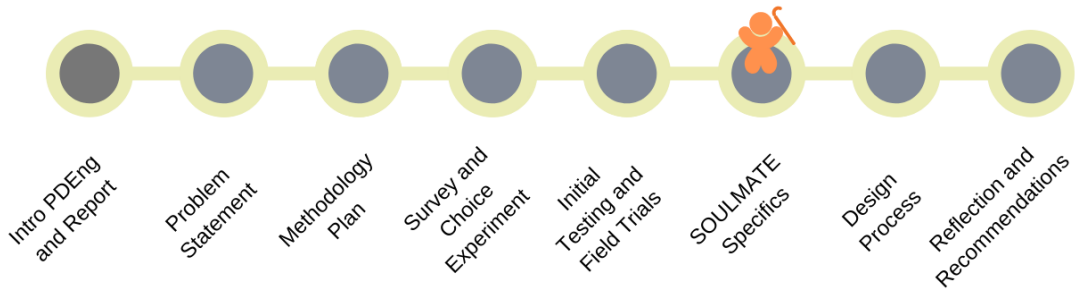
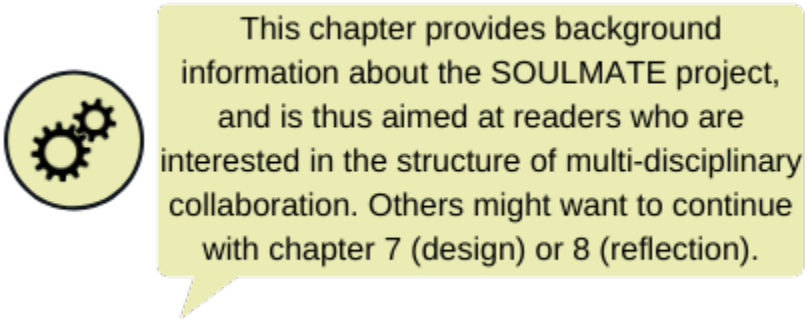


Figure 25. Adapted set-up of the field trials phase of the SOULMATE project. Describes additional workshops for testing and a small scale individual field experience.

6 SOULMATE Specifics



The SOULMATE specifics chapter provides background information on the logistics of the project; the structure and means by which SOULMATE is operated. Since the PDEng project reported in this document has been conducted in the framework of the SOULMATE project, the specifics described here can provide some context for the PDEng project. Overviews of SOULMATE project funding, consortium and division of work are included.



6.1 SOULMATE Funding

The SOULMATE project is the result of a proposal answering a call by the Active Assisted Living (AAL) program. This European funding program focuses on aging well in a digital world. Therefore, it supports many projects related to innovations that aim to keep our aging population healthy, active, happy, and connected. Being a European program, AAL encourages cooperation between international partners (within the EU). Additional funding is contributed by some national agencies from these countries. In the case of the testing and measurements in the Netherlands (and thus, the part of the project described here), additional funding is being provided by Zonmw; an agency that coordinates research projects regarding care and care innovation for the Dutch government. Involving a diverse group of citizens and applying scientific knowledge to innovate care systems, are some of the core values for the agency. The SOULMATE project fits the criteria of both agencies by aiming to develop a mobility application for, and with, seniors and forming a consortium with partners from Austria, Belgium, and the Netherlands.

6.2 The SOULMATE Project Consortium

The consortium of SOULMATE is made up of a complementary network of partners capable of providing the management, development and implementation of the project. The SOULMATE consortium has an interdisciplinary aspect, bringing together end-users, SMEs and research institutions. Thus, the consortium should have all the necessary resources and expertise to deploy the scientific, technical and marketing aspects of the SOULMATE project. Appendix L includes a short description of each consortium partner.

The consortium parties form an international team, with members originating from Belgium (Abeona Consult, Activ84Health, & Happy Aging), The Netherlands (TU/e, RRD, & Happy Aging), and Austria (FH Joanneum, CCCom, Fraiss, & GEFAS). Within the project each of the partners fills a main role, assisting others with their role where necessary. The main roles within the project include technology partner (Abeona Consult, FH Joanneum, CCCom & Fraiss), research partner (TU/e & RRD), and end-user partner (Happy Aging, Slimmer Leven, & GEFAS). In addition to these main roles, some partners contribute significantly to other roles as well; mainly FH Joanneum providing research related input and Abeona Consult doing project management tasks. Table 11 gives an overview of each partner's origin and main role within the project. A steering committee consisting of one member of each of these partners heads the consortium.

Table 11. Overview of SOULMATE consortium partners, main role in the project, and country of origin.

Partner	Main role	Country of origin
Abeona Consult	Technology	Belgium
Activ84Health	Technology	Belgium
Happy Aging	End-user	Belgium
TU/e	Research	The Netherlands
RRD	Research	The Netherlands
Slimmer Leven	End-user	The Netherlands
FH Joanneum	Technology	Austria
CCCom	Technology	Austria
Fraiss	Technology	Austria
GEFAS	End-user	Austria

All activities within the project are organized in such a way that they can be tackled by one of the roles. In short, research partners are responsible for setting up testing methods, analysis and reporting of results. Next, end-user partners make sure the testing methods match with their user-groups and conduct the

testing. Finally, technology partners develop the SOULMATE solution based on the input from testing, creating an updated version. Together, these activities create a feedback loop that allows for a continuous process of user involvement, testing, and development. To clarify what is required and what should result from each activity, work packages have been specified in more detail.

6.3 Division of Work: Work Packages & Deliverables

At the start of the project, 5 Work Packages (WPs) have been composed to specify which activities are being worked on by which partner and what deliverable should be the result of said activity. The first work package 1 is concerned with a co-creation process involving end-users and feature specifications. Work package 2 entails the integration of the already available technologies into an application that matches with the end-user specifications. Next, work package 3 involves the testing and evaluation of the application to continuously update the solution and see its impact on users. Work package 4 includes dissemination and exploitation strategies for bringing the solution to market. Finally, work package 5 is concerned with the overarching process of project management. The interaction between the work packages is illustrated in Figure 26. Ultimately, each work package results in one or more deliverables. These deliverables are reports and/or products that deliver on the content of the specified work package.

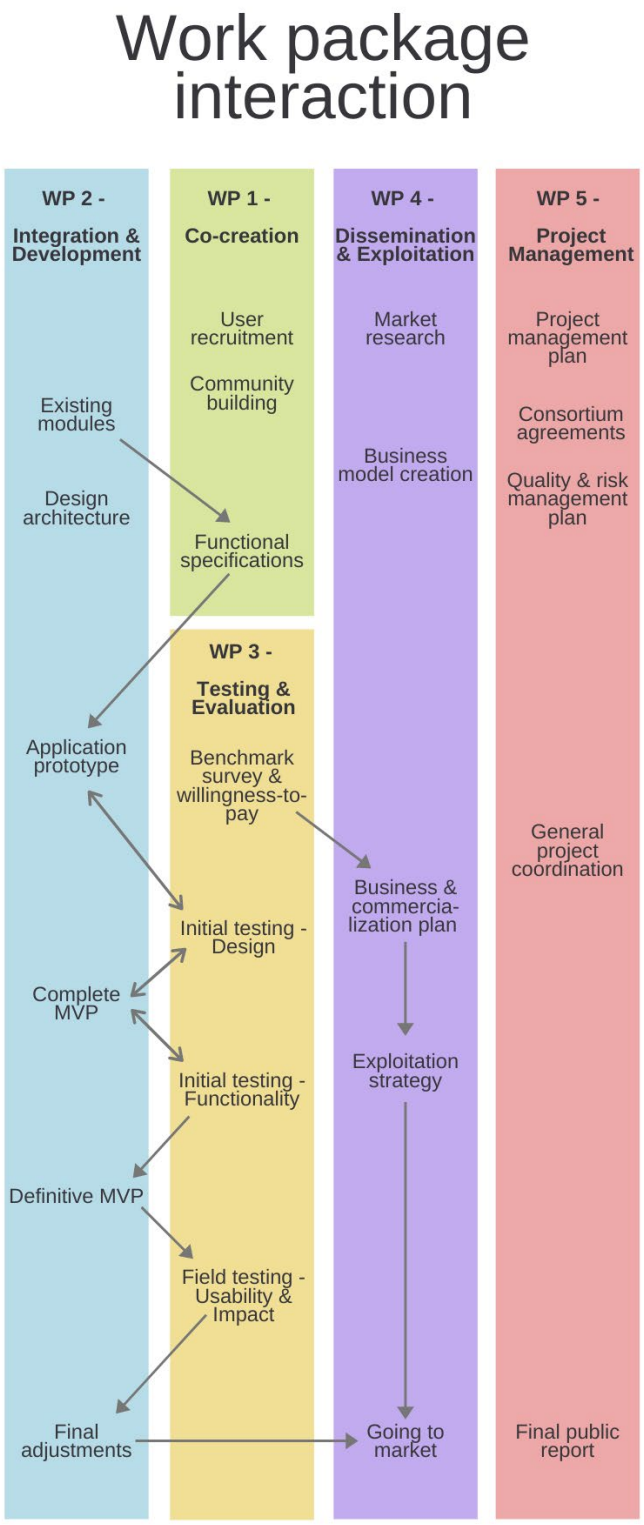
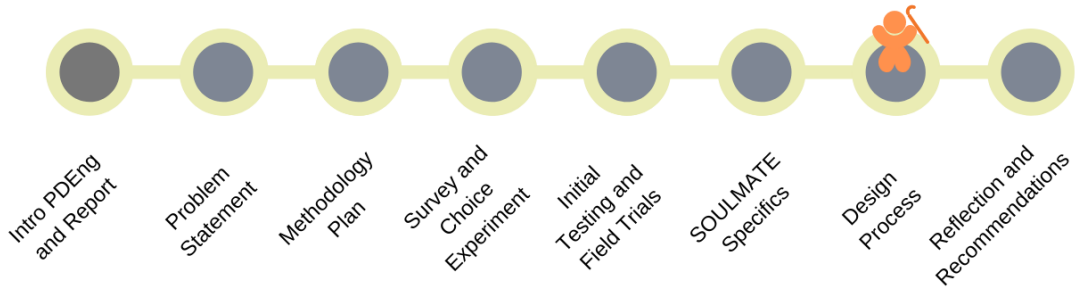
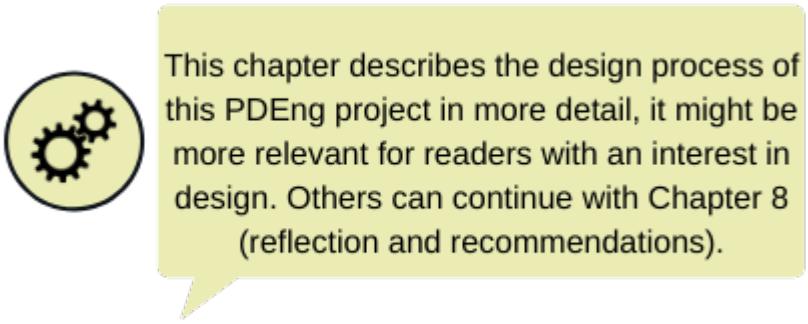


Figure 26. A diagram describing the interaction of SOULMATE work packages. The diagram describes which activities belong in which work package, from the start of the project (top) to the end (bottom). Arrows show how activities are related.

7 PDEng Design Process



With the development of a collaborative and iterative testing process being the main goal of this PDEng project, close cooperation with other partners in the consortium has been an important design aspect. This chapter describes some design aspects related to the PDEng project of this report and its role within SOULMATE. It covers important stakeholders in the development of the testing procedures and how their interests impacted the scope of the project. In addition, the chapter features a short history of the testing procedure development process; from the SOULMATE proposal and the testing and methodology plan, to the testing that was carried out. Finally, the design process that was adopted for the development of testing procedures is discussed. To that end, conceptual ideas on design are applied to the development of the choice experiment included in the SOULMATE benchmark survey.



7.1 Stakeholders and Scope

Most stakeholders for the PDEng project described in this report are partners in the SOULMATE consortium; these companies and organizations are directly impacted by the designed testing and measurement procedures. As the testing is being done for, and using available versions of the SOULMATE application, technology partners within the consortium play a key role in testing development. The main source of input of all testing comes from seniors and their feedback. Thus, seniors and their representative organizations in the consortium are important stakeholders as well. Final important stakeholders for the testing process are (other) research partners in the consortium, as well as the agencies that provide funding for the project. The most important stakeholders and their main interests with regard to the testing procedures are included in Table 12.

Table 12. Major stakeholders of the current PDEng project and their main interests.

Stakeholder	Type	Interest
Fraiss, CCCom, Activ84health, & FH Joanneum	Technology partners	Maintain technological feasibility
Seniors, GEFAS, Slimmerleven, & Happy Aging	End-users and end-user organization partners	Maintain acceptable participant burden
TU/e & RRD	Research partners	Gather academically interesting data
AAL & ZONMW	Funding agencies	Following proposal

At the start of the SOULMATE project all the relevant stakeholders agreed on a set of interests that would be followed during the project, as described in the SOULMATE proposal. However, with time and a better understanding of the more detailed activities of testing and measurement, some of the stakeholder interests were no longer in line with the scope of the project.

Upon gaining a better view of all testing procedures, the interests of technology partners and end-user organizations no longer aligned as well with the original proposal. For the technology partners, it became apparent that the functional specifications that were established during the co-creation phase of the project broadened the functional scope of the SOULMATE application beyond their available resources. This in turn prevented the extensive inclusion of user-generated requirements in the final application. For the end-user organizations, their intended user-base proved to be harder to establish and retain than originally expected. The participant burden, the amount of input required from each participant, was recognized as one of the important factors for these difficulties. Thus, with the goal of reaching and keeping end-users participating in the project, the end-user organizations advocated for reductions in participant burden. One could say that both technology and end-user stakeholders saw the importance of limiting the scope of the project, each for their own reasons.

In contrast, interests of funding organizations and research partners largely align with the originally proposed plans, as doing so covers most of their needs. If the goals in terms of planning and deliverables of the proposal are achieved, funding agencies will see their desired solution in a timely fashion. With the proposed amount of testing and measurements, enough data should be available for the research partners to write interesting publications for scientific literature. Figure 27 illustrates how the funding and research parties aim to increase or at least maintain the scope of the project, while end-user and technology partners advocate for decreasing the projects' scope for aforementioned reasons.

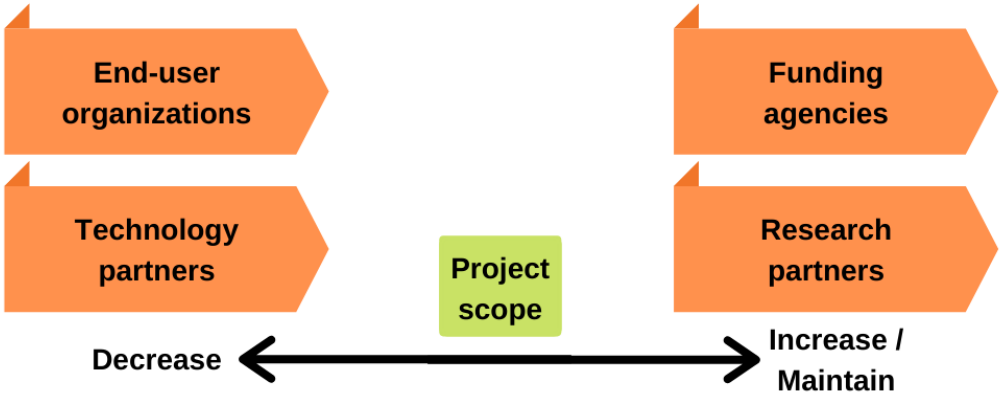


Figure 27. The most important stakeholders and their aim of increasing or decreasing the scope of the testing procedures designed in the SOULMATE project.

In short, while some of the relevant stakeholders aim to stick as close to the originally proposed plan as possible, others started to develop goals that favored deviation from it. The role of the project management and steering committee in this process is to determine an acceptable middle ground for the scope of the project. Supporting the steering committee in making these decisions, I have played a facilitating role by providing different set-ups of testing protocols and measurement options along the way. Carefully making sure that each iteration of testing and measurement fit with the then current progress of the project and application, and providing different viable options for the steering committee to decide upon. Concessions have been made to the scope of the project, mostly due to the technology developing at a different rate then was first expected, and estimations of participant burden being too optimistic. As will be described as part of the design process, the scope of the project has thus changed considerably since the proposal at the start.

7.2 Design Process

This paragraph describes the design process of the reported deliverables in more detail. Within the SOULMATE project, this process describes the transition from the already available project proposal to the testing and trial methodology plan and ultimately carried out testing and measurement activities.
The tasks that are part of the current design process were first formulated in the SOULMATE project proposal. This proposal had been set-up by the SOULMATE consortium, in order to give some indication of the activities the consortium was going to carry out during the project. In terms of testing and measuring (work package 3), the proposal included some preliminary measurements and ideas with regard to planning and subdivision of testing. These ideas were then investigated further by the research team in close cooperation with end-user and technology partners. After checking for feasibility and end-user burden (among other things), the proposed measurements have been detailed further in the testing and trial methodology plan (Chapter 3). This deliverable then functions as a guidebook for the development of detailed testing and measurement procedures and protocols. Based on the progression of the project and new insights attained during the development process, these guidelines are continuously updated. Thus, the final carried out testing and measurement methodologies deviate somewhat from the methodology plan as well. The final testing methodology is reflected in the deliverables describing the results of each testing component. These three stages of reporting on testing and measurement methodology are illustrated by Figure 28.

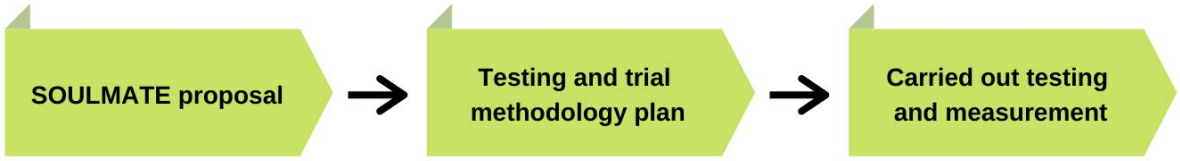


Figure 28. Sequence of the three stages of testing and measurement reporting in SOULMATE. Starting from the original proposal, a more detailed testing and trial methodology plan was developed. With developments in the application and project goals, these testing procedures were updated into the testing and measurements that were then carried out.

Further, this sequence of reporting can be compared to the timeline of the SOULMATE project. Here, the proposal was written and reported before the project started. Next, the testing and trial methodology plan was delivered roughly 6 months into the project. Finally, testing and measurement result reports have been delivered at several points (depending on when the testing was carried out).
While the overall goal and direction of testing and measurement has remained the same throughout the project, the iterative and cooperative development process has caused some notable changes as well. In some ways, the original proposal for the project turned out to be too optimistic in terms of available time and resources. Some of these issues are already addressed in the testing and trial methodology plan, while

others were adapted according to feedback in the lead up to actually carrying out the testing. In the end, several major adaptations have been made with respect to the original proposal. These adaptations include the division of the initial testing phase into separate design and functional testing phases. Other adaptations include changes in the intensity of concepts measured during the field trial phase and in the benchmark survey. As described in Paragraph 5.3, many changes had to be made to the set-up of the field trials; adapting it from a large impact measurement to an in depth user-experience investigation.

Table 13. Measures included in both field trials and benchmark survey at different stages of the project. Some measures are exclusively part of field trials (*) or benchmark survey (**).

Proposal	Testing and Trial Methodology Plan	Carried out Testing
Loneliness	Loneliness	Loneliness
Self-reported health	Self-reported health	Self-reported health
Social network	Social network	Social network
Travel behavior	Travel behavior	Travel behavior
Willingness to pay**	Willingness to pay**	Willingness to pay**
Patient empowerment	Patient empowerment*	
Quality of life	Quality of life	
Technology acceptance*	Technology acceptance*	
Caregiver burden		
Physical activity		
Physical performance		

As Table 13 shows, several of the measures that were originally planned to be part of the testing and measurement within the SOULMATE project did not make the final cut. Some of these measures were intentionally scaled down or removed for practical reasons. For example, physical activity measurement ended up being excluded from the SOULMATE application, and separate measurement instruments would be too cumbersome for participating seniors (Appendix J.4). Other measures such as technology acceptance were planned as part of the field testing, which ended up entirely changing in set-up. In the end, the tests that have been carried out as part of the initial testing phase or benchmark survey still provide valuable insights into the potential of a mobility application like SOULMATE. Even though the project was met with some unforeseen circumstances, the overall design methodology has allowed the testing process to be flexible without giving up on its goals and scientific foundation.

7.3 Design Methodology

The design of the testing methodology for the SOULMATE project has undergone three major stages; from proposal to testing plan and ultimately carried out testing. Two important cornerstones of the design methodology for the SOULMATE project (and by extension the PDEng project described in this report) are a scientific foundation and collaborative design.

A few steps were taken to ensure these goals of scientific rigor and collaboration are met within the design process of a testing methodology for the SOULMATE application. First, a broad overview of the literature would be established for the measurements and questionnaires, as well as underlying concepts. Then, early versions of protocols and measurement structures would be designed based on the aforementioned overview. These early documents would then be shared with consortium partners, after which an iterative discussion and adjustment process would begin. Repeated feedback would be shared between the testing design team, other research partners, technology partners, and end-user partners; each contributing their expertise in (for example) conducting measurements with seniors, needs for further application development input, and senior expectations. In sequence, this process is illustrated in Figure 29.

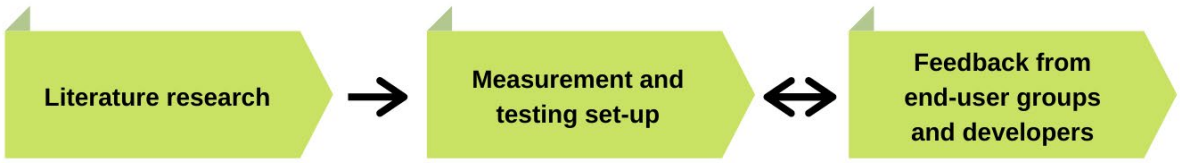


Figure 29. Design sequence of the testing methodology of the SOULMATE project; building an iterative and collaborative design process on an academic foundation.

One example for how this design approach was implemented is the testing and trial methodology plan, described earlier in this report (Chapter 3). This methodology plan was first described based on the SOULMATE proposal and an overview of the literature; providing considerations on various options for testing procedures that could be used in the project. These options were then discussed and updated repeatedly, until a definitive approach could be established. Main objectives of this approach would then be translated into protocols and measurement structures, which would again be shared for repeated discussion among consortium partners. Finally, this design approach allowed all consortium partners to shape the testing process to meet their needs, while the testing design team made sure there was a consistent structure and quality in testing across different phases of the project.

7.3.1 Formal Design Approach

Described structurally, the design approach adopted for this PDEng project can be related to the Design Council's framework for innovation (Design Council, 2019). Their double diamond design framework has inspired numerous design project over the past decade, providing designers across the world a valuable

a valuable tool to structure their design process. The main component of this framework, the double diamond, describes a two-step process in which the focus of the design diverges and converges (Figure 30). In the first step, different strategies are *discovered* based on a given design challenge; broadening (or diverging) the understanding of the challenge. Then, this deeper understanding allows the designer to *define* their challenge in a more concrete way; converging into a strategy for addressing the challenge. In the second step, a similar process happens. First, different solutions are *developed*, providing a broad range of implementations based on the strategy formulated in the first step. Then, different solutions are tested, converging until one solution can be *delivered.* While this process may appear linear, many points for feedback loops are possible, allowing designers the flexibility to adapt earlier decisions based on new information.

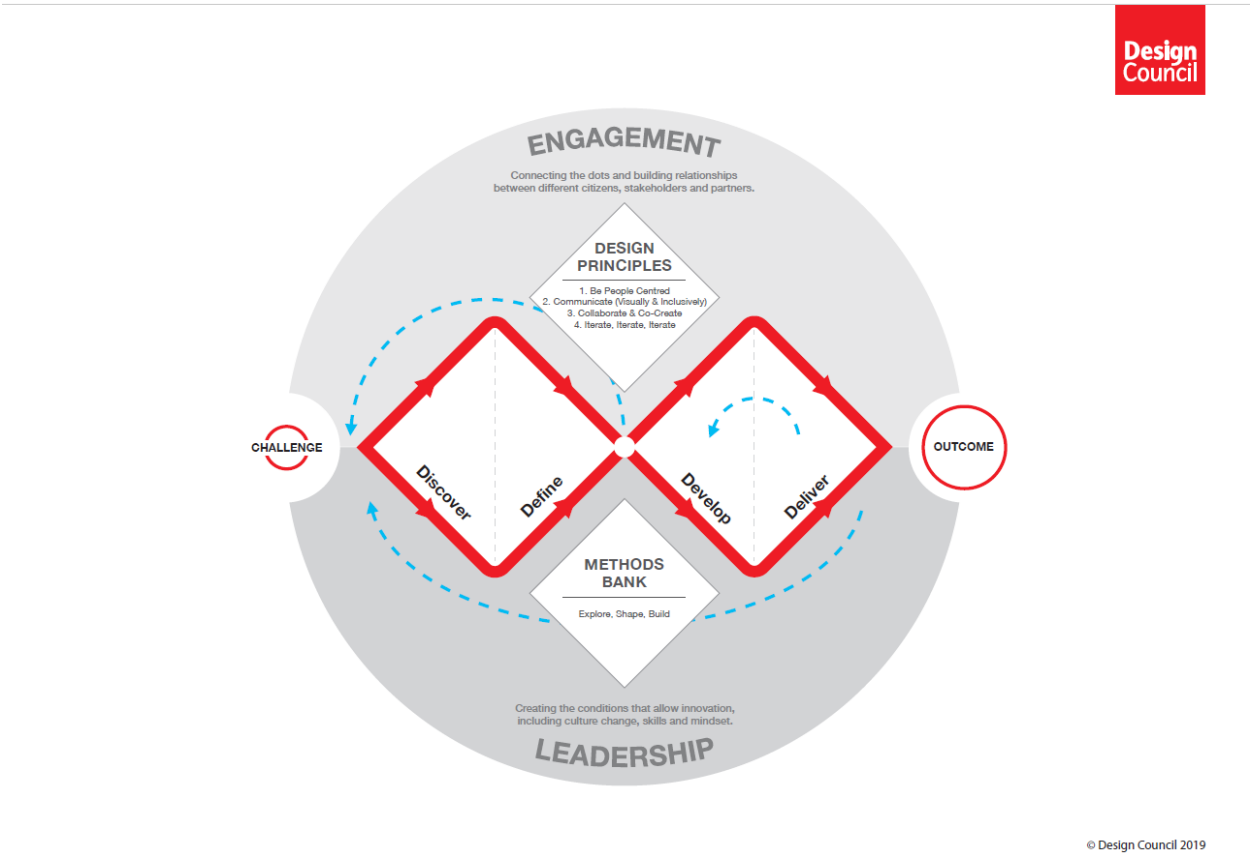


Figure 30. The Double Diamond framework for design (Design Council, 2019).

The design methodology adopted in the current PDEng project shares some similarities to the double diamond design framework, but there are key differences in emphasis as well. The first phase of the SOULMATE testing procedure design process aligned quite well with the first step of the double diamond. The process of diverging and converging into a strategy is done through literature; researching relevant (examples in the) literature to broaden the understanding of measurements and testing, followed by defining this knowledge into a more concrete plan (for example the testing and trial methodology plan described in Chapter 3). The second phase of the design process for SOULMATE however, focused more

on an iterative feedback process than the "*develop"* and "*deliver"* processes of the double diamond. Instead of creating and selecting many different solutions, the iterative feedback process for SOULMATE developed a general solution, which was then adapted and refined. Although these iterative loops are included in the double diamond framework as well, they played a much more central role in the design of the SOULMATE testing procedures. Figure 31 represents this new design methods that has been adopted in this PDEng project; the single diamond double iteration framework. In this model, the bottom half describes the core concepts of the design method: *Discover, Define,* and *Develop.* These concepts represent the main goals of each stage of the design process; diverging, converging, and then iterating. The top half of the model describes the ways in which these three goals were achieved in the SOULMATE project, through literature research, relevance discussions, and feasibility testing. Finally, the central role of feedback in the iterative process is included, emphasizing the important role input from end-users and experts played in the second stage of developing SOULMATE testing.

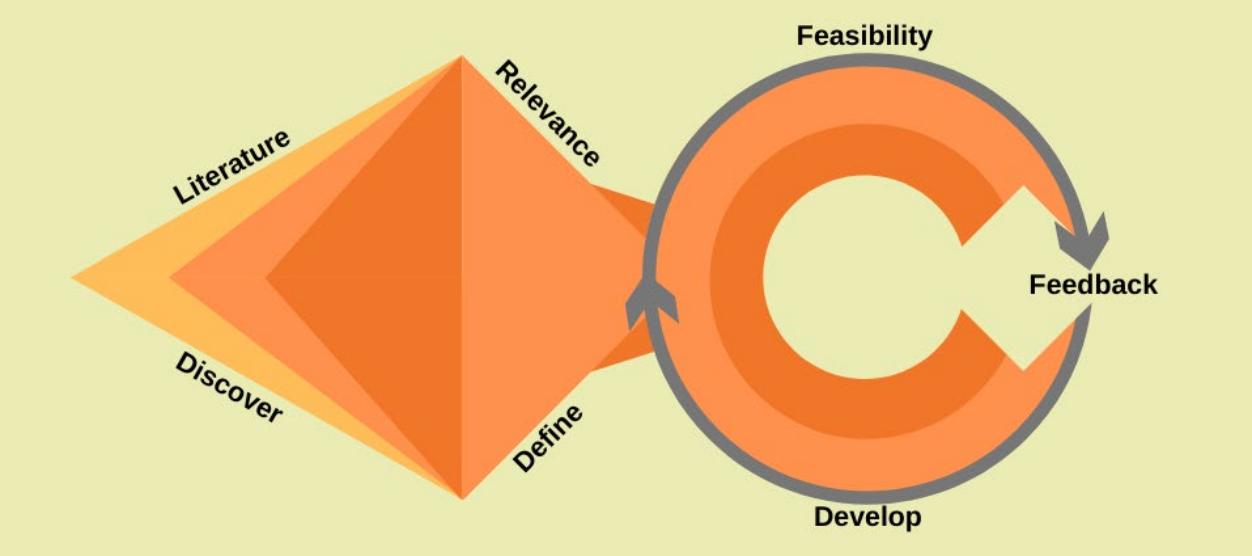


Figure 31. The single diamond – double iteration design framework used in the design process for the SOULMATE project. This framework emphasizes the role of creating a solid foundation on which an iterative collaboration can happen; through concepts of Discover, Define, and Develop.

7.3.2 Design Approach Application in the Choice Experiment Design Process

This paragraph covers a brief application of the iterative and collaborative design method described in the previous paragraph; resulting in the choice task that was included in the SOULMATE benchmark survey (described in Chapter 4).

First, the testing design team familiarized themselves with relevant literature on the design of choice experiments (e.g., Hensher, Rose, & Greene, 2005) and recent examples of studies that collected their data using choice experiments (for example, van der Waerden, Uralova, & van der Waerden, 2019). Then, preliminary versions of the choice experiment set-up were designed to be shared with the consortium

partners. Appendix K.1 shows an example of internal communication regarding early versions of the choice experiment, based on the reviewed literature and expert suggestions.

One of the first designs of the choice experiment included only a basic structure of vague attributes and small/medium/large levels, based on the three 'Pillars of SOULMATE' (Paragraph 2.4). While the project partners had some idea of what was going on in the first few choice task designs, they did not expect seniors not to easily be able to grasp the (admittedly abstract) meaning of the included attributes and their meanings. In an attempt to clarify the different attributes and strengths of their levels, a quick iteration added appropriately shaded colors to indicate the different components (Figure 32).

Application A	
Discovery Focus	Medium
Navigation Focus	Large
Assistance Focus	Small
Price	€ 3

Figure 32. One of the earliest iterations of the choice task design; includes colors to signify attributes and levels, but only uses abstract meanings of both.

While this version of the choice experiment design made it easier to distinguish between the three attributes and their levels, issues with the abstract nature of the included pillars of SOULMATE remained. In order to give more meaning to the included attributes, the next versions of the choice experiment design matched specific SOULMATE application functionalities to the levels of each attribute (Figure 33). For example, a small focus on assistance included only the 'following' functionality, while a medium focus on assistance would include both 'following' and 'video-calling' functionalities. The words small/medium/large were replaced with stars in this version as well; providing an easier visual cue for the level of each attribute. Although this version proved to be more concrete and accessible by consortium partners, the downside became an overflow of information for participants. Since the three attributes each had three levels, the full list of attribute and functionality descriptions became quite cumbersome (Appendix K.2). An additional complication of this more concrete design is that, while specific functionalities are included, analysis could still only provide results on the higher attribute level. In other words, a results could be that the assistance focus was important to participating seniors, but no conclusions on the individual contribution of 'video-calling' or 'following' could be made.

Application A	
Discovery Focus	☆☆ (virtual discovery + points of interest)
Navigation Focus	☆☆☆ (directions + facilities + transition information)
Assistance Focus	☆ (following)
Price	€ 3

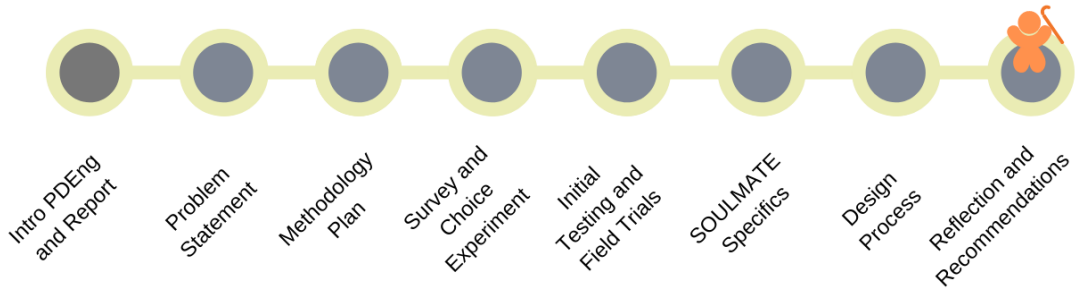
Figure 33. An example of a further iteration of the choice task design; still includes colors to signify attributes and levels, but adds icon signifiers for levels (stars) and concrete descriptions of what functionalities would be included in the level.

Ultimately, the decision was made to step away from the standard three-level design of the choice experiment attributes. Instead of using the combinations of SOULMATE functionalities in the attribute levels, they were moved to the attribute spot. Levels of these attributes could then be switched from the abstract small/medium/large to the simple present/not present. Over a few additional iterations, the number of included functionalities was reduced, a final set of attributes was selected, and the words present/not present were replaced by icons. Finally, the final choice experiment design was agreed upon, resulting in the choice experiment design reported in Chapter 4 (Figure 23).

Figure 34. Final choice experiment design, as included in the SOULMATE benchmark survey.

Even though choice experiments remain a complicated task only a handful of participating seniors indicated difficulties participating in it. Of course, improvements can always be made to the design, for instance by providing more or a better visual representation of application functionalities through pictures or video. However, with the current scope of the project and available options in the questionnaire software, the final choice experiment served its purpose well. By continually iterating on the design of the choice experiment and including feedback from the different SOULMATE consortium partners, a choice experiment was developed that could provide in-depth information on the preferences of seniors, while remaining accessible.

8 Reflection and Recommendations



The main goal of all methods and procedures reported in this document has been to design a structured and academically valid testing and reporting procedure for the development of the SOULMATE mobility application. To this end, the Testing and Trial Methodology Plan, Benchmark Survey and Choice Experiment, and Initial Testing and Field Trials have been designed and analyzed where possible. The deliverables included in this report (and their extensions in appendices) reflect the testing protocols, feedback forms, their results, and implications for the SOULMATE project. Due to the unexpected circumstances involving a COVID-19 pandemic there had to be some drastic adaptations to some of the testing activities that were originally planned. However, this report hopefully demonstrates the importance of collaborative testing and development; the added value of designing the SOULMATE mobility application together with the seniors who form its main audience. The adopted design methodology aided in achieving this value by allowing the design process to adapt to changing circumstances without compromising on standards of quality. Thus, all feedback and other data from participating seniors could be gathered and reported in a structured way across testing phases and countries, answering the right questions for further development of the application.

For the SOULMATE project, testing has shown that there is an audience for the functionalities the SOULMATE application aims to develop. All carried out testing moments have provided valuable information for the development and business of SOULMATE. The choice experiment indicated that there are seniors who are interested in every functionality of SOULMATE, especially regarding for finding nearby facilities such as benches and bathrooms and providing up-to-date public transport information. Furthermore, the choice experiment was able to distinguish between three groups of seniors with different preferences; those who were not very interested in the SOULMATE application, those who were very interested, and those who were interested but more sensitive to its price. This second group could include many potential early adopters, so it might be an interesting idea to focus development and/or promotion on the functionalities that are most important for this group; finding nearby facilities, public transport information, and video-calling. In addition, the initial design testing workshops have shown that many seniors liked the look and feel of the application; emphasizing there is promise in the way the SOULMATE application implements its functionalities. Nevertheless, the functional testing phase illustrated several performance and functionality challenges. Due to these challenges and the

aforementioned pandemic, planned field trials using the SOULMATE application had to be delayed. The extra time from this delay is currently being used for to further optimize the performance of the SOULMATE application, and earlier described suggestions for the postponed field trial period are adjusted accordingly. The field trial stage is recommended to continue functional testing to make sure the resulting Minimum Viable Product meets the expectations of the seniors using it. When this MVP is ready a small number of adventurous seniors can test the application in their daily life, while staying in close contact with the development team.

More generally, the design approach adopted in this project proved to work well for its intended purpose. Establishing a foundation based on scientific literature allowed the testing team to get a good overview of the testing and measurement possibilities, in order to create protocols and measures that were reliable, structured, and consistent. Moreover, all participating seniors have been a vital part of the design process; providing their expert real-life feedback and comments repeatedly during the project. Only through this close collaboration and seeing them as co-designers, the final mobility product might be able to achieve what present applications could not; develop a mobility application that seniors actually want to use. Future research should then further investigate what kind of impacts using a successful mobility application like SOULMATE can have on the daily lives of our seniors. In addition, the data collected in the benchmark survey included in this project could be linked to these new studies. Further, additional analyses could further investigate multi-variate relations between seniors' mobility, health, social environment, and preferences for mobility applications.

Ultimately, the testing procedure for the SOULMATE application described in this report has achieved its main goal of including seniors closely into the development process in a structured and academically valid way. Even though unforeseen circumstances necessitated flexibility in the direction of the project, valuable insights were gained in the needs, wants, and characteristics of our fellow senior citizens. Maybe seniors will be able to find their soulmate in the form of the developed application, maybe they won't. Regardless, this project has provided a meaningful contribution to a healthier and happier future for all of our seniors.

Acknowledgments

This report has been written as a PDEng traineeship in support of the SOULMATE project. Thus, the deliverables and results reported here are partly supported by funding of the TU/e and partly by project funding of AAL and ZONMW.

The SOULMATE testing and measurement methodology described in this report have been designed in close cooperation with Floor Luub; her PDEng report (Luub, 2020) serving as a companion piece to this one. Both PDEng projects have been conducted under expert supervision of Astrid Kemperman, Pauline van den Berg, and Tom Bellemans. This project would not have been possible without these people, as well as the rest of the SOULMATE consortium partners. Everyone in the SOULMATE consortium has been invaluable in every challenge described here, from providing general guidelines for the project in the SOULMATE project proposal and giving thoughtful feedback, to just keeping all spirits high in stressful times.

References

Addelman, S. (1962). Orthogonal main effects plans for asymmetrical factorial experiments. *Technometrics, 4,* 21-46. doi: 10.1080/00401706.1962.10489985

Akaike, H. (1987). Factor analysis and AIC. *Psychometrika, 52,* 317-332.

Alsnih, R., & Hensher, D. A., (2003). The mobility and accessibility expectations of seniors in an aging population. *Transportation Research Part A, 37,* 903-916. doi: 10.1016/S0965-8564(03)00073-9

Belbachir, A., Drobics, M., & Marschitz, W. (2010). Ambient Assisted Living for ageing well – an overview. *Elektrotechnik und Iformationstechnik, 127,* 200 – 205. doi: 10.1007/s00502-010-0747-9

Charness, N., & Boot, W. R. (2009). Aging and information technology use: Potential and barriers. *Current Directions in Psychological Science, 18,* 253-258.

Constanza, R. (2000). Visions of alternative (unpredictable) futures and their use in policy analysis. *Conservation Ecology, 4,* 5-22. Retrieved from: www.ecologyandsociety.org

Design Council (2019). *What is the framework for innovation? Design Council's evolved Double Diamond*. Retrieved from: https://www.designcouncil.org.uk/news-opinion/what-framework-innovation-design-councils-evolved-double-diamond

De Jong Gierveld, J., Van Tilburg, T. G. (2006). A six-item scale for overall, emotional and social loneliness: Confirmative tests on new survey data. *Research on Aging, 28,* 582-598. doi: 10.1177/0164027506289723

Deary, I. J., Corley, J., Gow, A. J., Harris, S. E., Houlihan, L. M., Marioni, R. E., … & Starr, J. M. (2009). Age-associated cognitive decline. *British Medical Bulletin, 92*, 135-52.2.

Elsawy, B., & Higgins, K. E. (2010). Physical activity guidelines for older adults. *American Family Physician, 81,* 55-59.

Finlayson, M. L., & Peterson, E. W. (2010). Falls, aging, and disability. *Physical Medicine and Rehabilitation Clinics of North America, 21,* 357–373.

Google (2020). Google Play store search results. Retrieved on May 20th 2020 from: https://play.google.com/store/search?q=senior%20mobility&c=apps&hl=en

Heblij, P. G. (2012). Willingness to pay for mobile apps. *Master thesis, Erasmus University Rotterdam School of Economics.* Retrieved from: thesis.eur.nl/pub/13913/Heblij-P.G.-375422pr-.docx

Hensher, D.A., Rose, J.M. & Greene, W.H. (2005) *Applied choice analysis: A primer*. Cambridge, UK: Cambridge University Press.

Holley-Moore, G., & Creighton, H. (2015). *The future of transport in an ageing society*. London, UK: International Longevity Centre-UK.

Hughes, D. E., & Peak, T. H. (2002). Investigating the value of spiritual well-being and psychosocial development in mitigating seniors' adulthood depression. *Activities, Adaptation & Aging, 26,* 15-35. doi: 10.1300/J016v26n03_02

Louviere, J.J., Hensher, D.A. & Swait, J.D. (2000) *Stated choice methods; analysis and application*. Melbourne, Australia: Cambridge University Press.

Louviere, J. J., & Islam, T. (2008). A comparison of importance weights and willingness-to-pay measures derived from choice-based conjoint, constant sum scales and best-worst scaling. *Journal of Business Research, 61,* 903-911. doi: 10.1016/j.jbusres.2006.11.010

Luub, F. (2020). Designing a testing and evaluation plan for SOULMATE, a mobility app for older adults. *PDEng report, Eindhoven University of Technology,* Eindhoven.

McCarty, C., Killworth, P. D., Bernard, H. R., Johnsen, E. C., & Shelley, G. A. (2001). Comparing two methods for estimating network size. *Human Organization, 60,* 28-39. doi: 10.17730/humo.60.1.efx5t9gjtgmga73y

Marsden, P. V. (2005). Recent developments in network measurement. In P. Carrington, J. Scott, & S. Wasserman (Eds.), *Models and methods in social network analysis* (pp 8-30). Cambridge, UK: Cambridge University Press. doi:10.1017/CBO9780511811395.002

Metz, D. H. (2000). Mobility of older people and their quality of life. *Transport Policy, 7*, 149-52.

O'Hern, S., Oxley, J. & Stevenson, M. (2017) Validation of a bicycle simulator for road safety research. *Accident Analysis and Prevention*, 100, 53-58.

Resnik, L., Allen, S., Isenstadt, D., Wasserman, M., & Iezzoni, L. (2009). Perspectives on use of mobility aids in a diverse population of seniors: Implications for intervention. *Disability and Health Journal, 2,* 77-85.

Reuben, D. B., Siu, A. L., & Kompau, S. (1992). The predictive validity of self-report and performance-based measures of function and health. *Journal of Gerontology, 47,* M106-M110. doi: 10.1093/geronj/47.4.M106

Rosenberg, D. E., Bombadier, C. H., Hoffman, J. M. & Belza, B. (2011). Physical activity among persons aging with mobility disabilities: Shaping a research agenda. *Journal of Aging Research, 2011,* 1-16. doi: 10.4061/2011/708510

Rosenbloom, S., 2001. Sustainability and automobility among the elderly: an international assessment. *Transportation, 28,* 375–408.

van den Berg, P. E. W., Arentze, T. A., & Timmermans, H. J. P. (2010). Location-type choice for face-to-face social activities and its effect on travel behavior. *Environment and Planning B: Planning and Design, 37,* 1057-1075. doi: 10.1068/b36019

van der Waerden, P., Uralova, S. K., & van der Waerden, J. (2019). Residents' preferences regarding package delivery services in urban parking garages. In *Proceedings of the 26th Conference on Recent Advances in Retailing and Services Science.* Technische Universiteit Eindhoven / EIRASS.

Verghese, J., Mahoney, J., Ambrose, A. F., Wang, C., & Holtzer, R. (2010). Effect of cognitive remediation on gait in sedentary seniors. *Journal of Gerontology: Medical Sciences, 65A,* 1338-1343. doi: 10.1093/gerona/glq127

Ware, J. E., Kosinski, M., Bayliss, M. S., McHorney, C. A., Rogers, W. H., & Raczek, A. (1995). Comparison of methods for the scoring and statistical analysis of SF-36 health profiles and summary measures: summary of results from the Medical Outcomes Study. *Medical Care, 33*, 264–279. doi: 10.1097/00005650-199501001-00005

Ware, J. E., Kosinski, M., & Keller, S. D. (1996). A 12-item short-form health survey: Construction of scales and preliminary tests of reliability and validity. *Medical Care, 34,* 220-223. doi: 10.1097/00005650-199603000-00003

Weiss, R. S. (1973). *Loneliness: The experience of emotional and social isolation*. Cambridge, MA: The MIT Press.

Wiek, A., & Iwaniec, D. (2014). Quality criteria for visions and visioning in sustainability science. *Sustainability Science, 9,* 497-512. doi: 10.1007/s11625-013-0208-6

Zeuwts, L., Vansteenkiste, P., Deconinck, F., Van Maarseveen, M., Savelsbergh, G. Cardon, G. & Lenoir, M. (2016). Is gaze behavior in a laboratory context similar to that in real-life? A study in bicyclists. *Transportation Research Part F, 43*, 131-140.

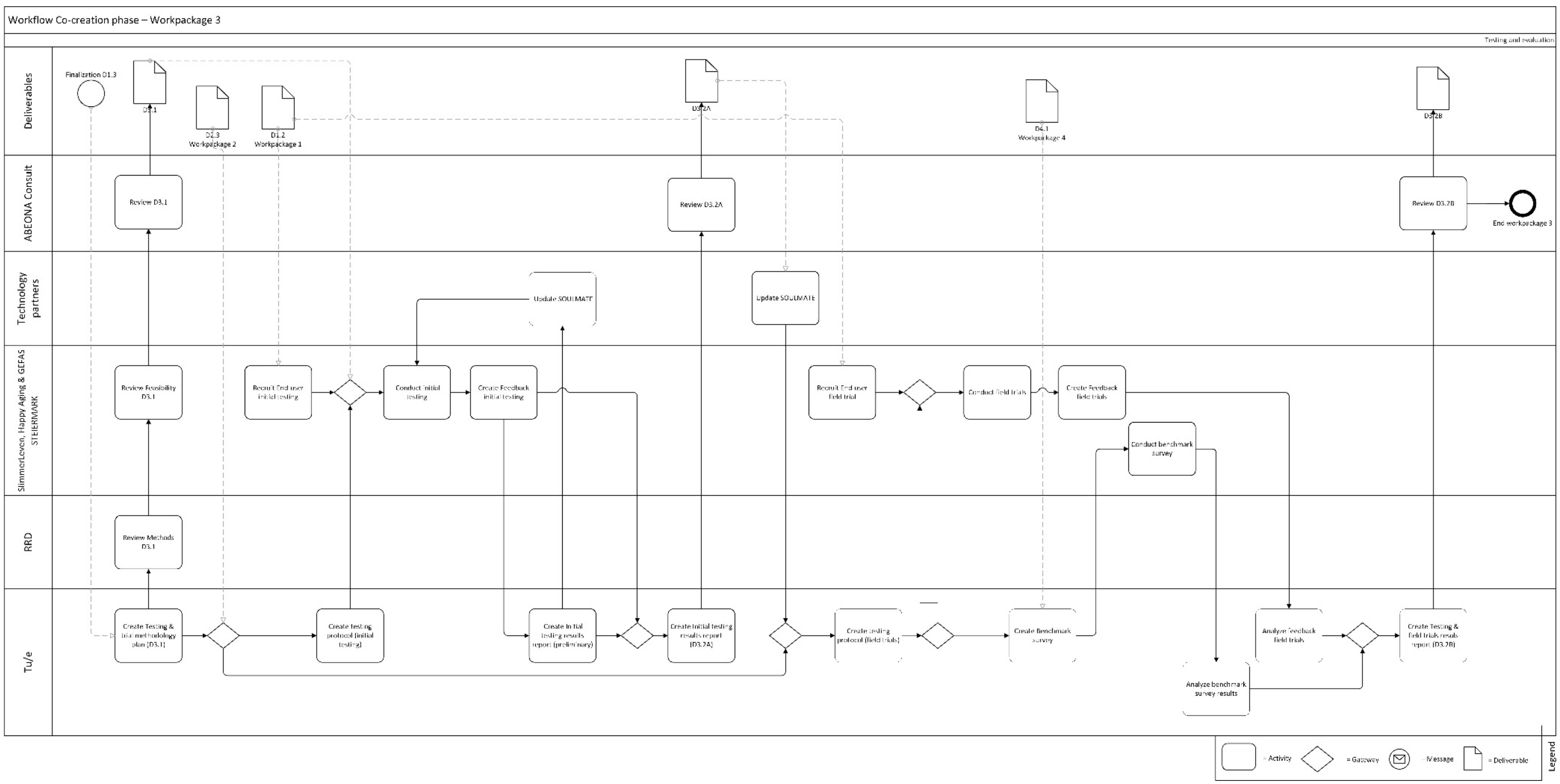
Appendices

Appendix A.1 Testing and Trial Methodology Plan

1. Introduction

In the SOULMATE project, diverse travel wishes and needs of older adults (aged 65+) are addressed in order to engage in (and to ensure) an active, healthy and independent living in a secure way through active mobility and physical activity. The integrated SOULMATE consists of three complementary modules, training of the route (Activ84Health), security during the trips (Viamigo) and routing during the trips (Ways4All). In the project, the three service solution partners (i.e. Activ84Health, ABEONA Consult and FH Joanneum) are accompanied by a research partner with expertise in mobility and activity patterns (TU/e), a business partner with expertise in co-creation approaches (RRD), and two business partners with technical expertise in the development of services for elderly (c.c.com Moser GmbH and FRAISS). Three end user organizations (SlimmerLeven, Happy Aging and GEFAS STEIERMARK) will intensively test and evaluate the integrated solution from a user (primary, secondary and tertiary), technical and business perspective.

This document is part of work package 3 of the development process of the SOULMATE solution. The objective of this third work package is to test the SOULMATE prototypes and solution among a heterogeneous group of end-users. The testing will be two-fold, including both behavioral outcomes and technical aspects. Therefore, the current document describes what outcomes will be tested to measure the effectiveness of the SOULMATE solution and the results that each stage of the measurement process will yield. The figure below depicts the workflow between the partners of the SOULMATE consortium involved in work package 3.


Workflow Co-creation phase – Workpackage 3
Testing and evaluation
Deliverables
ABEONA Consult
Technology partners
SlimmerLeven, Happy Aging & GEFAS STEIERMARK
RRD
Tu/e
Finalization D1.3
D3.1
D2.3 Workpackage 2
D1.2 Workpackage 1
D3.2A
D4.1 Workpackage 4
D3.2B
Review D3.1
Review D3.2A
Review D3.2B
End workpackage 3
Update SOULMATE
Update SOULMATE
Review Feasibility D3.1
Recruit End user initial testing
Conduct initial testing
Create Feedback initial testing
Recruit End user field trial
Conduct field trials
Create Feedback field trials
Conduct benchmark survey
Review Methods D3.1
Create Testing & trial methodology plan (D3.1)
Create testing protocol (initial testing)
Create Initial testing results report (preliminary)
Create initial testing results report (D3.2A)
Create testing protocol (field trials)
Create Benchmark survey
Analyze benchmark survey results
Analyze feedback field trials
Create Testing & field trials results report (D3.2B)
Legend
= Activity
= Gateway
Message
= Deliverable

This deliverable builds forth on the development of the SOULMATE solution as specified through the functional requirements of D1.3. The testing and trial methodology plan of this deliverable will specify the testing process of the SOULMATE project. Therefore, this document will provide direct input for the dissemination of these testing results in deliverable D3.2 testing and field trials results. In line with the different phases of testing specified here, deliverable D3.2 will consist of two parts:

• Part A: Initial testing results,

• Part B: Field trials.

In addition to these testing results, a general benchmark survey will be conducted among the target population which will include a willingness-to-pay experiment. Results of this survey will be reported in deliverable D3.3.

The SOULMATE solution is being developed in iterative co-creation with end-users themselves, and the solution will be tested and evaluated intensively in three different countries based on usability, technical and business aspects. End-users are involved in the different project phases (initial testing, field trials and benchmark survey), and in the business modeling (e.g. willingness-to-pay). In essence, the taken approach is therefore based on a user-centered design process. This user-centered approach is necessary in order to reveal and understand the actual user needs and avoid making incorrect assumptions based on generalizations of the developers' personal experiences with end-users, which is a common pitfall in software design. Hereby, an important aim is to develop a product with a high usefulness for the end-user, increasing the likelihood of acceptance and actual use of the final product (Nedopil, Schauber, & Glende, 2013; Rubin & Chisnell, 2008). The present Testing and Trial Methodology Plan is further structured as follows:

1. A short description of the target group of end-users (in accordance with the User Recruitment Plan, D1.2)

Detailed descriptions of each testing phase with all planned measurements;

2. Initial testing

3. Field trails

4. Benchmark survey and willingness-to-pay

1. End-user involvement in the development of SOULMATE

The end-user group of elderly is defined by age, in this case 65 years and older. However, the elderly population is comprised of increasingly diverse individuals with different wishes and needs regarding travel that can no longer be considered a homogeneous group. In general with an increase in age, health declines and the number of impairments rise. This does not mean that all elderly people are mobility impaired and the needs of older people are the same as impaired people. Fiedler (2007) found that the travel patterns and needs of older people differ from those who are mobility impaired. Even elderly with mobility impairment and elderly without mobility impairment show different travel patterns and travel needs (Hildebrand, 2003). Other studies indicate that, in addition to mobility impairment, a migration

background may also play a role in travel behavior of people. Both Blumenberg and Shiki, (2007) and Harms (2007) found differences in terms of preferred transport mode and number of trips between natives and immigrants that were still present when controlling for the difference in socio-demographic variables such as income, car ownership, and urban density. These studies made no distinction between age groups but the differences between immigrant and non-immigrant are expected to also exist for older adults. In addition, older adults with a migrant background often experience language barriers which prevents them from using the available modes of public transport (Haustein, et al., 2013). Not only mobility impairment and migration background but also home location should be taken into account when examining the travel needs and wishes of older adults. Over the last decade the shops and services in rural areas and city centers have disappeared or moved to the commercial areas on the outskirts of urban areas outside of walking or cycling distance. This has increased the car dependency for daily life. When growing older it becomes more difficult or impossible to drive, and the availability of alternative transport modes differs for different urban density levels. For example, trains only support travel between or within cities but do not service small towns in rural areas; here the bus and taxi are more used alternatives. In addition, in rural areas it is difficult to maintain profitable public transport, and without public transport and shops or services within walking or cycling distance it has become difficult to live independently when driving has become difficult or impossible (Fiedler, 2007). Several studies found a difference in preference for public transport modes between rural and urban areas (Bell, et al., 2013). This implies different user needs for elderly in rural and urban areas. Concluding, it is important to keep in mind that older adults are a very diverse group; as only some migrants experience language barriers, while others might find it difficult to drive, but there are also many that don't experience the same problems.

The three characteristics discussed above (mobility impairment, migration background and urban density) are often mentioned to be the reasons why older adult's transportation needs and wishes are diverse. In order to discover whether these differences have implications for the expected outcomes of the SOULMATE solution, end-users involved in the testing phase will differ on:

- Mobility impaired or not;
- Migration background (natives vs. immigrants).
- Urban density level of neighborhood (urban vs. rural areas);

The number of end-users that will be recruited and involved in each of the phases are defined in careful consideration with the end-user organizations in the 3 countries (Belgium, Austria and the Netherlands). The end-users must of course be willing to engage in the testing, must be able to participate (some with help of secondary end-users) and test the SOULMATE solution, and give and discuss their feedback. Each participant will be asked to sign an informed consent form. End-users participating in the development of SOULMATE must meet the following criteria:

- 65 years or older,
- Willing to participate and sign informed consent form,
- Able to participate, discuss and give feedback.

Table 1 shows a specific overview of number and characteristics of end-users involved in the various phases of the process.

Table 1 Overview of number and characteristics of end-users involved in the various phases of the SOULMATE project

Co-creation Workshops ("Service Design" & "Feature Selection")	**Initial testing**	**Field trials**	**Benchmark Survey**	**Total**
AU	Natives: 6 + 6 Immigrants: 6 + 6	5	Natives: 20 Immigrants: 20	100	169
B	Complete mobile: 6 + 6 Mobility impaired: 6 + 6	5	Complete mobile: 20 Mobility impaired: 20	100	169
NL	Urban: 6 + 6 Rural: 6 + 6	5	Urban area: 20 Rural area: 20	100	169
Total	72	15	60	60	300	507

Over the different phases of the development process of SOULMATE the motives for including end-users differs:

• (Completed) Co-creation process: Getting familiar with the needs, wishes and functionalities of end-users,

• (2.) Initial testing: Acquire extensive feedback on prototype,

• (3.) Field trails: Examine the impact on real-life and stress testing of the application,

• (4.) Benchmark survey: Baseline outcome measures and market perspective.

The following chapters describe each phase of Testing and Measurement, as well as how the end-users are involved in the development process.

2. Initial Testing SOULMATE

In the initial testing, the initial versions of the instrument will be tested by 5 motivated end-users per country in iterative loops. Based on preset travel scenario's these end-users will be asked to test the functional limits of our solution, for a number of consecutive prototypes. Selection of these elderly needs to be done carefully, based on the probability that end-users are capable of carrying out preset scenario's and deal with bugs and uncertainty in the solution; have the ability to give extensive verbal feedback and are cognitively able to reflect on their interaction with the solution. A match between the module to be tested and the specific needs of the test user will be sought for to produce relevant feedback. During regular, bi- to four-weekly, meetings with the end-users, in a place familiar to them (e.g., office end-user organization), their use of and experience with the SOULMATE solution will be extensively discussed and includes among others perceived usefulness, integration in everyday life, usability, acceptance, and safety. The results will be discussed with the developers to continuously evaluate and improve the instrument until a final version of the instrument is ready to be extensively tested. TU/e and RRD will

develop a structure for the initial testing and contact moments with the end-users which will guide the end-user organization during the meetings with the end-users. Feedback and outcome of the initial tests will be analyzed and summarized by TU/e and RRD. For an instruction regarding the functional feedback meeting, including feedback form see Appendix A1 through A3. Additional feedback rounds regarding the design of the SOULMATE solution (as opposed to the functional aspects described above) can be flexibly implemented by the technical partners whenever required in the design process. These design sessions will use mock ups or demo versions of the application and focus on how the solution looks and feels to the target audience rather than assess how it performs. Methods of feedback that are similar to the ones described above will be used to get input from end-users on their preferences in terms of design. A potential design feedback form is included below.

3. Field Trials SOULMATE

During the field trials, 40 end-users per country will use the SOULMATE solution during their real-life trips. The living labs, created by the end-user organizations, will be the end-users single point of contact during the field trails, and are responsible for recruitment of end-users as well as keeping them engaged (e.g. by community building activities). At the start and after 6 months (end of field trials), the travel behavior, quality of life and physical activity of the participants will be measured by means of a survey. Additionally, interviews with the participants will further clarify the findings of these surveys. Participants' demographic information (age, gender, socio-economic status) will be gathered at the start of the field trials.

As can be seen in the planning of the field trials (Figure 2), different groups of end-users will start with the field trials procedure in a sequential way. This way, potential burdens on the end-user organizations to provide information and support can be alleviated. All participants in the field trials will meet with the field trial coordinator several times; in a start-up workshop, at measurement points 1 and 2, and at the end-workshop. During the start-up workshop, end-users will receive the SOULMATE solution and instructions on how to use it in their daily life. Demos can be used to show the different functionalities of the app, and end-users can be given time to practice on their own. Users will be guided in making the necessary preparations to start using the app on their own, including (but not limited to) setting up an account and entering contact information. Additionally, the procedure of the measurement period will be discussed with the participants, in order to describe what they can expect and what is expected of them. This includes a more specific instruction on how and when to keep their travel diary. Finally, the required informed consent forms for participation in the field trial measurements will be signed by participants.

At each measurement point (1 and 2), the same set of measures will be filled out by participants. This includes the questionnaires described below, the activity and travel diary, and any physical measurements that may be included. Participants will be asked to keep travel diaries for a week prior to the measurement point, where they can hand them in to the measurement coordinator. These measurement points will also function as community support events where end-user organizations can plan activities to stimulate engagement with the project and where participants can voice and discuss their opinions or ask additional questions about the app.

The end-workshop will function as a debriefing and clean-up session. Here, participants will be guided through uninstalling the field-trial version of the SOULMATE app. In addition, the measurement

coordinators will inform the participating end-users about the rest of the project ("what happens now?") and allows for a structured reflection on the field trial process.

Document D3.2C will elaborate on all the results of the field trails of the SOULMATE project. The following measures and questionnaires will be implemented during each phase of the field trials:

Measures <between brackets> were originally included in the project proposal but are currently under consideration for inclusion in the final testing.

Measures

• Actual travel behavior of end-users will be measured by means of travel diaries to gather information on their mobility patterns. This includes among others: activity space, number of trips, activity locations and travel party.

• Activity patterns will be measured by a travel diary and the Groningen Activity Restriction Scale (GARS).

• <Physical activity will be assessed by means of collecting physical activity sensor data (which will be subsequently categorized as either sedentary, or low-intensively, moderate intensive, or vigorous activity), which will be provided to the field trial participants for the duration of one week.>

• <Physical Performance will be rated through the Short Physical Performance Battery (SPPB). The short test battery includes three 'exercises' that can easily be rated on performance by an observer.>

Questionnaires

• Quality of Life will be measured with the WHOQoL-OLD survey. A questionnaire developed by the World Health Organization that specifically aims to measure the quality of life in older adults.

• Social Networks will be measured using a name generation task. This task will be able to measure the size of participants' social network, as well as some characteristics about these relationships.

• Loneliness will be measured by the De Jong Gierveld Loneliness Scale. This scale is a short questionnaire that inquires about social and emotional loneliness.

• Self-Reported Health will be assessed with the SF-36 questionnaire. This questionnaire can be used to determine how participants rate different aspects of their physical and mental health.

• Patient Empowerment is being measured with the Patient Enablement Instrument (PEI). Using a few statements this scale measures how empowered participants feel after using the SOULMATE solution, in terms of their ability to take care of their health and life in general.

• <Burden on the Informal Caregiver will be rated by participants' caregivers through the Zarit Burden Interview. Through a series of statements, the informal caregiver can indicate to what extent they experience taking care of the participant as a burden.>

4. Benchmark survey SOULMATE

In addition to the field trials, a benchmark survey will be sent out to a large group of respondents from the target population. This survey will include the main measures that are used in the Field Trials described above, which will function as base lines to which the field trial measures can be compared. The following indicators will therefore be included in the survey:

• QoL & perceived autonomy score: (WHOQoL-OLD survey) to test for, among others: sensory abilities; autonomy; past, present and future activities; and social participation.

• Social network will be analyzed using the social network analysis approach (Van den Berg, 2012).

• Loneliness: The 6-item loneliness scale contains items on overall, emotional and social loneliness.

• Self-reported health will be assessed by means of the Short Form (36) Health Survey (SF36).

• <Patient empowerment will be assessed by means of the Patient Enablement Instrument (PEI).>

• <Burden on informal caregiver: we will question the end-users' informal caregivers about the burden they experience while taking care of somebody else (12-item version of the Zarit Burden Interview).>

During the follow-up measurements the same indicators are measured and changes are compared to the baseline to test for the effect of using the SOULMATE solution. Hereby, this survey will allow testing and quantifying the effects of using SOULMATE by the end-users and will provide information to the developers on how to maximize and personalize the capabilities of the instrument for a variety of end-users. Moreover, the survey will include a Willingness-To-Pay for and Acceptance of (WTP) experiment to test what future users are willing to pay for the various components of the SOULMATE solution. More specifically, a choice experiment design will ask respondents to choose between different versions of the potential SOULMATE solution for different pricing values and strategies. Gained information will then provide input for the business plan and go-to-market strategy of the SOULMATE solution. Relevant results of the Benchmark Survey will be reported in document D3.3 of the deliverables.

References

Blumenberg, E., & Shiki, K. (2007). Transportation Assimilation: Immigrants, Race and Ethnicity, and Mode Choice. *Transportation Research Board 86th Annual Meeting*, (p. 18). Washington, DC.

Fiedler, M. (2007). Older People and Public Transport: Challenges and Chances of an Ageing Society. Final Report. Retrieved from: http://www. emta. com/IMG/pdf/Final_Report_Older_People_protec. pdf

Harms, L. (2007). Mobility among Ethnic Minorities in the Urban Netherlands. In Urban Mobility and Social Inequity. Retrieved from: https://difu.de/publikationen/mobility-among-ethnic-minorities-in-the-urban-netherlands.html

Haustein, S., Anu, K., Framke, E., Bell, D., Pofkriefke, E., Alauzet, A., ... O'Neill, D. (2013). Demographic Change and Transport. *European Commission.*

Hildebrand, E. D. (2003). Dimensions in elderly travel behaviour: A simplified activity-based model using lifestyle clusters. *Transportation 30(3)*, 285-306.

Nedopil, C., Schauber, C., & Glende, S. (2013). *Guideline: The art and joy of user integration in AAL projects*. Brussels, Belgium: Ambient Assisted Living Association.

Rubin, J., & Chisnell, D. (2008). *Handbook of Usability testing: How to Plan, Design, and Conduct Effective Tests (2nd ed.)*. New York, NY: Wiley Publishing, Inc.

Van den Berg, P. (2012). Social activity-travel patterns: The role of personal networks and communication technology. Eindhoven: Eindhoven University of Technology.

Appendix A.2 Initial Testing Version 2

In the initial testing phase, early versions of the SOULMATE application will be tested by a small group of (5) motivated end-users in each of the three participating countries. In iterative loops, the design and functionality of the service will be tested and discussed by these end-users in order to shape the development of a solution they want and need. The initial testing phase will be split up in two stages; design testing and functional testing. Both stages will require extensive discussion and feedback of a select group of end-users. Selection of these elderly needs to be done carefully, based on the probability that end-users are capable of carrying out preset scenario's and deal with bugs and uncertainty in the solution; have the ability to give extensive verbal feedback and are cognitively able to reflect on their interaction with the solution. A match between the module to be tested and the specific needs of the test user will be sought for to produce relevant feedback. In addition to using the same selection criteria, the two stages of initial testing will also use a similar set-up. These testing sessions will be (estimated) half-day workshops in a place that is familiar to the end-users (e.g., the office of an end-user organization) in small groups of 5 at a time. In these workshops the end-users are first introduced to some part of the SOULMATE service and then interact with it in a structured way. After these interactive sessions, participants will be asked to challenge the limits of the current version and provide feedback on the strengths and issues of this version of the application. TU/e and RRD have developed a structure for the initial testing and contact moments with the end-users which will guide the end-user organization during the meetings with the end-users. Feedback and outcome of the initial tests will be analyzed and summarized by TU/e and RRD.

First, the design of the SOULMATE solution will be reviewed by end-users. These design sessions will use a click-dummy version of the application. A click-dummy displays a sequence of static screens that can be navigated simply by tapping the buttons, thus creating a trial experience that feels like an actual application. Some screenshots of the available click-dummy will be included. As workshops will be conducted in different countries, the click-dummy and all other materials (e.g., feedback forms) will be translated from English to German and Dutch. The design testing sessions will focus on how the solution looks and feels to the target audience. Design includes aspects such as position and size of buttons, phrasing of labels, and intuitiveness of screens and sequences. The full structure of the design testing workshop will be described. In general, the workshops are expected to span half a day. During this time, end-users will be introduced to the aim of the SOULMATE solution in general and the current click-dummy more specifically. To guide participants through the click-dummy, several scenarios have been set-up. Starting with a full step-by-step direction on what to do, these scenarios continuously decrease in the amount of specific instructions they give. This way, participants get more freedom and responsibility to figure out how to complete the scenario as they get further down the list. Eventually, the end-users should run into most issues of counter-intuitive menus and button placements as they try to figure out what to do. Of course, the workshop organizer will always be present to assist the participants and avoid potential frustration. Near the end of the workshop, written feedback on the design of the click-dummy will be asked from participants. A short questionnaire was designed to guide end-users in giving this feedback, including some quantitative (ratings) and qualitative (aspects and suggestions) items. These questions can further be discussed during the workshop, to allow the end-users to expand on their answers further and

weigh different opinions. Results of the initial design testing workshops will be reported in deliverable D3.2A.

Next, the functionality of the SOULMATE solution will be reviewed by end-users. Similar to the click-dummy of the design workshop, an early version of the actual application will be developed for the functional testing workshops. Again, the version of the application that will be used during the workshop will have English, German, and Dutch translations. This time, however, end-users will be asked to test the functionality of the application. Functional aspects include finding bugs or things that do not work at all, but also making sure the functionality of the app works in ways that the end-users expect. The same general structure of the design testing workshops will be used again for the functional testing workshops. In general, these workshops are expected to span half a day. During this time, end-users will be introduced (or reminded of) the aim of the SOULMATE solution in general and the current version of the application more specifically. To guide participants through this version of the app, several scenarios will be set-up, with content depending on the functionality that is available in the most recent version of the application at that time. Starting with full step-by-step directions on what to do, these scenarios will also continuously decrease in the amount of specific instructions that are included. More so than with the design testing workshops, end-users will be asked to seek the limits of that version of the application; through experimentation with different functions and button combinations. Eventually, users are expected to run into functions that do not work, or at least not as they expect them to. Near the end of the workshop, written feedback on the design of the click-dummy will be asked from participants. A short questionnaire was designed to guide end-users in giving this feedback, including some quantitative (ratings) and qualitative (aspects and suggestions) items. These questions can further be discussed during the workshop, to allow the end-users to expand on their answers further and weigh different opinions. Results of the initial functional testing workshops will be reported in deliverable D3.2B.

Appendix B Benchmark Survey Paper Version (Dutch)

SOULMATE Vragenlijst

Welkom bij de SOULMATE vragenlijst!

Allereerst heel erg bedankt voor uw deelname aan de SOULMATE vragenlijst. Hierin gaan we u verschillende vragen stellen over uw activiteiten, ervaringen in het dagelijks leven en over mogelijke elementen voor de SOULMATE apps die we gaan ontwikkelen. Met deze informatie helpt u ons bij het ontwikkelen van een app die het beste aansluit bij uw wensen en voorkeuren. Het invullen zal ongeveer 45 minuten duren.

In deze vragenlijst zijn we geïnteresseerd in uw meningen en in hoeverre u het eens of oneens bent met verschillende stellingen. Er zijn dus geen goede of foute antwoorden voor de vragen.

Leest u alstublieft de uitleg bij de vragen grondig door voordat u begint met het beantwoorden van de vragen. Wanneer er iets onduidelijk is, kan u natuurlijk contact opnemen met de verantwoordelijke persoon.

In lijn met de toestemmingsverklaring die u hieronder ziet zullen al uw gegevens vertrouwelijk en anoniem behandeld worden.

Algemene vragen

Wat is uw geslacht?

- ◯ Man
- ◯ Vrouw
- ◯ Anders

Tot welke leeftijdscategorie behoort u?

- ◯ Jonger dan 60 jaar
- ◯ 61 – 65 jaar
- ◯ 66 - 70 jaar
- ◯ 71 - 75 jaar
- ◯ 76 - 80 jaar
- ◯ 81 - 85 jaar
- ◯ 86 - 90 jaar
- ◯ 91 - 95 jaar
- ◯ 96 - 100 jaar
- ◯ Ouder dan 100 jaar

Wat is uw hoogst voltooide opleiding?

- ◯ Geen opleiding voltooid
- ◯ Basis onderwijs, lager onderwijs
- ◯ Lager beroepsonderwijs of vglo, lavo, mavo, mulo, vmbo, bso
- ◯ Middelbaar beroepsonderwijs of havo, atheneum, gymnasium, mms, hbs, aso, kso, tso
- ◯ Hoger beroepsonderwijs, universiteit
- ◯ Andere opleiding
- ◯ Onbekend

Bent u geboren in het land waar u nu woont?

- ◯ Ja
- ◯ Nee

Waar woont u?

- ◯ In een stad

◯ In een dorp
◯ In het buitengebied (buiten de bebouwde kom)

Wat is uw huidige woonsituatie?

◯ Eengezinswoning (Vrijstaand, rijtjeshuis, 2 onder 1 kap, halfopen bebouwing)
◯ Appartement of flat
◯ Zelfstandige ouderenwoning, aanleunwoning, serviceflat, kangoeroewoning
◯ Verpleeghuis
◯ Overige

Woont u op dit moment samen met een partner?

◯ Ja
◯ Nee

Heeft u een auto?

◯ Ja
◯ Nee

Verplaatsingsgedrag

In dit deel proberen we een beeld te krijgen van uw verplaatsingsgedrag.

Hoe vaak maakt u voor de volgende aktiviteiten een verplaatsing?

Kies het meest toepasselijke antwoord voor elk onderdeel:

	Zelden tot nooit	1 x per maand	2-3 x per maand	1 x per week	Meerdere keren per week	Vrijwel dagelijks
Op bezoek/ logeren	◯	◯	◯	◯	◯	◯
Fietsen/ wandelen/ rond rijden	◯	◯	◯	◯	◯	◯
Dagje uit/ horeca/ theater/ museumbezoek	◯	◯	◯	◯	◯	◯
Winkelen/ boodschappen doen	◯	◯	◯	◯	◯	◯
Persoonlijke verzorging/ diensten	◯	◯	◯	◯	◯	◯
(vrijwilligers) Werk	◯	◯	◯	◯	◯	◯
Sport/ hobby	◯	◯	◯	◯	◯	◯
Onderwijs/ cursus volgen	◯	◯	◯	◯	◯	◯
Andere categorie	◯	◯	◯	◯	◯	◯

Hoe vaak gebruikt u de volgende vervoersmiddelen?

Kies het meest toepasselijke antwoord voor elk onderdeel:

	Zelden tot nooit	1 keer per maand	2-3 keer per maand	1 keer per week	Meerdere keren per week	Vrijwel dagelijks
Te voet	○	○	○	○	○	○
Elektrische fiets/ fiets	○	○	○	○	○	○
Brommer/ scooter/ scootmobiel	○	○	○	○	○	○
Auto als bestuurder	○	○	○	○	○	○
Auto als passagier	○	○	○	○	○	○
Motor	○	○	○	○	○	○
Bus/tram/metro	○	○	○	○	○	○
Trein	○	○	○	○	○	○
Taxi	○	○	○	○	○	○

Zelfredzaamheid

De volgende vragen gaan erover of u *op dit moment* een aantal werkzaamheden, die regelmatig gedaan moeten worden, zelfstandig kunt uitvoeren.

Het gaat er dus niet om of u bepaalde werkzaamheden ook werkelijk doet, maar of u ze zou kunnen verrichten (indien dat nodig is of nodig mocht zijn).

Algemene dagelijkse levensverrichtingen

Kies het meest toepasselijke antwoord voor elk onderdeel:

	Ja, dat kan ik geheel zelfstandig zonder enige moeite. 1	Ja, dat kan ik geheel zelfstandig maar wel met enige moeite. 2	Ja, dat kan ik geheel zelfstandig maar met veel moeite. 3	Nee, Dat kan ik niet zelfstandig, maar alleen met hulp van anderen. 4
Kunt u zich, geheel zelfstandig aan- en uitkleden?	◯	◯	◯	◯
Kunt u, geheel zelfstandig, in en uit bed komen?	◯	◯	◯	◯
Kunt u, geheel zelfstandig, vanuit een stoel overeind komen?	◯	◯	◯	◯

	Ja, dat kan ik geheel zelfstandig zonder enige moeite. 1	Ja, dat kan ik geheel zelfstandig maar wel met enige moeite. 2	Ja, dat kan ik geheel zelfstandig maar met veel moeite. 3	Nee, Dat kan ik niet zelfstandig, maar alleen met hulp van anderen. 4
Kunt u, geheel zelfstandig, uw gezicht en handen wassen?	◯	◯	◯	◯
Kunt u, geheel zelfstandig, uw hele lichaam wassen en afdrogen?	◯	◯	◯	◯
Kunt u, geheel zelfstandig, van en naar het toilet gaan?	◯	◯	◯	◯
Kunt u, geheel zelfstandig, eten en drinken?	◯	◯	◯	◯
Kunt u, geheel zelfstandig, rondlopen in huis (eventueel met stok)?	◯	◯	◯	◯
Kunt u, geheel zelfstandig, de trap op en aflopen?	◯	◯	◯	◯
Kunt u, geheel zelfstandig, buitenshuis rondlopen (eventueel met stok)?	◯	◯	◯	◯
Kunt u, geheel zelfstandig, uw voeten en teennagels verzorgen?	◯	◯	◯	◯

Huishoudelijke dagelijkse levensverrichtingen

Kies het meest toepasselijke antwoord voor elk onderdeel:

	Ja, dat kan ik geheel zelfstandig zonder enige moeite. 1	Ja, dat kan ik geheel zelfstandig maar wel met enige moeite. 2	Ja, dat kan ik geheel zelfstandig maar met veel moeite. 3	Nee, Dat kan ik niet zelfstandig, maar alleen met hulp van anderen. 4
Kunt u, geheel zelfstandig, ontbijt of lunch klaarmaken?	○	○	○	○
Kunt u, geheel zelfstandig, warm eten klaar maken?	○	○	○	○
Kunt u, geheel zelfstandig, "lichte" huishoudelijke werkzaamheden verrichten (bijv. Stof afnemen of prullen opruimen)?	○	○	○	○
Kunt u, geheel zelfstandig, "zware" huishoudelijke werkzaamheden verrichten (bijv. Dweilen, ramen lappen of stofzuigen)	○	○	○	○
Kunt u, geheel zelfstandig, uw kleren wassen en strijken?	○	○	○	○
Kunt u, geheel zelfstandig, de bedden verschonen en/of opmaken?	○	○	○	○
Kunt u, geheel zelfstandig, de boodschappen doen?	○	○	○	○

Sociaal Netwerk

De volgende vragen gaan over uw sociale omgeving. We vragen u hiervoor de namen te noemen van personen waar u een sterke band mee hebt *buiten uw huishouden.* Denk hierbij aan mensen waar u regelmatig een praatje mee maakt, meer dan alleen een begroeting op straat bijvoorbeeld. Om het bedenken van deze namen wat makkelijker te maken, hebben we twee categorieën gemaakt: 1) Familie en 2) Vrienden/ Buren/ Anderen. Denk bij Anderen bijvoorbeeld aan verenigingen of clubs waar u bij bent. Per categorie wordt u eerst gevraagd *maximaal 15* namen te noemen, dit mogen er natuurlijk ook minder zijn. Alleen de voornaam van iedere persoon is genoeg, zelfs een bijnaam of alleen voorletters zijn prima. Vul eerst linksboven de naam in. Geef daarna aan hoe vaak u fysiek en niet-fysiek contact hebt met deze persoon. Met fysiek contact bedoelen we een persoonlijke face-to-face ontmoeting. Denk bij niet-fysiek contact aan telefoongesprekken, gebruik van whatsapp, of het verzenden van facebookberichten. Ook vragen we hoe dicht deze persoon bij u in de buurt woont.

1) **Familie**

Naam:	Minder dan 1 keer per maand	1 tot 3 keer per maand	1 keer per week	Meerdere keren per week	Vrijwel dagelijks
Fysiek contact	○	○	○	○	○
Niet-fysiek contact	○	○	○	○	○

	In dezelfde buurt	Buiten mijn buurt maar in dezelfde woonplaats	Buiten mijn woonplaats
Afstand	○	○	○

Naam:	Minder dan 1 keer per maand	1 tot 3 keer per maand	1 keer per week	Meerdere keren per week	Vrijwel dagelijks
Fysiek contact	○	○	○	○	○
Niet-fysiek contact	○	○	○	○	○

	In dezelfde buurt	Buiten mijn buurt maar in dezelfde woonplaats	Buiten mijn woonplaats
Afstand	○	○	○

Naam:	Minder dan 1 keer per maand	1 tot 3 keer per maand	1 keer per week	Meerdere keren per week	Vrijwel dagelijks
Fysiek contact	○	○	○	○	○
Niet-fysiek contact	○	○	○	○	○

	In dezelfde buurt	Buiten mijn buurt maar in dezelfde woonplaats	Buiten mijn woonplaats
Afstand	○	○	○

Naam:	Minder dan 1 keer per maand	1 tot 3 keer per maand	1 keer per week	Meerdere keren per week	Vrijwel dagelijks
Fysiek contact	○	○	○	○	○
Niet-fysiek contact	○	○	○	○	○

	In dezelfde buurt	Buiten mijn buurt maar in dezelfde woonplaats	Buiten mijn woonplaats
Afstand	○	○	○

Naam:	Minder dan 1 keer per maand	1 tot 3 keer per maand	1 keer per week	Meerdere keren per week	Vrijwel dagelijks
Fysiek contact	○	○	○	○	○
Niet-fysiek contact	○	○	○	○	○

	In dezelfde buurt	Buiten mijn buurt maar in dezelfde woonplaats	Buiten mijn woonplaats
Afstand	○	○	○

Naam:	Minder dan 1 keer per maand	1 tot 3 keer per maand	1 keer per week	Meerdere keren per week	Vrijwel dagelijks
Fysiek contact	○	○	○	○	○
Niet-fysiek contact	○	○	○	○	○

	In dezelfde buurt	Buiten mijn buurt maar in dezelfde woonplaats	Buiten mijn woonplaats
Afstand	○	○	○

Naam:	Minder dan 1 keer per maand	1 tot 3 keer per maand	1 keer per week	Meerdere keren per week	Vrijwel dagelijks
Fysiek contact	◯	◯	◯	◯	◯
Niet-fysiek contact	◯	◯	◯	◯	◯
	In dezelfde buurt	Buiten mijn buurt maar in dezelfde woonplaats		Buiten mijn woonplaats	
Afstand	◯	◯		◯	

Naam:	Minder dan 1 keer per maand	1 tot 3 keer per maand	1 keer per week	Meerdere keren per week	Vrijwel dagelijks
Fysiek contact	◯	◯	◯	◯	◯
Niet-fysiek contact	◯	◯	◯	◯	◯
	In dezelfde buurt	Buiten mijn buurt maar in dezelfde woonplaats		Buiten mijn woonplaats	
Afstand	◯	◯		◯	

Naam:	Minder dan 1 keer per maand	1 tot 3 keer per maand	1 keer per week	Meerdere keren per week	Vrijwel dagelijks
Fysiek contact	◯	◯	◯	◯	◯
Niet-fysiek contact	◯	◯	◯	◯	◯
	In dezelfde buurt	Buiten mijn buurt maar in dezelfde woonplaats		Buiten mijn woonplaats	
Afstand	◯	◯		◯	

Naam:	Minder dan 1 keer per maand	1 tot 3 keer per maand	1 keer per week	Meerdere keren per week	Vrijwel dagelijks
Fysiek contact	○	○	○	○	○
Niet-fysiek contact	○	○	○	○	○
	In dezelfde buurt	Buiten mijn buurt maar in dezelfde woonplaats		Buiten mijn woonplaats	
Afstand	○	○		○	

Naam:	Minder dan 1 keer per maand	1 tot 3 keer per maand	1 keer per week	Meerdere keren per week	Vrijwel dagelijks
Fysiek contact	○	○	○	○	○
Niet-fysiek contact	○	○	○	○	○
	In dezelfde buurt	Buiten mijn buurt maar in dezelfde woonplaats		Buiten mijn woonplaats	
Afstand	○	○		○	

Naam:	Minder dan 1 keer per maand	1 tot 3 keer per maand	1 keer per week	Meerdere keren per week	Vrijwel dagelijks
Fysiek contact	○	○	○	○	○
Niet-fysiek contact	○	○	○	○	○
	In dezelfde buurt	Buiten mijn buurt maar in dezelfde woonplaats		Buiten mijn woonplaats	
Afstand	○	○		○	

Naam:	Minder dan 1 keer per maand	1 tot 3 keer per maand	1 keer per week	Meerdere keren per week	Vrijwel dagelijks
Fysiek contact	○	○	○	○	○
Niet-fysiek contact	○	○	○	○	○
	In dezelfde buurt	Buiten mijn buurt maar in dezelfde woonplaats		Buiten mijn woonplaats	
Afstand	○	○		○	

Naam:	Minder dan 1 keer per maand	1 tot 3 keer per maand	1 keer per week	Meerdere keren per week	Vrijwel dagelijks
Fysiek contact	○	○	○	○	○
Niet-fysiek contact	○	○	○	○	○
	In dezelfde buurt	Buiten mijn buurt maar in dezelfde woonplaats		Buiten mijn woonplaats	
Afstand	○	○		○	

Naam:	Minder dan 1 keer per maand	1 tot 3 keer per maand	1 keer per week	Meerdere keren per week	Vrijwel dagelijks
Fysiek contact	○	○	○	○	○
Niet-fysiek contact	○	○	○	○	○
	In dezelfde buurt	Buiten mijn buurt maar in dezelfde woonplaats		Buiten mijn woonplaats	
Afstand	○	○		○	

2) **Vrienden, buren en anderen** (denk hierbij bijvoorbeeld aan leden van verenigingen of clubs).

Naam:	Minder dan 1 keer per maand	1 tot 3 keer per maand	1 keer per week	Meerdere keren per week	Vrijwel dagelijks
Fysiek contact	◯	◯	◯	◯	◯
Niet-fysiek contact	◯	◯	◯	◯	◯
	In dezelfde buurt	Buiten mijn buurt maar in dezelfde woonplaats		Buiten mijn woonplaats	
Afstand	◯	◯		◯	

Naam:	Minder dan 1 keer per maand	1 tot 3 keer per maand	1 keer per week	Meerdere keren per week	Vrijwel dagelijks
Fysiek contact	◯	◯	◯	◯	◯
Niet-fysiek contact	◯	◯	◯	◯	◯
	In dezelfde buurt	Buiten mijn buurt maar in dezelfde woonplaats		Buiten mijn woonplaats	
Afstand	◯	◯		◯	

Naam:	Minder dan 1 keer per maand	1 tot 3 keer per maand	1 keer per week	Meerdere keren per week	Vrijwel dagelijks
Fysiek contact	◯	◯	◯	◯	◯
Niet-fysiek contact	◯	◯	◯	◯	◯
	In dezelfde buurt	Buiten mijn buurt maar in dezelfde woonplaats		Buiten mijn woonplaats	
Afstand	◯	◯		◯	

Naam:	Minder dan 1 keer per maand	1 tot 3 keer per maand	1 keer per week	Meerdere keren per week	Vrijwel dagelijks
Fysiek contact	◯	◯	◯	◯	◯
Niet-fysiek contact	◯	◯	◯	◯	◯
	In dezelfde buurt	Buiten mijn buurt maar in dezelfde woonplaats		Buiten mijn woonplaats	
Afstand	◯	◯		◯	

Naam:	Minder dan 1 keer per maand	1 tot 3 keer per maand	1 keer per week	Meerdere keren per week	Vrijwel dagelijks
Fysiek contact	◯	◯	◯	◯	◯
Niet-fysiek contact	◯	◯	◯	◯	◯
	In dezelfde buurt	Buiten mijn buurt maar in dezelfde woonplaats		Buiten mijn woonplaats	
Afstand	◯	◯		◯	

Naam:	Minder dan 1 keer per maand	1 tot 3 keer per maand	1 keer per week	Meerdere keren per week	Vrijwel dagelijks
Fysiek contact	◯	◯	◯	◯	◯
Niet-fysiek contact	◯	◯	◯	◯	◯
	In dezelfde buurt	Buiten mijn buurt maar in dezelfde woonplaats		Buiten mijn woonplaats	
Afstand	◯	◯		◯	

Naam:	Minder dan 1 keer per maand	1 tot 3 keer per maand	1 keer per week	Meerdere keren per week	Vrijwel dagelijks
Fysiek contact	◯	◯	◯	◯	◯
Niet-fysiek contact	◯	◯	◯	◯	◯
	In dezelfde buurt	Buiten mijn buurt maar in dezelfde woonplaats		Buiten mijn woonplaats	
Afstand	◯	◯		◯	

Naam:	Minder dan 1 keer per maand	1 tot 3 keer per maand	1 keer per week	Meerdere keren per week	Vrijwel dagelijks
Fysiek contact	◯	◯	◯	◯	◯
Niet-fysiek contact	◯	◯	◯	◯	◯
	In dezelfde buurt	Buiten mijn buurt maar in dezelfde woonplaats		Buiten mijn woonplaats	
Afstand	◯	◯		◯	

Naam:	Minder dan 1 keer per maand	1 tot 3 keer per maand	1 keer per week	Meerdere keren per week	Vrijwel dagelijks
Fysiek contact	◯	◯	◯	◯	◯
Niet-fysiek contact	◯	◯	◯	◯	◯
	In dezelfde buurt	Buiten mijn buurt maar in dezelfde woonplaats		Buiten mijn woonplaats	
Afstand	◯	◯		◯	

Naam:	Minder dan 1 keer per maand	1 tot 3 keer per maand	1 keer per week	Meerdere keren per week	Vrijwel dagelijks
Fysiek contact	◯	◯	◯	◯	◯
Niet-fysiek contact	◯	◯	◯	◯	◯
	In dezelfde buurt	Buiten mijn buurt maar in dezelfde woonplaats		Buiten mijn woonplaats	
Afstand	◯	◯		◯	

Naam:	Minder dan 1 keer per maand	1 tot 3 keer per maand	1 keer per week	Meerdere keren per week	Vrijwel dagelijks

Fysiek contact	◯	◯	◯	◯	◯
Niet-fysiek contact	◯	◯	◯	◯	◯
	In dezelfde buurt	Buiten mijn buurt maar in dezelfde woonplaats		Buiten mijn woonplaats	
Afstand	◯	◯		◯	

Sociale Contacten

Geef aan of de volgende stellingen op u van toepassing zijn:

Kies het meest toepasselijke antwoord voor elk onderdeel:

	Nee	Min of meer	Ja
Ik ervaar leegte om me heen	◯	◯	◯
Er zijn genoeg mensen op wie ik in geval van narigheid kan terugvallen	◯	◯	◯
Ik heb veel mensen op wie ik volledig kan vertrouwen	◯	◯	◯
Ik mis mensen om me heen	◯	◯	◯
Er zijn voldoende mensen met wie ik me nauw verbonden voel	◯	◯	◯
Vaak voel ik me in de steek gelaten	◯	◯	◯

Gezondheid (zelf-rapportage)

Dit onderdeel van de vragenlijst gaat over uw beoordeling van uw gezondheid. Wanneer u twijfelt over de beantwoording van een vraag, kies dan de best mogelijke optie. Beantwoord alstublieft *alle* vragen.

Hoe zou u over het algemeen uw gezondheid noemen?

Uitstekend	Zeer goed	Goed	Matig	Slecht
◯	◯	◯	◯	◯

De volgende vragen gaan over de bezigheden die u misschien doet op een doorsnee dag. Wordt u door uw gezondheid op dit moment beperkt bij deze bezigheden? Zo ja in welke mate

Kies het meest toepasselijke antwoord voor elk onderdeel:

	Ja, daarbij voel ik me ernstig beperkt	Ja, daarbij voel ik me een beetje beperkt	Nee, daarbij voel ik me helemaal niet beperkt
Matige inspanning, zoals een tafel verplaatsen, stofzuigen, zwemmen of fietsen	◯	◯	◯
Een paar trappen oplopen	◯	◯	◯

Heeft u de afgelopen 4 weken, een van de volgende problemen bij uw werk of andere dagelijkse bezigheden gehad, ten gevolge van uw lichamelijke gezondheid?

Kies het meest toepasselijke antwoord voor elk onderdeel:

	Ja	Nee
U heeft minder bereikt dan u zou willen	◯	◯
U was beperkt in het soort werk of andere bezigheden	◯	◯

Heeft u de afgelopen 4 weken, een van de volgende problemen bij uw werk of andere dagelijkse bezigheden gehad, ten gevolge van uw emotionele toestand (zoals depressief voelen)?

Kies het meest toepasselijke antwoord voor elk onderdeel:

	Ja	Nee
U heeft minder bereikt dan u zou willen	◯	◯
U deed uw werk of andere bezigheden niet zo zorgvuldig als gewoonlijk	◯	◯

In welke mate bent u de afgelopen 4 weken door pijn gehinderd in uw normale werk? Zowel buitenshuis als huishoudelijk werk.

Helemaal niet	Een klein beetje	Nogal	Veel	Heel erg veel
◯	◯	◯	◯	◯

Hoe voelde u zich gedurende de afgelopen 4 weken?

Kies het meest toepasselijke antwoord voor elk onderdeel:

	Altijd	Meestal	Vaak	Soms	Zelden	Nooit
Voelde u zich rustig en tevreden?	◯	◯	◯	◯	◯	◯
Had u veel energie?	◯	◯	◯	◯	◯	◯
Voelde u zich somber en neerslachtig?	◯	◯	◯	◯	◯	◯

Hoe vaak hebben uw lichamelijke gezondheid of emotionele problemen u gedurende de afgelopen 4 weken gehinderd bij uw activiteiten (zoals vrienden of familie bezoeken etc.)?

Altijd	Meestal	Soms	Zelden	Nooit
◯	◯	◯	◯	◯

Keuzetaak

In het volgende deel leggen we u mogelijke SOULMATE apps voor. Omdat SOULMATE een app voor mobiliteit is, zit er altijd navigatie in: De app laat u routes maken en opslaan, zodat u die later kan gebruiken tijdens een verplaatsing. De apps die u gaat zien zullen ook verschillen van elkaar. Namelijk in hun prijs, en in welke extra functies aanwezig zijn bovenop de basis navigatie. Omdat deze functies wellicht nieuw voor u zijn, zullen we ze eerst verder toelichten.

- **Streetview 3D ontdekken**: Met deze functie kunt u de omgeving van een verplaatsing ontdekken vanuit uw huiskamer. In een virtuele 3D omgeving kunt u rondkijken op uw geplande route, zodat u alvast kan zien hoe de straten en gebouwen eruit zien nog voordat u een stap buiten de deur hoeft te zetten.

- **Gebouwen 3D ontdekken**: Met deze functie kunt u de binnenkant van gebouwen ontdekken vanuit uw huiskamer. In een virtuele 3D omgeving kunt u rondkijken binnenin publieke gebouwen zoals treinstations en het gemeentehuis, zodat u alvast kan zien waar u bijvoorbeeld een kaartje kunt kopen.

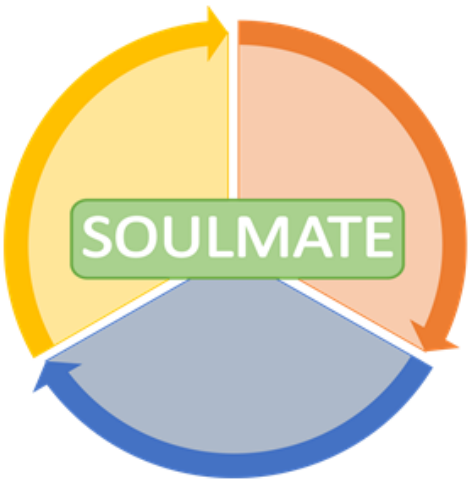
- **Route naar dichtstbijzijnde voorzieningen:** Met deze functie kunt u onderweg voorzieningen vinden. Wanneer u een verplaatsing maakt, kunt u met een simpele druk op de knop het dichtstbijzijnde toilet of bankje vinden. De app zal u dan de route geven naar de door u gekozen voorziening.

- Actuele openbaar vervoer informatie: Met deze functie kunt u onderweg actuele informatie vinden over het openbaar vervoer. Zo kan de app u bijvoorbeeld vertellen hoe laat de volgende bus naar uw bestemming vertrekt, hoe u bij de halte kunt komen, en hoe laat u verwacht aankomt.

- **Delen van route en positie met anderen**: Met deze functie kunt u uw verplaatsing delen met anderen. Voelt u zich net wat veiliger als iemand weet waar u bent? U kunt de app vragen uw verplaatsing te delen met iemand die u vertrouwt. Deze persoon kan uw positie dan volgen zolang als uw verplaatsing duurt.

- **Interactie met anderen (videobellen)**: Met deze functie kunt u contact maken met anderen als u hulp wilt met de verplaatsing. Gebeurt er onderweg iets? Met een enkele druk op een knop kunt u (video-)bellen met een van uw contacten of hulpdiensten. Ook kunt u de app zo instellen dat deze automatisch iemand belt als er iets gebeurt.

De apps die u zo dadelijk gaat zien hebben een aantal van deze functies hebben met daarbij een prijskaartje in de vorm van een **eenmalige betaling in euro**. Hierbij geeft een groen vinkje aan dat een functie in de app zit en een rood kruis dat die functie er niet in zit. Een voorbeeld:



SOULMATE – Uw reispartner op de smartphone

★★★★★

Streetview 3D ontdekken	X
Gebouwen 3D ontdekken	X
Route naar dichtsbijzijnde voorzieningen	X
Actuele openbaar vervoer informatie	X
Delen van route en positie met anderen	X
Interactie met anderen (videobellen)	√
Prijs	€ 2

In dit voorbeeld heeft de app dus de basis navigatie functie, met als uitbreiding de mogelijkheid onderweg te videobellen met anderen. De app in dit voorbeeld kost eenmalig 2 euro waarmee u de app oneindig kunt gebruiken.

Zo dadelijk ziet u telkens twee apps naast elkaar zien. U kunt daarbij uw voorkeur aangeven voor een van de twee aangeboden SOULMATE apps door dit antwoord te omcirkelen. Heeft geen van beide apps uw voorkeur, dan kunt u voor de "Geen van deze" optie kiezen. De apps zijn fictief, u hoeft natuurlijk niet echt te betalen. U zult in totaal 8 keer gevraagd worden een keuze te maken.

Hieronder staat eerst een voorbeeld keuze set, op de volgende pagina beginnen de echte keuzes!

Streetview 3D ontdekken	X
Gebouwen 3D ontdekken	X
Route naar dichtsbijzijnde voorzieningen	X
Actuele openbaar vervoer informatie	X
Delen van route en positie met anderen	X
Interactie met anderen (videobellen)	√
Prijs	€ 2

A

Streetview 3D ontdekken	X
Gebouwen 3D ontdekken	√
Route naar dichtsbijzijnde voorzieningen	X
Actuele openbaar vervoer informatie	√
Delen van route en positie met anderen	X
Interactie met anderen (videobellen)	√
Prijs	€ 6

B

Geen van deze

C

Versie A

Keuze 1

*Omcirkel uw keuze

Streetview 3D ontdekken	X
Gebouwen 3D ontdekken	X
Route naar dichtsbijzijnde voorzieningen	√
Actuele openbaar vervoer informatie	X
Delen van route en positie met anderen	X
Interactie met anderen (videobellen)	√
Prijs	€ 4

A

Streetview 3D ontdekken	√
Gebouwen 3D ontdekken	√
Route naar dichtsbijzijnde voorzieningen	√
Actuele openbaar vervoer informatie	X
Delen van route en positie met anderen	√
Interactie met anderen (videobellen)	X
Prijs	€ 4

B

Geen van deze

C

Keuze 2

*Omcirkel uw keuze

Streetview 3D ontdekken	X
Gebouwen 3D ontdekken	X
Route naar dichtsbijzijnde voorzieningen	√
Actuele openbaar vervoer informatie	X
Delen van route en positie met anderen	√
Interactie met anderen (videobellen)	X
Prijs	€ 4

A

Streetview 3D ontdekken	√
Gebouwen 3D ontdekken	√
Route naar dichtsbijzijnde voorzieningen	√
Actuele openbaar vervoer informatie	√
Delen van route en positie met anderen	X
Interactie met anderen (videobellen)	X
Prijs	€ 2

B

Geen van deze

C

Keuze 3

*Omcirkel uw keuze

Streetview 3D ontdekken	√
Gebouwen 3D ontdekken	X
Route naar dichtsbijzijnde voorzieningen	X
Actuele openbaar vervoer informatie	√
Delen van route en positie met anderen	X
Interactie met anderen (videobellen)	X
Prijs	€ 4

A

Streetview 3D ontdekken	X
Gebouwen 3D ontdekken	√
Route naar dichtsbijzijnde voorzieningen	X
Actuele openbaar vervoer informatie	√
Delen van route en positie met anderen	√
Interactie met anderen (videobellen)	√
Prijs	€ 4

B

Geen van deze

C

Keuze 4

*Omcirkel uw keuze

Streetview 3D ontdekken	X
Gebouwen 3D ontdekken	√
Route naar dichtsbijzijnde voorzieningen	X
Actuele openbaar vervoer informatie	X
Delen van route en positie met anderen	√
Interactie met anderen (videobellen)	X
Prijs	€ 2

A

Streetview 3D ontdekken	√
Gebouwen 3D ontdekken	X
Route naar dichtsbijzijnde voorzieningen	X
Actuele openbaar vervoer informatie	X
Delen van route en positie met anderen	√
Interactie met anderen (videobellen)	X
Prijs	€ 6

B

Geen van deze

C

Keuze 5

*Omcirkel uw keuze

Streetview 3D ontdekken	√
Gebouwen 3D ontdekken	√
Route naar dichtsbijzijnde voorzieningen	√
Actuele openbaar vervoer informatie	√
Delen van route en positie met anderen	√
Interactie met anderen (videobellen)	√
Prijs	€ 6

A

Streetview 3D ontdekken	X
Gebouwen 3D ontdekken	√
Route naar dichtsbijzijnde voorzieningen	X
Actuele openbaar vervoer informatie	√
Delen van route en positie met anderen	X
Interactie met anderen (videobellen)	X
Prijs	€ 4

B

Geen van deze

C

Keuze 6

*Omcirkel uw keuze

Streetview 3D ontdekken	√
Gebouwen 3D ontdekken	X
Route naar dichtsbijzijnde voorzieningen	X
Actuele openbaar vervoer informatie	√
Delen van route en positie met anderen	√
Interactie met anderen (videobellen)	√
Prijs	€ 4

A

Streetview 3D ontdekken	√
Gebouwen 3D ontdekken	X
Route naar dichtsbijzijnde voorzieningen	X
Actuele openbaar vervoer informatie	X
Delen van route en positie met anderen	X
Interactie met anderen (videobellen)	√
Prijs	€ 2

B

C

Geen van deze

Keuze 7

*Omcirkel uw keuze

Streetview 3D ontdekken	X
Gebouwen 3D ontdekken	√
Route naar dichtsbijzijnde voorzieningen	X
Actuele openbaar vervoer informatie	X
Delen van route en positie met anderen	X
Interactie met anderen (videobellen)	√
Prijs	€ 6

A

Streetview 3D ontdekken	X
Gebouwen 3D ontdekken	X
Route naar dichtsbijzijnde voorzieningen	√
Actuele openbaar vervoer informatie	√
Delen van route en positie met anderen	X
Interactie met anderen (videobellen)	X
Prijs	€ 6

B

Geen van deze

C

Keuze 8

*Omcirkel uw keuze

Streetview 3D ontdekken	X
Gebouwen 3D ontdekken	X
Route naar dichtsbijzijnde voorzieningen	√
Actuele openbaar vervoer informatie	√
Delen van route en positie met anderen	√
Interactie met anderen (videobellen)	√
Prijs	€ 2

A

Streetview 3D ontdekken	√
Gebouwen 3D ontdekken	√
Route naar dichtsbijzijnde voorzieningen	√
Actuele openbaar vervoer informatie	X
Delen van route en positie met anderen	X
Interactie met anderen (videobellen)	√
Prijs	€ 4

B

C

Geen van deze

Opmerkingen

Heeft u nog vragen of opmerkingen over deze vragenlijst?

Dit is het einde van de SOULMATE vragenlijst.

Heel erg bedankt voor uw deelname!

Voor meer informatie over het SOULMATE project kunt u kijken op de project pagina's:

https://www.soulmate-project.eu/

http://www.aal-europe.eu/projects/soulmate/

Appendix C – Benchmark Survey Demographics Frequencies

COUNTRY Vanuit welk land doet u mee aan deze vragenlijst?

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	1 BE	105	29,2	29,2	29,2
	2 NL	254	70,8	70,8	100,0
	Total	359	100,0	100,0	

GENDER Wat is uw geslacht?

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	1 Man	203	56,5	56,7	56,7
	2 Vrouw	154	42,9	43,0	99,7
	3 Anders	1	,3	,3	100,0
	Total	358	99,7	100,0	
Missing	System	1	,3		
Total		359	100,0		

EDU Wat is uw hoogst voltooide opleiding?

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	1 Geen opleiding voltooid	2	,6	,6	,6
	2 Basis onderwijs, lager onderwijs	22	6,1	6,1	6,7
	3 Lager beroepsonderwijs of vglo, lavo, mavo, mulo, vmbo	93	25,9	25,9	32,6
	4 Middelbaar beroepsonderwijs of havo, atheneum, gymnasium, mms, hbs	128	35,7	35,7	68,2
	5 Hoger beroepsonderwijs, universiteit	106	29,5	29,5	97,8
	6 Andere opleiding	6	1,7	1,7	99,4
	7 Onbekend	2	,6	,6	100,0
	Total	359	100,0	100,0	

MIGRANT Bent u geboren in het land waar u nu woont?

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	1 Ja	323	90,0	90,7	90,7
	2 Nee	33	9,2	9,3	100,0
	Total	356	99,2	100,0	
Missing	System	3	,8		
Total		359	100,0		

AGE Tot welke leeftijdscategorie behoort u?

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	1 Jonger dan 60 jaar	2	,6	,6	,6
	2 61 - 65 jaar	27	7,5	7,5	8,1
	3 66 - 70 jaar	166	46,2	46,2	54,3
	4 71 - 75 jaar	96	26,7	26,7	81,1
	5 76 - 80 jaar	45	12,5	12,5	93,6
	6 81 - 85 jaar	16	4,5	4,5	98,1
	7 86 - 90 jaar	2	,6	,6	98,6
	8 91 - 95 jaar	5	1,4	1,4	100,0
	Total	359	100,0	100,0	

HOUSE Wat is uw huidige woonsituatie?

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	1 Eengezinswoning (Vrijstaand, rijtjeshuis, 2 onder 1 kap, halfopen bebouwing)	262	73,0	73,2	73,2
	2 Appartement of flat	84	23,4	23,5	96,6
	3 Zelfstandige ouderenwoning, aanleunwoning, serviceflat, kangoeroewoning	9	2,5	2,5	99,2
	5 Overige	3	,8	,8	100,0
	Total	358	99,7	100,0	
Missing	System	1	,3		
Total		359	100,0		

CAR Heeft u een auto?

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	1 Ja	312	86,9	87,2	87,2
	2 Nee	46	12,8	12,8	100,0
	Total	358	99,7	100,0	
Missing	System	1	,3		
Total		359	100,0		

URBAN Waar woont u?

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	1 In een stad	162	45,1	45,1	45,1
	2 In een dorp	168	46,8	46,8	91,9
	3 In het buitengebied (buiten de bebouwde kom)	29	8,1	8,1	100,0
	Total	359	100,0	100,0	

PARTNER Woont u op dit moment samen met een partner?

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	1 Ja	265	73,8	73,8	73,8
	2 Nee	94	26,2	26,2	100,0
	Total	359	100,0	100,0	

Appendix D.1 Initial Design Testing Set-Up

In the SOULMATE project, a highly innovative, multi-suite traveling companion will be developed for the target group of older adults. This innovation will be based on existing mobile services, focused on route planning, route navigation, route training, and emergency help during trips, that are offered by the SME's that participate in the SOULMATE project. The goal of this deliverable is to present the results that have been gathered through initial design testing workshops with future end-users.

Place in the SOULMATE project

This deliverable builds forth on D3.1 in which the overall testing and trial methodology of the SOULMATE service is described. The click-dummy used in this phase is based on earlier co-creation sessions detailed in deliverable D1.3. The results of the design testing workshops are gathered and reported here, as part of the initial testing phase of the project. The results of this deliverable will therefore provide direct input for 1) the graphical design of the SOULMATE service, 2) the different evaluations that will be conducted within the project, and 3) methodological feedback that can be used in the set-up of the functional testing workshops; the next stage of initial testing. After the co-creation activities, the Initial design testing phase is the first step in the testing and measurement stage of the project.

In the initial testing phase, early versions of the SOULMATE application will be tested by a small group of motivated end-users in each of the three participating countries. In iterative loops, the design and functionality of the service will be tested and discussed by these end-users in order to shape the development of a solution they want and need. The initial testing phase will be split up in two stages; design testing and functional testing. Both stages will require extensive discussion and feedback of a select group of end-users. Selection of these elderly needs to be done carefully, based on the probability that end-users are capable of carrying out pre-set scenario's and deal with bugs and uncertainty in the solution; have the ability to give extensive verbal feedback and are cognitively able to reflect on their interaction with the solution. A match between the module to be tested and the specific needs of the test user will be sought for to produce relevant feedback. In addition to using the same selection criteria, the two stages of initial testing will also use the same set-up. These testing sessions will be (estimated) half-day workshops in a place that is familiar to the end-users (e.g., the office of an end-user organization) in small groups of 5 at a time. In these workshops the end-users are first introduced to some part of the SOULMATE service and then interact with it in a structured way. After these interactive sessions, participants will be asked to challenge the limits of the current version and provide feedback on the strengths and issues of this version of the application. TU/e and RRD have developed a structure for the initial testing and contact moments with the end-users which will guide the end-user organization during the meetings with the end-users. Feedback and outcome of the initial tests will be analysed and summarized by TU/e and RRD.

These design testing sessions aim to establish end-user preferences in terms of the design of the SOULMATE service. To gather tangible feedback from these end-users, a click-dummy was created as an early trial version of the application. This click-dummy contains a series of potential screens that display different aspects within the application, which can be navigated through simple taps on the screen. The click-dummy therefore feels similar to an actual application but with static, pre-set screens. Using this

click-dummy, the focus of the gathered feedback lies on how intuitive and aesthetically pleasing these screens look. Important aspects include the position and size of buttons to press, the size and phrasing of labels and how intuitive sequences of screens are.

Here, the design of the SOULMATE solution will be reviewed. These design sessions have used a click-dummy version of the application. A click-dummy displays a sequence of static screens that can be navigated simply by tapping the buttons, thus creating a trial experience that feels like an actual application. See some screenshots of the available click-dummy. As workshops are being conducted in different countries, the click-dummy and all other materials (e.g., feedback forms) have been translated from English to German and Dutch. The design testing sessions have focused on how the solution looks and feels to the target audience. Design includes aspects such as position and size of buttons, phrasing of labels, and intuitiveness of screens and sequences. The full structure of the design testing workshop is detailed below. In general, the workshops have spanned half a day. During this time, end-users have been introduced to the aim of the SOULMATE solution in general and the current click-dummy more specifically. To guide participants through the click-dummy, several scenarios have been set-up. Starting with a full step-by-step direction on what to do, these scenarios continuously decrease in the amount of specific instructions they give. This way, participants get more freedom and responsibility to figure out how to complete the scenario as they get further down the list. Eventually, the end-users should run into most issues of non-intuitive menus and button placements as they try to figure out what to do. Of course, the workshop organizer was always present to assist the participants and avoid potential frustration. Near the end of the workshop, written feedback on the design of the click-dummy was asked from participants. A short questionnaire was designed to guide end-users in giving this feedback, including some quantitative (ratings) and qualitative (aspects and suggestions) items. These questions were further discussed during the workshop, to allow the end-users to expand on their answers further and weigh different opinions.

Appendix D.2 Initial Design Testing Protocol

Setup SOULMATE Initial Testing session 1

Authors: Jaap van der Waerden (TU/E), based on co-creation script by Lex van Velsen (RRD) & Marit Dekker (RRD)

Version: 1.0

Date: 22, 02, 2019

Duration: 130 Minutes

Location: NL, BE, AUT.

Session goals:

- Testing the design of the click-dummy that is made as an example of what the SOULMATE solution could look like.
- Get input on design choices from the end-users, in terms of intuitiveness and attractiveness of the design.

Participants:

- Older adults that are capable of using and evaluating smartphone technology

	What	**Who**	**Time**	**Material**
1	Walk-in		5 min	- Name signs - Coffee & Tea & Cookies - Laptop & Beamer - Large screen/White wall - Pens
2	Introduction initial testing session - Introduction of moderators (- A brief description of the SOULMATE solution and goals could be added, if participants are not familiar with this yet.)		5 min	(Refresher on technologies)

	- Explain goal of the session: To show off some scenarios that the SOULMATE solution could help participants with, and ask for their opinions and suggestions about how the design looks. Think about colors and images of buttons, but also how intuitive the menus and functions are. Stress the value of their input in the design process.			
3	Gather Informed consent (+ use of photographs)		5 min	- Informed consent form with checkbox option for photo use
4	Introduction round participants Please state your name and tell us (or ask on paper): - your age - your living situation (alone, with someone else) - How often do you travel within your municipality (to do groceries, to (volunteer) work, etc.) - How familiar you are with smart technology (using a phone or tablet to: Browse the internet, use Whatsapp or Facebook, play games, use navigation) If there are any, stakeholders can introduce themselves by stating their name and their reason for joining the session. Alternative: “Get to know each other game”		10 min	PPT sheet with the three questions (or on paper) Script “Never have I ever”
5	Explanation of the current click-dummy: - Talk about what the participants are going to see/do in the scenario; - Explain that the current version is not an actual application but an example; some they can click/tap through options but it is not connected to google maps or anything.		10 min	

	- Explain what the point of the scenario is: In the future, the application should help them explore and travel routes.			
6	Walk through the first scenario together with the participants. Do this step by step, and make sure that everyone is clear on what is displayed and what needs to be pressed to continue (make sure you have seen all screens beforehand!). All scenarios start from the Home screen (1/28), the number represents the screen of the web-version of the click-dummy. 1. Click the green arrow to get to the next screen (4/28). Click "add new destination" to get to that entry screen (5/28). They cannot enter anything at the moment, so just click start to go to the mode choice screen (6/28). Choose to walk which leads to the map screen (13/28). Here, the desired route would be chosen and the trip can start. (/end scenario). Go back to the home screen by pressing the house on top (1/28). Once the first scenario is done, discuss with the participants how it went. Note any interesting things they mention (in Discussion Notes). [this might be a good time for a break] The scenarios that follow are no longer step by step, so you will be able to see whether the functions are intuitive for the participants. Give them some time to figure out what to do, but guide them to the right place before they get frustrated. Take as long as you need for these scenarios and make sure everyone has completed one before you go to the next. There is no need to finish all the scenarios, just see how far you get in the described time. We've tried to make sure		60 min	

	that they go from easier to more complicated. 2. Open the Settings screen (2/28). Nothing is working here yet, so continue to the Tutorial screen (14/28). Read the information and go back to the Home screen. 3. Use the application to complete a trip home. What is the duration of this example trip? 4. Use the application to start a home trip. After three steps (27/28), try to call an emergency contact (3/28); in the form of person 1 (28/28). 5. Use the application to start a home trip. After two steps (25/28), try to find the way to a restaurant on the way (26/28). 6. Free exploration of other screens.			
7	Written feedback and discussion - Ask participants to fill in the written questionnaire first (individually); - Feel free to let the participants tap through the different screens to find specific things they like or dislike (or show/discuss them plenary) Discuss what the participants think is already looking good, what could use improvement, and their suggestions. Moderate this discussion if required, and try to note the overall evaluation of the functionality and important points that come up. Additionally, we have been requested to look at the function of the SOS button in more detail. Appendices A6 (Dutch) and A7		30 min	- Design Feedback Form (Dutch and German) for the workshop, per participant. - Specific questions forms ((Dutch) or (German)) per participant. - Discussion Notes - Specific SOS button Notes

	(German) show two different implementations of this button. Discuss with the participants which of these they would prefer; the SOS button as a panic button (emergency function), or the HELP button as a tool to get more information (when they are lost or stuck, but not panicked or in danger). Please add the general consensus (option SOS or HELP and option EMERGENCY SERVICES FIRST or EMERGENCY SERVICES LAST) and any useful comments to the discussion notes.			
8	Closure - Explain the next steps within the Initial Testing process (most likely functional testing with an actual app prototype) and how we will use their input in the project (to keep the end users close and use their valuable input in the design process). We appreciate their input and how they will stay involved in all parts of the development. - Ask if there are any questions/comments - Thank participants		5 min	
Total			130 minutes	

Appendix D.3 Design Testing Feedback Form

Name: _____

Place: _____

Date: _____

Please answer the following questions with the scenarios you just did in mind. There are no right or wrong answers, your honest opinion can help us the most. If you have questions, feel free to ask them of the workshop attendant at any point. We greatly appreciate your opinion!

How intuitive and easy to use would you rate the app in each of the following scenarios?

Scenario 1: Planning a route

Not easy to use at all Very easy to use

☐ ☐ ☐ ☐ ☐

Scenario 2: Settings and the "Help" function

Not easy to use at all Very easy to use

☐ ☐ ☐ ☐ ☐

Scenario 3: Finding your way home

Not easy to use at all Very easy to use

☐ ☐ ☐ ☐ ☐

Scenario 4: Making an emergency call

Not easy to use at all Very easy to use

☐ ☐ ☐ ☐ ☐

Scenario 5: Finding a nearby restaurant

Not easy to use at all Very easy to use

☐ ☐ ☐ ☐ ☐

What is your first impression about the design of the app?

Scenario 1: Planning a route

I do not like it at all I like it very much

☐ ☐ ☐ ☐ ☐

Scenario 2: Settings and the “Help” function

I do not like it at all I like it very much

☐ ☐ ☐ ☐ ☐

Scenario 3: Finding your way home

I do not like it at all I like it very much

☐ ☐ ☐ ☐ ☐

Scenario 4: Making and emergency call

I do not like it at all I like it very much

☐ ☐ ☐ ☐ ☐

Scenario 5: Finding a nearby restaurant

I do not like it at all I like it very much

☐ ☐ ☐ ☐ ☐

Which elements of the design do you like?

Which elements of the design do you not like?

Are there elements of the application that confuse you or are not intuitive?

What improvements would you make about the design of the app?

Do you have any other comments?

Appendix E Initial Design Testing Results

As the workshop protocol and feedback forms show, three different kinds of results are being collected during the Initial Design Testing workshops. First, there are several closed ended questions to get an overall rating of the look and feel of the application's design. Then, there are several open ended questions in which participants could voice their opinions on general aspects of the click-dummy and the specific scenarios. Finally, general sentiment and workshop discussion points have been collected by the workshop coordinators.

In terms of participation, the workshop in Belgium included 5 participants, while the workshops in the Netherlands and Austria each included 7 seniors. General results will be discussed, as well as data per country.

Closed ended questions

Table 1 shows the average scores given to the closed questions on the feedback form. Each closed ended question could be answered on a 5-point scale, with answering options ranging from 'very negative' (e.g., very ugly, not easy to use at all) to 'very positive' (e.g., very pretty, very intuitive). The average score on the intuitiveness and ease of use of the click dummy is 4.2 (out of 5) which translates to pretty intuitive. The design is given a score of 4.2 which indicates the design is liked by the participants of the workshops.

Table 1 Results of closed ended questions, on a scale of 1-5.

	AVERAGE	*STD. DEV.*	*Average BE*	*Average AU*	*Average NL*
Intuitiveness & ease of use	**4,2**	**1,1**	**4,2**	**4,2**	**4,2**
Planning a route	4,6	0,6	5,0	4,3	4,7
Settings & Help	3,5	1,4	4,2	4,0	2,6
Finding the way home	4,2	1,1	3,4	4,1	4,7
Emergency call	4,7	0,8	5,0	4,1	5,0
Finding a restaurant	4,1	1,2	3,4	4,6	4,2
Design	**4,2**	**1,0**	**4,2**	**4,3**	**4,1**
Planning a route	4,6	0,6	4,4	4,7	4,6
Settings & Help	3,8	1,0	4,0	4,1	3,4
Finding the way home	4,0	1,0	3,4	3,9	4,6

Emergency call	4,7	0,9	5,0	4,9	4,3
Finding a restaurant	4,1	1,0	4,2	4,1	3,9

Analyzing the scoring of the separate questions shows that the "Finding the way home" is scored lowest both on intuitiveness/ ease-of-use and design by Belgium participants. The scores given by Austrian participant is also below average on this topic. "Setting & Help" scored low in the Netherlands.

Open ended questions

The results of open questions are discussed per question. The answers are categorized in different design aspects. Note again BE: n=5, AUS: n=7, NL: n=7.

Open question 1: Which elements of the design do you like?

	BE	***NL***	***AU***	***All***
Overall design	**2**	**1**	**4**	**8**
Symbols	**1**	**3**	**0**	**4**
Colors	**1**	**3**	**5**	**9**
Fixed frame	**1**	**0**	**0**	**1**
Font size	**0**	**0**	**3**	**3**
Button size	**0**	**0**	**1**	**1**
Button placement	**0**	**0**	**2**	**2**

The participants mentioned the overall design several times as an element they liked. They specifically liked the colors used in the click dummy, they fit their functions and combine well together.

Open question 2: Which elements of the design do you dislike?

.	***BE***	***NL***	***AU***	***All***
Too much info	**3**	**0**	**2**	**5**
No. arrows	**0**	**0**	**2**	**2**

Wording	**0**	**0**	**2**	**2**
Symbol meaning	**0**	**0**	**2**	**2**
Font size (too small)	**0**	**0**	**1**	**1**
Wallpaper	**0**	**0**	**1**	**1**
Button size (too big)	**0**	**0**	**2**	**2**
Button size (too small)	**0**	**1**	**3**	**4**
Contrast	**0**	**0**	**2**	**2**
Colours	**0**	**0**	**1**	**1**
Keyboard size (too small)	**0**	**0**	**1**	**1**

Several participants don't like the amount of information presented on the screens, the number of arrows is specifically mentioned 2 times. The button size (or click area) is mentioned 4 times as being too small, this may result in people pressing the wrong button. The button size is mentioned 2 times as being too big. This is specifically the case for the SOS-button (which people are afraid to accidentally press), and the display of time (which they might find irrelevant to other information on the screen). The symbols are mentioned twice, which indicates that the symbols are not self-explanatory to everyone.

Open question 3: Which elements confuse you?

	BE	***NL***	***AU***	***All***
Multiple routes	**1**	**0**	**5**	**6**
Symbol meaning	**1**	**2**	**6**	**9**
How things work	**1**	**1**	**3**	**5**
Distance display	**0**	**0**	**1**	**1**
Speed indicator	**0**	**0**	**1**	**1**

That the symbols are not self-explanatory, can also be concluded from the answers to open question 3. It is not clear if "i"-symbol gives information about the trip, its POI's, or about the functions of the app. Furthermore, the toilet symbol, star symbol and house symbol (at destination reached screen) are mentioned. The number of arrows mentioned in question 2 corresponds with the multiple route options which remain available during the trip. This is confusing, only the selected route should be indicated (with arrows) on the screen. Furthermore, not for all functions is clear how they work (not intuitive), this can

be caused by the color usage (yellow for calling or hanging-up?) or by the fact that it was a click dummy and not function worked.

Open question 4: How can the design be improved?

	BE	*NL*	*AU*	*All*
Less info	**1**	**0**	**2**	**3**
More info	**3**	**0**	**0**	**3**
Possible options	**3**	**1**	**10**	**10**
Symbol size (bigger)	**1**	**2**	**2**	**5**
Colour	**1**	**0**	**1**	**2**
Contrast	**0**	**0**	**1**	**1**
Symbol meaning	**0**	**0**	**1**	**1**
Longer time for input	**0**	**0**	**1**	**1**

The answers to the previous questions in combination with the answers to question number 4 indicate that there is too much information presented at once at the screens. This should be avoided. The requests for more information concern unexpected events, travel time left and more info on a selected POI. Similar to the answers for question 2, these answers indicate that the Symbol (buttons) are too small to see without glasses or press and need to be made bigger. 10 times additional options are mentioned to improve the app, including but not limited to: Voice input, save trips, additional POI, displaying actual weather.

Open question 5,6,7: Regarding the Emergency function

In the Netherlands the participants preferred labeling the emergency button with “Help” and that first the personal contacts are shown and then the emergency services. This is because they are afraid they will call the emergency services by accident. They think the label “Hulpdiensten” is appropriate for this button.

This question was not asked in Belgium. However, during the discussion the topic did come up. Various participants indicated that they have a 112-app on their phone. An added value of that application is that the indicated contact-person is alarmed automatically once an emergency call is made.

Three participants in Austria preferred the label “Hilfe” for the emergency button, three preferred “SOS”, and for one participant it did not matter. 4 of the participants wanted a trusted person on the top of the SOS-contact list, the rest (3) preferred the number of the ambulance to be on top of the emergency

contact list. In Austria there are different phone numbers for the different emergency services (in contrast to Belgium and the Netherlands where 112 connects you to all emergency services). For this reason, the question was asked whether the button should say “SOS” or “die Rettung”, 5 participants preferred “die Rettung”, 1 preferred “SOS”, and 1 preferred “SOS”, but only if all emergency services could be contacted using the button.

General discussion of the click-dummy

As part of the workshop, coordinators were asked to guide discussions and take notes on important points. General comments that users made while receiving instructions or other points resulting from discussing the feedback forms could be captured in this way. Summaries of these discussion notes and questions are described below.

Netherlands

Overall, the participants enjoyed seeing what became of their input from the co-creation session and liked having something tangible (the click-dummy!) to talk about. The seniors indicated a preference for an emergency button that says “HELP” instead of SOS. They would like to see their personal contacts first and emergency services after, as they expect to need to call their contacts more often. They are also afraid to accidentally call the emergency services. The name “Hulpdiensten” fit their expectations. An additional point of feedback that keeps coming back but is not necessarily related to design is a voice command function. Participants keep coming back to the convenience of having that available in the application. In this session there was one person who had not experience whatsoever with technology. Even though the workshop coordinator and other seniors tried to help, it is not entirely clear whether they understood the different scenario’s and questions. Additionally, there was not a lot of feedback on the open questions, the seniors found it hard to give written feedback in such an unstructured way. Orally might work better in this case.

Belgium

There are already a lot of questions among the seniors that were invited. Most these questions are not specifically related to the design but can indicate functional aspects the users are already concerned with. These aspects include battery use of the application, how often it will require updates, the availability of voice commands, the option to save (intermediate) locations for return trips and possible recommendations for ‘eco’ options. For each scenario, some important questions were raised as well. Mentions related specifically to design are italicized, other comments are more focused on function.

Scenario 1:

- Can the route be started from somewhere other than the current location?

- *The differences between main and alternative routes was unclear.*

- What about privacy - What does the application do with location data?

- *Travel time to destination is given before the trip start, but not during.*

Scenario 2:

- *There was confusion between the information button "I" and the settings button [gear].*

- It was hard for participants to come up with things they would include in settings, fewer options should help with usability.

Scenario 3:

- *The icon with every location doesn't add value; maps can't be read or recognized on such a small screen.*

- *In the maps view, the pink-colored arrows get mixed reactions. Some participants state that the contrast is rather low, others compliment the choice of colors.*

- Can I enlarge the map? If so, how; by swiping (like Google Maps) or with + and – buttons?

- *The special options (restaurant, toilet) in the left border of the screen cause the screen to become crowded very quickly.*

- Are there also verbal instructions (e.g., "Turn left")? These are definitely required in the car or on a bike.

Scenario 4:

- Various participants already had a "112" app on their phone. A potential added value of the application could be that the indicated contact person is alarmed automatically once an emergency call is made.

Scenario 5:

- Easy access to contact details of the restaurants would be nice (e.g., to find opening hours or make a reservation).
- Does the "find a toilet" option include only public restrooms (not very common in BE) or toilets in stores or restaurants as well?

- The contrast between the direction arrows (pink) and the special place arrows (orange) is not clear.

Austria

During the test session, a lot of Feedback was given. The following points were discussed: Can the App be handled with one hand, or are always two hands needed? They find it useful if it's possible to use it with one hand. Will there be a one-dimensional menu for example for visually impaired people? Discussion about chosen colors: The title SOULMATE on the start screen would be preferred by some in a bright orange (more contrast than the presented gray). For other people, a very neutral color like the already chosen one would do also. Very important is a well visible contrast between bright background and dark text for optimal reading. The colors of the guidance system are good. It is a clear way to show it to the user. Participants were asked how they liked the symbol for the direction of view on the map (it looked like a Pac-Man or three quarters of a cake) and they said, they would prefer a different symbol, for example an arrow. Some of the elderly people have problems with the size of the symbols and the distance/vicinity of them. Some symbols are very small and close to the others and by incident the wrong symbol was pressed. Since they have minor eye problems, the contrast and size are very important aspects

for them if they will accept the app or not. The question was asked if the SOS-Button is fixed on one spot on the screen or can be placed on a spot where the user wants it. In Austria, there are different numbers for police, ambulance and fire brigade. Furthermore, the international number 112 can be used and is used by some participants. Unclear is which number is under the SOS-Button or can you place all numbers there? It was mentioned that, also if you accidentally call the police they will connect you to the ambulance, etc. If an SOS-Call is made, a photo of the person should be sent to the emergency organization, so they can see if the person is alright. Also the state of health (medicine use, chronic illnesses, allergies etc.) as well the GPS-position. On this way, it is made sure that the emergency service knows who called them, what the medical background is and where to find the person. Discussion about symbols: The symbol for sights/landmarks was not recognized (it was a kind of Acropolis), for the symbol for the toilets, "WC" would be preferred, because it's simpler than the symbol (man and woman drawing). It was wished to have the possibility to add symbols for POIs or to rearrange the symbols (own favorites of POIs). Furthermore, the place where the buttons are shown would be nice to be able to adapt it. It was discussed if the buttons are preferred in the bottom or left or right region. No general preference was agreed on and it depends on whether the display is in horizontal or vertical use. What was also addressed was the possibility for voice input and output (vocal commands, spoken instructions) in addition to text, you have to read and write. Then the question occurred about the time of touching the screen. How long to you need to touch it before the command is applied? The participants experienced some problems in this field using the click-dummy. Finally they discussed the color of the phone or rather the case/shell itself. It would be nice if it would have a colorful color, so they find it more easily. In the workshop we used black phones.

4. Conclusions and Guidelines

Based on the feedback forms end general notes that have been collected during the Initial Testing Design workshops, some conclusions and guidelines can be established. First and foremost the heterogeneity of (even this small) user-group needs to be addressed. While some general trends and feedback points can be distinguished, there are also parts where end-users show contradicting opinions. In general, participants are already pretty fond of the design of the application. Combined over intuitiveness and design, the current click-dummy scored 4.2 out of 5. Especially the general design and color scheme of the click-dummy were pleasing to the users. Of course, some indications for improvement have been found as well. Both on average and in the number of feedback points, users found the “settings” and “help” functions not very intuitive to use. This coincides with several mentions of the “I” symbol being confusing or in a confusing place on the screen. Additionally, users indicate that some screens contain too much information. The inclusion of several buttons and multiple arrows while making a trip, is a good example of this informational overload, which is mentioned multiple times. Not enough contrast between directional arrows, combined with the overload of information makes the distinction between main and alternatives routes hard for participants. Further, there are several mentions of buttons having an unclear meaning or a size that is too small to press or see comfortably. For the emergency-function specifically, Dutch users preferred it to be called “Help” (instead of “SOS”) and to first show a personal contact. Austrian users were divided in their answers, some agreeing with their Dutch counterparts, but others preferring an “SOS” function with emergency services listed first. Another important note from these

workshops has been that it is difficult to separate design from function (which can be hard in general, but specifically for end-users without technical backgrounds). Regarding this, the addition of a speech command function keeps appearing in user-feedback. Although this was not part of the current aim of the workshop and feedback, it bears mentioning.

Based on these results, some general recommendations can be made with regards to the design. First, the “settings” and “help” functions should be straightforward and not include a lot of options or textual explanations. In general, screens should only display limited information at once. Different functional options are nice, but ultimately useless if users cannot find them or do not understand how to use them. When more information has to be displayed on screen, different elements need to be contrasted clearly with each other to increase visibility and intuitiveness of use. Further, buttons should be large enough to press (and not accidentally press something else), and button symbols should be checked (with some end-users) for understanding in the different situations/countries. Finally, in terms of the emergency-function, the users prefer a more casual “Help” function (that calls a personal contact) over a panic “SOS” function that immediately calls the emergency services. However, the situations in which these functions would be used are different (i.e. getting lost vs getting in an accident), which might cause different interpretations of the function. As the general design and colour scheme was found pleasing by most participants, expanding on the current version would be recommended. For specific suggestions and feedback points, we would recommend going through the full feedback notes in Appendices C1-C4.

Concluding:

- General design and color scheme is liked by end-users;

- Limit the information presented at one time;

- A “Help” function that notifies a personal contact is generally preferred over an “SOS” function that contacts emergency services.

Appendix F.1 Initial Functional Testing Set-Up

In the SOULMATE project, a highly innovative, multi-suite traveling companion will be developed for the target group of older adults. This innovation will be based on existing mobile services, focused on route planning, route navigation, route training, and emergency help during trips, that are offered by the SME's that participate in the SOULMATE project. The goal of this deliverable is to present the results that have been gathered through initial design testing workshops with future end-users.

These functional testing sessions aim to test the limits of the most recent version of the SOULMATE application on functionality and accessibility specifically for the end-users. To gather tangible feedback from these end-users, they were familiarized with an early prototype version of the application. This prototype contains some of the core functions that the ultimate SOULMATE app aims to have, without most of the polish. The prototype thus creates a good feeling of what using the actual app would be like in terms of what it can do. Using this prototype, the focus of the gathered feedback lies on how well the included functionalities work. Important aspects include the accessibility of the functionalities, speed of operation and any found bugs end-users encounter.

Place in the SOULMATE project

This deliverable builds on D3.1 in which the overall testing and trial methodology of the SOULMATE service is described. The prototype application used in this phase is based on earlier co-creation sessions detailed in deliverable D1.3, as well as earlier design related feedback detailed in deliverable D3.2A. The results of the functional testing workshops are gathered and reported here, as part of the initial testing phase of the project. The results of this deliverable will therefore provide direct input for 1) the further functional development of the SOULMATE service, 2) the different evaluations that will be conducted within the project, and 3) methodological feedback that can be used in the set-up of the field trials; the next stage of initial testing.

In the initial testing phase, early versions of the SOULMATE application will be tested by a small group of motivated end-users in each of the three participating countries. In iterative loops, the design and functionality of the service will be tested and discussed by these end-users in order to shape the development of a solution they want and need. The initial testing phase will be split up in two stages; design testing and functional testing. Both stages will require extensive discussion and feedback of a select group of end-users. Selection of these elderly needs to be done carefully, based on the probability that end-users are capable of carrying out pre-set scenario's and deal with bugs and uncertainty in the solution; have the ability to give extensive verbal feedback and are cognitively able to reflect on their interaction with the solution. A match between the module to be tested and the specific needs of the test user will be sought for to produce relevant feedback. In addition to using the same selection criteria, the two stages of initial testing will also use the same set-up. These testing sessions will be (estimated) half-day workshops in a place that is familiar to the end-users (e.g., the office of an end-user organization) in small groups of 5 at a time. In these workshops the end-users are first introduced to some part of the SOULMATE service and then interact with it in a structured way. After these interactive sessions, participants will be asked to challenge the limits of the current version and provide feedback on the strengths and issues of this version of the application. TU/e and RRD have developed a structure for the initial testing and contact

moments with the end-users which will guide the end-user organization during the meetings with the end-users. Feedback and outcome of the initial tests will be analyzed and summarized by TU/e and RRD.

Here, the functionality of the SOULMATE solution will be reviewed by end-users. In contrast to the click-dummy used in the design workshops, an early version of the actual application has been developed for the functional testing workshops. Again, the version of the application that is used during the workshops will have English, German, and Dutch translations. This time, however, end-users were asked to test the functionality of the application. Functional aspects include finding bugs or things that do not work at all, but also making sure the functionality of the app works in ways that the end-users expect. The same general structure of the design testing workshops has been used again for the functional testing workshops. In general, these workshops spanned around half a day. During this time, end-users were introduced (or reminded of) the aim of the SOULMATE solution in general and the current version of the application more specifically. To guide participants through this version of the app, several scenarios were set-up, with content depending on the functionality that was available in the most recent version of the application at that time. Starting with full step-by-step directions on what to do, these scenarios would also continuously decrease in the amount of specific instructions that were included. More so than with the design testing workshops, end-users were asked to seek the limits of that version of the application; through experimentation with different functions and button combinations. Eventually, users would run into functions that did not work, or at least not as they expected them to. A short description of the background of “bugs” is included in the workshop, to illustrate what is meant with this term. Near the end of the workshop, written feedback on the functionality of the prototype was asked from participants. A short questionnaire was designed to guide end-users in giving this feedback, including some quantitative (ratings) and qualitative (aspects and suggestions) items. In addition, participants were asked to fill out bug-reports regarding errors or unexpected things they encountered. These questions and bugs were discussed further during the workshop, to allow the end-users to expand on their answers further and weigh different opinions.

Appendix F.2 Initial Functional Testing Final Protocol

Setup SOULMATE Initial Testing session 2

Authors: Jaap van der Waerden (TU/E), based on co-creation script by Lex van Velsen (RRD) & Marit Dekker (RRD)

Version: 1.0

Date: 16- 09, 2019

Duration: 130 Minutes

Location: NL, BE, AUT.

Session goals:

1. Testing the overall functionality of the first MVP version of the SOULMATE solution.
2. Find bugs or functions that work differently than expected.

Participants:

- Older adults that are familiar with using smartphone technology, in such a way that they can find report on bugs and irregularities that may come up while using the app.

	What	**Who**	**Time**	**Material**
1	Walk-in		5 min	- Name signs - Coffee & Tea & Cookies - Laptop & Beamer - Large screen/White wall - Pens
2	Introduction initial testing session - Introduction of moderators (- A brief description of the SOULMATE solution and goals could be added, if participants are not familiar with this yet.)		5 min	

	- Explain goal of the session: To show off some scenarios that the SOULMATE solution will help participants with, and ask for their opinions and suggestions on how the app functions. We have some scenarios to go through, as well as a 'Bug Catching' segment. Stress the value of their input in the design process.			
3	Gather Informed consent (+ use of photographs)		5 min	- Informed consent form with checkbox option for photo use
4	Introduction round participants Please state your name and tell us (or ask on paper): - your age - your living situation (alone, with someone else) - How often do you travel within your municipality (to do groceries, to (volunteer) work, etc.) - How familiar you are with smart technology (using a phone or tablet to: Browse the internet, use Whatsapp or Facebook, play games, use navigation) If there are any, stakeholders can introduce themselves by stating their name and their reason for joining the session. Alternative: "Get to know each other game"		10 min	PPT sheet with the three questions (or on paper) Script "Never have I ever"
5	Explanation of the current MVP version of SOULMATE: Talk about what the participants are going to see/do in the scenarios; Explain that the current version is an actual working app, which may still have some hiccups in different functions.		10 min	

	Explain what the point of the workshop is; a 'Bug Catching' as well as seeing if functions work the way they are expecting them to. Give a little background on bugs.			See "Background on Bugs"
6a	< Scenarios> Try to log in Try to Create and Save a route (Create a very small route around the workshop place) Try to Load the Saved route With the route loaded, go outside with the group and walk a part of the route While on the way, deviate from the route and deal with any warning that happens Finish the route Try to make an emergency call		40 min	
6b	Bug Catching (Maybe teams of 2?) Start from the <SOME SCREEN> screen, navigate around to different screens from there. Report bugs or crashes to the Master Bug Catcher (workshop leader). *Reproduce* the bug with the participant that found it and note the following; On what screen did the bug happen; What action causes the bug to happen? (e.g., clicking a button, entering certain information); What kind of bug is it (e.g., blank screen, crash, goes to the wrong follow up screen); <Other relevant info the Technical team might want> Repeat for several screens. Gather a bug report on how many different bugs the team has discovered.		20 min	- Bug Catch Report
7	Written feedback and discussion Ask participants to fill in the written questionnaire first (individually);		30 min	- Functional Feedback Form Dutch and German for the workshop, per participant.

	Feel free to let the participants tap through the different screens to find specific things they like or dislike (or show/discuss them plenary) Communicate the Bug Catch Report back to the group (in a general way, i.e. 25 bugs were found!). Discuss what the participants think is already working well, what could use improvement, and their suggestions. Moderate this discussion if required, and try to note the overall evaluation of the functionality and important points that come up.			- Discussion Notes
8	Closure - Explain the next steps within the Initial Testing process (most likely functional testing with an actual app prototype) and how we will use their input in the project (to keep the end users close and use their valuable input in the design process). We appreciate their input and how they will stay involved in all parts of the development. - Ask if there are any questions/comments - Thank participants		5 min	
Total			130 minutes	

Background on 'Bugs'

In 1946, when computer pioneer Grace Hopper was released from active duty in WWII, she joined the Harvard Faculty at the Computation Laboratory to put her mathematical skills to good use. Here she continued her work on the Mark II and Mark III, early computers with both electrical and mechanical parts. When the Mark II suddenly stopped working, the operators traced the error back to a moth trapped in one of the relays. The moth was carefully removed from the machine and taped to the logbook, making history as the first ever computer bug. Stemming from this first bug, today we call errors or glitches in a computer program a *bug*. (Modified from Wikipedia)

So, what is a bug exactly? Here, we consider bugs to be anything the app does other than what we expect it to do. A button that does nothing after pressing? That's a bug. Same for the application crashing or showing a blank screen after pushing two buttons at the same time. Or, the app returning to the login screen without you doing anything. Keep in mind that the app does not need to 'break' necessarily for something to be a bug. If you press to button for 'options', and end up in a route selection screen, that can be considered a bug as well. To some extent, words being in the wrong place or errors in spelling can even be considered bugs.

Errors and glitches in the application may vary in how severe they are. A typo or word in the wrong place might not be a big problem, but the app crashing or showing a blank screen is another story. This is why we want to categorize the bugs as Big (prevents you from continuing; such as crashing, freezing, page not loading entirely) or Small (might be annoying but the functionality still works; such as buttons or words in the wrong place, one image not loading).

Appendix F.3 Functional Testing Feedback Form

Name: _____

Place: _____

Date: _____

Please answer the following questions with the scenarios you just did in mind. There are no right or wrong answers, your honest opinion can help us the most. If you have questions, feel free to ask them of the workshop attendant at any point. We greatly appreciate your opinion!

- In general, how well do you think the application functions on a technical level?

Very Bad	Bad	Acceptable	Good	Very Good
1	2	3	4	5

- In general, how useful did you find the functions of the application you tested today?

Very useless	useless	neither useless or useful	useful	Very useful
1	2	3	4	5

- In general, how well did the application respond to your inputs? (How fast and accurately did the application respond)

Very Bad	Bad	Acceptable	Good	Very Good
1	2	3	4	5

- In your opinion, which functionalities of the application were already working well?

- Which functionalities of the application should we definitely improve?

Thank you very much for your contribution!

Bug Catch Report

Bug	Info
ID number	<bug ID>
Name	<identifier for type of bug>
Reporter	<who reported the bug?>
Submit Date	<when was the bug reported?>
Summary	<what happened?>
Screenshot	<add screenshot if possible and relevant>
Operating System	<what type and version of operating system is on the phone?>
App version	<which version of the app is tested?>
Severity	<how severe is the bug? Low (something is unclear) or High (crashing, freezing, vital buttons missing)>

Appendix G Initial Functional Testing Results

As the workshop protocol and feedback forms show, three different kinds of results are being collected during the Functional Testing workshops. First, there are several closed-ended questions to get an overall rating of the look and feel of the application's functionality. Then, there are several open-ended questions in which participants could voice their opinions on what worked well and what could be improved. Finally, there was a section where participants could report bugs they encountered while using the app. In terms of participation, the workshop in Belgium included 2 participants, the workshops in the Netherlands included 5 participants and Austria included 6 seniors. General results will be discussed, as well as data per country.

Closed ended questions

The feedback form contained 3 closed ended:

1. How well did the app function on a technical level?
2. How useful did you find the app?
3. How well did the app react to your actions?

Each closed ended question could be answered on a 5-point scale, with answering options ranging from 'very negative' (e.g., very bad, very useless) to 'very good' (e.g., very good, very useful). Tables 1-3 show the answer frequencies of each question, Table 4 shows the average, standard deviation and average per country for each of the questions.

Table 1 - Frequencies technical functioning, on a scale of 1-5.

Question 1	*Very bad*	*Bad*	*Acceptable*	*Good*	*Very good*
BE	2	-	-	-	-
AU	-	1	3	1	1
NL	1	3	-	-	-
Total	**3**	**4**	**3**	**1**	**1**

Table 2 - Frequencies usefulness, on a scale of 1-5.

Question 2	*Very useless*	*Useless*	*Somewhat useful*	*Useful*	*Very useful*
BE	1	-	-	1	-
AU	1	-	1	2	1
NL	-	2	3	-	-
Total	**2**	**2**	**4**	**3**	**1**

Table 3 - Frequencies responsiveness, on a scale of 1-5.

Question 3	*Very bad*	*Bad*	*Acceptable*	*Good*	*Very good*
BE	1	1	-	-	-
AU	-	2	3	1	-
NL	2	3	-	-	-
Total	**3**	**6**	**3**	**1**	**-**

Table 4 - Averages of closed ended questions

	AVERAGE	*STD. DEV.*	*Average BE*	*Average AU*	*Average NL*
Question 1	2.42	1.19	1	3.3	1.8
Question 2	2.92	1.19	2.5	3.4	2.6
Question 3	2.15	0.86	1.5	2.8	1.6
Overall	**2.49**	**1.15**	**1.67**	**3.18**	**2.00**

The results in Table 4 indicate that participants score the apps functionality, usefulness and in general with a 2.49 (between bad and acceptable). Noticeable is that the average in Austria is higher than in Belgium and the Netherlands. This can be explained by the Austrian facilitators having the technical support at location during the workshop and approaching the participants as beta-testers lowering their expectations of the app.

Open ended questions

The results of open questions are discussed per question. The answers are categorized in types of functionality. Note again BE: n=2, AUS: n=6, NL: n=5.

Open question 1: Which functions of the app worked well?

	BE	*NL*	*AU*	*All*
Quick response	**0**	**0**	**1**	**1**
Correct Information	**0**	**0**	**1**	**1**
i-button	**0**	**0**	**2**	**2**
Nothing	**2**	**4**	**2**	**8**

The most mentioned function of the app that worked well is “Nothing”. This is a negative comment and explains the low average scores in the previous questions.

Open question 2: Which elements of the app can we improve?

	BE	*NL*	*AU*	*All*
Route creation	**4**	**1**	**7**	**12**
Navigation	**0**	**1**	**6**	**7**
POI’s	**0**	**0**	**5**	**5**
SOS function	**4**	**1**	**2**	**7**
Coach function	**4**	**1**	**1**	**6**
Everything	**2**	**0**	**2**	**4**

All functionalities of the app are mentioned as “needing improvement”. The creation of a route is mentioned most often.

Additional feedback

During the workshop the app was also discussed which resulted in additional feedback on functionality (see Table 5). During this discussion, design elements were also brought up. Since these comments may be of value but are not part of the intended goal for this workshop, they are reported directly to the technology partners.

Table 5. Additional comments to the SOULMATE prototype, not directly related to performance.

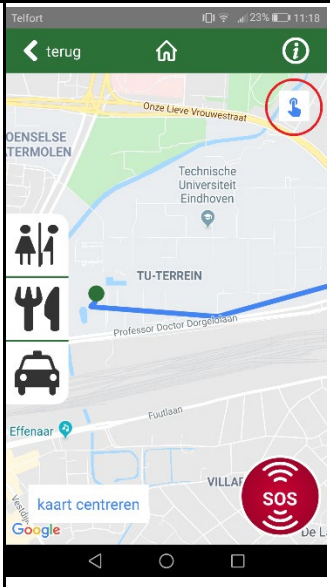
Positive/ Negative	***Feedback***	***Times mentioned***
Positive	Emergency button is useful	**3**
Negative	Autocomplete for address is confusing	**1**
Negative	Keyboard is difficult to use (want voice input)	**1**
Negative	Coach is required before starting navigation	**1**
Negative	Not possible to save emergency contact that is not in phonebook	**3**
Negative	No message when error with coach/contact occurs	**2**
Negative	No message that contact gave (or denied) permission	**1**
Negative	No searching through contacts only scrolling	**1**
Negative	No dialing sound when using SOS function	**2**
Negative	SOS function, coach must perform too many steps	**2**
Negative	Too technical for elderly	**1**
Negative	Unclear what next step in the app is	**1**
Negative	App functions differently on different android versions	**2**

These comments show that there is some positive feedback, but also a lot of improvements that can be made on the app design and app functionality. Some of these aspects were already mentioned during previous rounds of co-creation workshops (e.g. voice input) but did not make it in the Minimal Viable Product. This additional feedback is useful for further development but does not provide actionable points at the moment.

Bug testing

In Belgium and the Netherlands there was no technical support available during the workshops. This resulted in very poor performance of the app, which left the respondents with the feeling that nothing worked. Due to not being able to properly test the app no bugs were reported in Belgium and the Netherlands. In Austria technical support was present during the workshop and the bugs were discussed verbally with the technical parties in detail. For some examples of bug reports see Table 6 and Table 7. All bugs found have been communicated to the development team.

Table 6. Example of a filled in bug report, tested by an internal member of the development team.

ID number	TUE004
Name	Redundant button
Reporter	TesterB100
Submit Date	28/11/2019
Summary	Button on screen while navigation that does nothing.
Screenshot	
Operating System	Android 7.0
App version	V0.1.1.20191126001

Severity	Low

Table 7. A second example of a filled in bug report, tested by one of the seniors participating in the functional testing workshop.

ID number	AT003
Name	App closes
Reporter	BeA
Submit Date	19/11/2019
Summary	After filling in the first information regarding the contact person and pressing "continue", the app closed automatically.
Screenshot	N/A
Operating System	Android 7.0
App version	V0.1.1.20191119001
Severity	High

Conclusions and Guidelines

Based on the feedback forms and general notes that have been collected during the Functional Testing workshops, some conclusions can be made. First and foremost, the heterogeneity of (even this small) user-group needs to be addressed. While general trends and feedback points can be distinguished, there are also contradicting points of feedback between end-users. In general, participants are critical of how well the current version of the application functions. With the overall rating for the application scoring well below average, user send a clear message of needed improvement. It should be noted that the ratings in the Austrian workshops are more positive, even though they remain just above average. The presence of technology partners at this meeting is a likely reason for this, allowing for an easier back-and-forth with the end-users and a more pronounced "tester" role for participants. These factors could have made these participants feel more comfortable with encountering bugs and failures of the application. The message of improvement comes through in the open-ended feedback as well, showing a majority of negative comments.

When asked which functionalities of the current application worked well, "none" is the most common response. Similarly, participants mention several points of improvement to each specific functionality. Especially the 'creating routes' function is stated as a major point of improvement by various comments, with user statements mentioning routes not showing up, their position not showing up on the map, and overall the functionality not working as they expected. For an example of the latter; workshop participants

expected that they would be able to use the map shown in the route creation screen to directly specify their destination, but they had to fill in an address instead. The navigational functionalities show much room for improvement as well. Participants state disappointment that only walking routes can be generated with this version of the application, and the routes that are generated are often not the fastest or easiest way to the specified destination. Finally, while participants deem the SOS functionality as useful, they also state it needs more improvement. These comments range from not receiving feedback regarding whether the contact has accepted or rejected their call, to the video call at times not working altogether.

A final note from these workshops is that it remains difficult to separate design from function (which can be hard in general, but specifically for end-users without technical backgrounds). Many design related comments, such as the color and contrast of the application (or specific parts), the inclusion of a speech command, and size of buttons and text. Although they were not part of the current aim of the functional workshop and feedback, these things bear mentioning.

Concluding, the current version of the SOULMATE application shows a lot of room for (functional) improvement. Even when end-users were asked to evaluate the application as a work in progress, the majority shows a negative evaluation of the functionality of the app. Although the application is under constant development, many improvements will need to be made to meet the expectations of end-users. In future workshops/measurements with end-users, it should be stressed that they are part of the development process and a technological expert should be present. Additionally, the specific feedback points included in this report should be dealt with, and the bugs that are reported should be fixed. In its current state, the application is not fit for further testing with end-users and thus needs major improvements to make sure the functionality meets proposed standards.

Appendix H Formal Specification of Choice Experiment Models

Standard Multinomial Logit model

To get some first insights into the importance of the included SOULMATE application functionalities, the preferences of the respondents are first analyzed using a standard multinomial logit model. The model relates the choices made by the respondents to the levels of the application offer attributes. The standard multinomial logit model is defined as follows (Louviere, Hensher, & Swait, 2000):

$$P_i = \frac{e^{V_i}}{\sum_j e^{V_j}}$$

Where,

P_i stands for the probability that application offer *i* will be chosen as most preferred;

V_i stands for the total utility of application offer *i*.

The total utility of application offer *i* is built up using the part-worth utilities of the individual attributes *k* with corresponding attribute level *l* of that specify application offer *i*. Each part-worth utility is calculated using a weight (β_k) and the value of the level *l* of attribute (x_{kl}).

$$V_i = \sum_k \beta_k x_{\mathrm{kl}}$$

Latent Class model

To investigate if there are specific subsets of respondents in their choice behavior, a Latent Class model was used to analyze their responses as well. The latent class model allows testing of heterogeneity of the current sample based on the preferred attributes of the application offers. The standard behavior model used here is a logit model for discrete choice, and is defined as follows (Hensher, Rose, & Greene, 2005):

$$\text{Prob[choice } j \text{ by individual } i \text{ in choice situation } t \,|\, \text{class } q] = \frac{\exp(\mathbf{x}'_{it,j}\boldsymbol{\beta}_q)}{\sum_{j=1}^{J_i} \exp(\mathbf{x}'_{it,j}\boldsymbol{\beta}_q)} = F(i,t,j \,|\, q).$$

Where,

F(i,t,j|q) stands for the probability of a respondent belonging to class *q,* given the choice *j* by individual *i* in situation *t*.

For convenience, the probability of an individual making a specific choice is often denoted as y_{it} , providing the following simplified equation:

$$P_{it|q}(j) = \text{Prob}(y_{it} = j \,|\, \text{class} = q).$$

References

Hensher, D.A., Rose, J.M. & Greene, W.H. (2005) *Applied Choice Analysis: A Primer*, Cambridge University Press, Cambridge, UK.

Louviere, J.J., Hensher, D.A. & Swait, J.D. (2000) *Stated Choice Methods; Analysis and Application*, Cambridge University Press, Melbourne, Australia.

Appendix I Original Field Trials Set-Up

Field Trials- Respondent Activities

This document provides a short overview of the workload of the participants for the Field Trials. Note, it only describes the Field trials, NOT the Benchmark survey (this is a different group of participants).

Prior to Field trials

- Read the information letter
- Ask Slimmer Leven (NL), Happy Aging (BE), or Gefas Steiermark (AU) questions if something is unclear.
- Keep travel diary for all trips for one week(7days), before using the Soulmate app. (online or paper).

Field Trials week 0

- Sign informed consent form
- Attend Start-workshop organized by Slimmer Leven (NL), Happy Aging (BE), or Gefas Steiermark (AU). During which the Soulmate app is installed.
- Fill in Field trials START questionnaire (online or paper).

Field Trials week 1-10

- Use Soulmate app as often as possible/desired during trips.
- Optional: attend workshop/meeting organized by Slimmer Leven (NL), Happy Aging (BE), or Gefas Steiermark (AU).

Field Trials week 11 (according to new planning)

- Keep travel diary for all trips for one week(7days), while using the Soulmate app. (online or paper). Preferably the week before the final week.

Field Trials week 12 (according to new planning)

- Attend Start-workshop organized by Slimmer Leven (NL), Happy Aging (BE), or Gefas Steiermark (AU). During which the Soulmate app is removed.
- Fill in Field trials END questionnaire (online or paper).

Length of questionnaires

- The length of the Field Trial Start questionnaire is similar to the Benchmark survey, which has been sent around.
- The Field Trials End questionnaire is the same + 24 multiple choice questions regarding acceptance of the Soulmate app and “Patient enablement”. There is also an extra field for additional feedback on the app.
- The travel diary is 7 multiple choice questions and one question about the address of their destination (one A4 page when using font size 14 on paper, an also available online).

Care-giver

- According to the proposal we planned to do some measurements on caregiver burden. During our Skype meetings we agreed on asking participants if they have a caregiver that is willing to answer some questions on this.

Appendix J Literature Background of Investigated Measures

Design process and academic rigor require some literature overview and psychometric properties of the different measures that have been considered for inclusion in the project. This overview includes a short description of what the questionnaire or measurement intends to measure conceptually; validity. Another important psychometric property that is discussed is reliability; the extent to which participants provide consistent answers across different times or situations. The measurement reports here are an expansion of the background on these measures, the questions and protocols for asking them are included in the main text. Information regarding all *considered* measures are included in this chapter, regardless of whether or not they were included in the final testing and measurements performed in the project. As the investigation of these measures has been a team effort some are included here, while others are included in Luub (2020), depending on who did the final write up for the measure.

Included are:

J.1 Self- reported health

J.2 Loneliness

J.3 Social networks

J.4 Physical activity (not included in final testing)

J.5 Physical performance (not included in final testing)

Appendix J.1 Self-Reported Health

Through the 70's and 80's, researchers in the medical field were looking for ways to properly compare the health of groups of patients suffering from different illnesses. This had been difficult up until that point due to the existing questionnaires and measures being very specific to the condition that was being assessed. As part of the Medical Outcomes Study (Stewart & Ware, 1992), a new assessment tool was compiled from the more general questions and items in existing questionnaires. The resulting Functioning and Well-Being Profile (FWBP; Stewart & Ware, 1992) contained almost 150 different items of a general nature, enabling the comparison of health between patients with different illnesses. However, due to its length, the FWBP could not be considered practical for inclusion in larger surveys. In order to address this issue, Ware and Sherbourne (1992) distilled the large number of items into a short 36 question measure (the 36-Item Short Form Health Survey, or SF-36) which, along with its revised version (Ware & Kosinski, 1996) is still often used today (e.g., Katz, Larson, Phillips, Fossel, & Liang, 1992; McDowell, 2006). The SF-36 has been found to be a consistent tool to assess self-reported health in different populations (e.g., Bayliss et al., 1998; Fitzsimmons et al., 2009) and even seems to outperform condition specific questionnaires on some psychometric properties (Ünal et al., 2001). In addition, over the years the SF-36 has been translated and validated for several different languages (e.g., Dutch; Aaronson et al., 1998).

An even shorter form 12 item version of the health survey has been created as well, in order to fit even better in large-scale health monitoring projects (SF-12; Ware, Kosinski, & Keller, 1996). While many of the predictive qualities of the survey remained intact even in this shorter form, the authors note that the variance in SF-12 scores was much higher than the variance in SF-36 scores. This implies that the shorter 12-item scale is mostly useful for larger population surveys and might not be accurate enough to describe level of health on an individual level.

As described in Figure 1, 35 of the SF-36 individual items (the 36th item regarding health transition is assessed separately) are categorized in 8 different scales regarding different aspects of health. These 8 scales (each consisting of 2 to 10 items) can then be summed up to two different total health scores regarding physical and mental health. The figure also indicates which items are included in the shorter 12-item SF-12 scale. Figure 2 illustrates that (although there is some overlap) each scale contributes mainly to either the physical or the mental component. Since the items use different answering scales (2 – 6 answering options), scores are standardized between 0 and 100 before computing scale total scores. For example, an item with 3 answering categories results in a score of 0, 50 or 100, while an item with 6 categories would contain scores of 0, 20, 40, 60, 80, or 100. This rescaling process can simultaneously account for mirroring items (reversal of negatively phrased questions or statements). The average of all items included in a scale can subsequently be calculated, indicating how (e.g. physically) healthy a person is on a scale of 0 to 100.

Reliability estimates have been investigated for all different scale scores and for the two summary scores (Ware, 2000). Several studies have shown the scale scores to be sufficiently reliable for research purposes and group comparison (i.e. coefficients of over .70; Tsai, Bayliss, & Ware, 1997). Moreover, the reliability of the summary scores can be described as excellent, as they generally pass .90 (Ware, Kosinski, & Keller, 1994). Both types of scores appear to be consistently reliable in different subgroups as well (McHorney,

Ware, Lu, & Sherbourne, 1994). In terms of the SF-36's validity, positive evidence has been found for its content validity (Ware, Snow, Kosinski, & Gandek, 1993), construct validity (McHorney, Ware, & Raczek, 1993; Ware, Kosinski, & Keller, 1994) and criterion validity (Krousel-Wood, McCune, Abdoh, & Re, 1994; Stewart, Hays, & Ware, 1988). Additionally, it was found that the usage of (2) summary scores instead of the (8) scale scores only caused limited to no loss of information or predictive ability (Ware et al., 1995), indicating that usage of the usage of the summary scores as a more general and simplified health score can be valid.

English and Dutch Versions of the SF-36 and SF-12 Questionnaires are available, as well as scoring instructions.

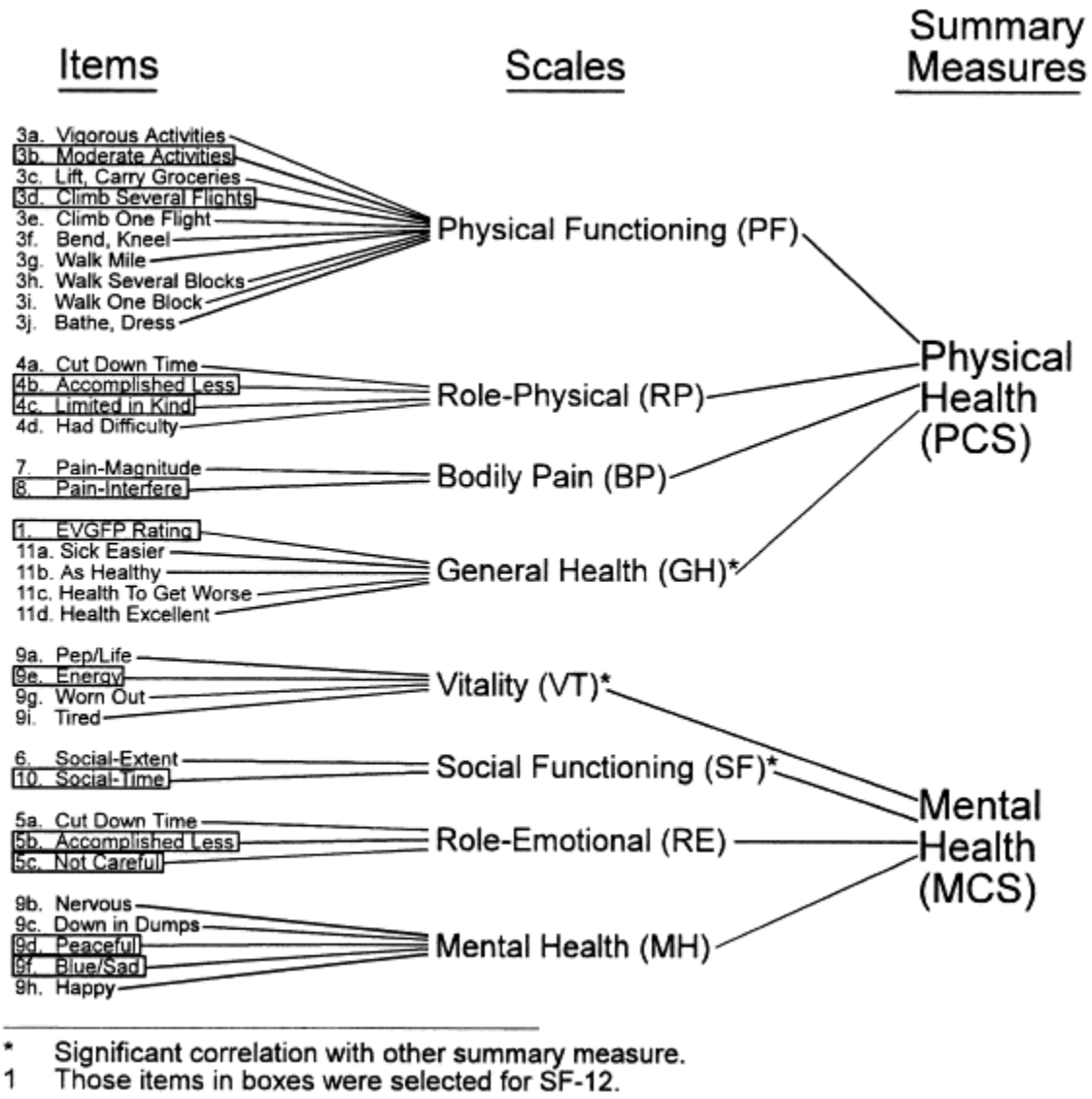


Figure 1. Taxonomy of the SF-36 scoring (Ware, Kosinski, & Keller, 1996)

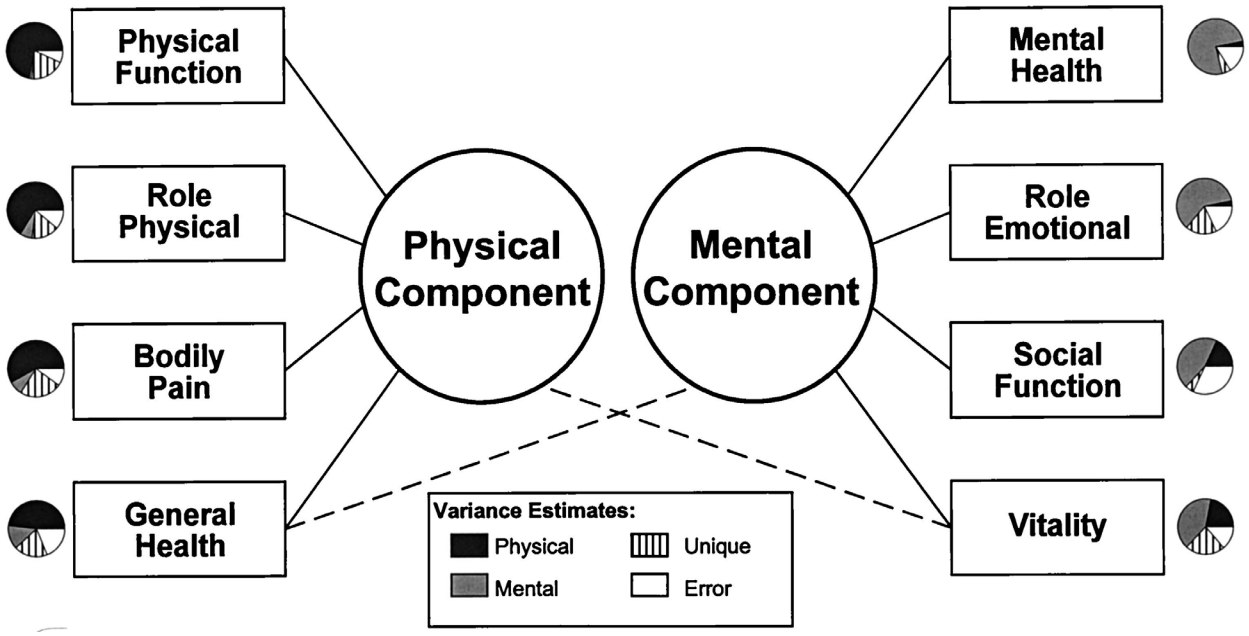


Figure 2. Distribution of scales into underlying (physical and mental) component scores (Ware, 2000)

References

Aaronson, N. K., Muller, M., Cohen, P. D., Essink-Bot, M. L., Fekkes, M., Sanderman, R., … Verrips, E. (1998). Translation, validation and norming of the Dutch language version of the SF-36 Health Survey in community and chronic disease populations. *Journal of Clinical Epidemiology, 51*, 1055-1068. doi: 10.1016/S0895-4356(98)00097-3

Bayliss, M. S., Gandek, B., Bungay, K. M., Sugano, D., Hsu, M. A., & Ware, J. E. (1998). A questionnaire to assess the generic and disease-specific health outcomes of patients with chronic hepatitis C. *Quality of Life Research, 7,* 39-55. Retrieved from: https://www.springer.com/medicine/journal/11136

Fitzsimmons, D., Gilbert, J., Howse, F., Young, T., Arrarras, J., Bredart, A., … Johnson, C. D. (2009). A systematic review of the use and validation of health-related quality of life instruments in older cancer patients. *European Journal of Cancer, 45*, 19-32. doi: 10.1016/j.ejca.2008.07.036

Katz, J. N., Larson, M. G., Phillips, C. B., Fossel, A. H., & Liang, M. H. (1992). Comparative measurement sensitivity of short and longer health status instruments. *Medical Care, 30*, 917–925. doi: 10.1097/00005650-199210000-00004

Krousel-Wood, M. A., McCune, T. W., Abdoh, A., & Re, R. N. (1994). Predicting work status for patients in an occupational medicine setting who report back pain. *Archives of Family Medicine, 3*, 349–355. Retrieved from https://clockss.org/clockss/Archives_of_Family_Medicine

McDowell, I. (2006). *Measuring health: A guide to rating scales and questionnaires. 3rd edition.* New York, NY: Oxford University Press.

McHorney, C. A., Ware, J. E., Lu, J. F. R., & Sherbourne, C. D. (1994). The MOS 36-Item Short-Form Health Survey (SF-36): III. Tests of data quality, scaling assumptions and reliability across diverse patient groups. *Medical Care, 32*, 40–66. doi: 10.1097/00005650-199401000-00004

McHorney, C. A., Ware, J. E., & Raczek, A. E. (1993). The MOS 36-Item Short-Form Health Survey (SF-36): II. Psychometric and clinical tests of validity in measuring physical and mental health constructs. Medical Care, 31, 247–263. doi: 10.1097/00005650-199303000-00006

Stewart, A. L., Hays, R. D., & Ware, J. E. (1988). The MOS short-form general health survey: Reliability and validity in a patient population. *Medical Care, 26,* 724–735. doi: 10.1097/00005650-198807000-00007

Stewart, A. L., & Ware, J. E. (1992). *Measuring functioning and well-being: The medical outcomes study approach*. Durham, NC: Duke University Press. Retrieved from https://www.dukeupress.edu/measuring-functioning-and-well-being/?viewby=title

Tsai, C., Bayliss, M. S., & Ware, J. E. (1997). *SF-36 health survey annotated bibliography: Second edition (1988–1996)*. Boston, MA: Health Assessment Lab, New England Medical Center.

Ünal, G., de Boer, J. B., Borsboom, G. J. J. M., Brouwer, J. T., Essink-Bot, M. L., & de Man, R. A. (2001). A psychometric comparison of health related quality of life measures in chronic liver diseases. *Journal of Clinical Epidemiology, 54*, 587-596. doi: 10.1016/S0895-4356(00)00372-3

Ware, J. E. (2000). SF-36 health survey update. *Spine, 25,* 3130-3139. doi: 10.1097/00007632-200012150-00008

Ware, J. E., & Kosinski, M. (1996). *The SF-36 Health Survey (Version 2.0) Technical Note*. Boston, MA: Health Assessment Lab, New England Medical Center.

Ware, J. E., Kosinski, M., Bayliss, M. S., McHorney, C. A., Rogers, W. H., & Raczek, A. (1995). Comparison of methods for the scoring and statistical analysis of SF-36 health profiles and summary measures:

summary of results from the Medical Outcomes Study. *Medical Care, 33*, 264–279. doi: 10.1097/00005650-199501001-00005

Ware, J. E., Kosinski, M., & Keller, S. K. (1994). *SF-36 Physical and Mental Health Summary Scales: A User's Manual.* Boston, MA: The Health Institute, New England Medical Center.

Ware, J. E., Kosinski, M., & Keller, S. D. (1996). A 12-item short-form health survey: Construction of scales and preliminary tests of reliability and validity. *Medical Care, 34,* 220-223. doi: 10.1097/00005650-199603000-00003

Ware, J. E., Sherbourne, C. D. (1992). The MOS 36-Item short-form health survey (SF-36): I. Conceptual framework and item selection*. Medical Care*, 30, 473–483. zdoi: 10.1097/00005650-199206000-00002

Ware, J. E., Snow, K. K., Kosinski, M., & Gandek, B. (1993). *SF-36 Health Survey Manual and Interpretation Guide.* Boston, MA: The Health Institute, New England Medical Center.

Appendix J.2 Loneliness

While related, it is important to distinguish loneliness from social isolation. Social isolation can be described as an objective measure of the social involvement of a person (ranging from isolated to involved), based on the number of personal connections a person has (Comwell & Waite, 2009). Loneliness however, is more of a subjective feeling; the cognitive awareness that one's social connections are fewer than the desired or the norm (De Jong Gierveld & Van Tilburg, 2010). Therefore, a person can be relatively isolated but not lonely and vice versa. Two different kinds of loneliness can be recognized; social loneliness and emotional loneliness (Weiss, 1973). Where social loneliness describes (the lack of) a person's place in the community as a whole, emotional loneliness describes (the lack of) meaningful, deep relations with a best friend or partner. To illustrate, social loneliness would be reported by a person moving to a new country or town, while emotional loneliness could be caused by the passing of a spouse or a divorce. These two dimensions of loneliness are reflected in the short version of the De Jong Gierveld *Loneliness Scale* (De Jong Gierveld & van Tilburg, 2006), which contains 3 items for each. The 6 statements included are as follows:

"I experience a general sense of emptiness" $_{e}$

"I miss having people around" $_{e}$

"Often, I feel rejected" $_{e}$

"There are plenty of people that I can lean on in case of trouble" $_{s}$

"There are plenty of people that I can count on completely" $_{s}$

"There are enough people that I feel close to" $_{s}$

With the instruction to: "Please indicate for each of the statements, the extent to which they apply to your situation, the way you feel now. Please circle the appropriate answer." All these statements have the response options; "no", "more or less" and "yes". Categorizing the responses, for the negatively phrased statements ($_{e}$) the answers "yes" and "more or less" count towards (1) more loneliness, while for the positively phrased statements ($_{s}$) the answering options "more or less" and "no" add (1) towards the loneliness score. The resulting scores can thus vary from 0 to 3 on emotional and on social loneliness. Optionally, these two can then be added into a general loneliness score (ranging from 0 to 6, with higher scores signifying more loneliness).

Note that none of these items mentions or refers to the concept of (or the word) loneliness directly. This in order to circumvent possible negative connotations that the word can have (Russell, Peplau, & Cutrona, 1980).

According to a meta-analysis (Pinquart & Sörensen, 2001), there are two common ways in which loneliness is measured in the literature. The first consists of directly asking for frequency or intensity of feelings of loneliness. While the face-validity of this method is high, there could be a potential bias of the generally negative connotations that come with describing oneself as lonely (Russel, Peplau, & Cutrona, 1980; Borys & Perlman, 1985). The other method consists of a questionnaire containing multiple items,

of which the UCLA Loneliness scale is used most often (Russell, Peplau, & Cutrona, 1980; Russel, 1982; Russel, 1996). The De Jong Gierveld (2006) questionnaire mentioned above, however, has a validated short version (in multiple languages) that can distinguish two potentially different aspects of loneliness. Therefore, it seems most fitting for our current purpose.

Dutch version of the questions:

Wilt u van elk van de volgende uitspraken aangeven in hoeverre die op u, zoals u de laatste tijd bent, van toepassing is? Omcirkel dat antwoord.

- Er is altijd wel iemand in mijn omgeving bij wie ik met mijn dagelijkse probleempjes terecht kan.
- Ik ervaar een leegte om me heen.
- Er zijn genoeg mensen op wie ik in geval van narigheid kan terugvallen.
- Er zijn voldoende mensen met wie ik me nauw verbonden voel.
- Ik mis mensen om me heen.
- Vaak voel ik me in de steek gelaten.

(Mogelijke antwoorden: 'nee', 'min of meer' en 'ja'.)
https://home.fsw.vu.nl/tg.van.tilburg/manual_loneliness_scale_1999.html

References

Borys, S., & Perlman, D. (1985). Gender differences in loneliness. *Personality and Social Psychology Bulletin, 11,* 63–75. http://journals.sagepub.com/home/psp

Cornwell, E. Y., Waite, L. J. (2009). Measuring social isolation among older adults using multiple indicators from the NSHAP Study. *Journals of Gerontology. Series B, Psychological Sciences and Social Sciences, 64,* 38-46. doi: 10.1093/geronb/gbp037

De Jong Gierveld, J., Van Tilburg, T. G. (2006). A six-item scale for overall, emotional and social loneliness: confirmative tests on new survey data. *Research on Aging, 28,* 582-598. doi: 10.1177/0164027506289723

De Jong Gierveld, J., Van Tilburg, T. G. (2010). The De Jong Gierveld short scales for emotional and social loneliness: Tested on data from 7 countries in the UN generations and gender surveys. *European Journal of Ageing, 7,* 121-130. doi: 10.1007/s10433-010-0144-6

Pinquart, M., & Sorensen, S. (2010). Influences on loneliness in older adults: A meta-analysis. *Basic and Applied Social Psychology, 23,* 245-266. doi: 10.1207/S15324834BASP2304_2

Russell, D. W. (1982). The measurement of loneliness. In L. A. Peplau & D. Perlman (Eds.), *Loneliness. A sourcebook of current theory, research and therapy* (pp. 81–104). New York, NY: Wiley.

Russell, D. W. (1996). UCLA loneliness scale (version 3): Reliability, validity, and factor structure. *Journal of Personality Assessment, 66,* 20-40. doi: 10.1207/s15327752jpa6601_2

Russell, D. W., Peplau, L. A., & Cutrona, C. E. (1980). The revised UCLA Loneliness Scale: Concurrent and discriminant validity evidence. *Journal of Personality and Social Psychology, 39,* 472–480. http://www.apa.org/pubs/journals/psp/

Weiss, R. S. (1973). *Loneliness: The experience of emotional and social isolation*. Cambridge, MA: The MIT Press.

Appendix J.3 Social Networks

Social network theory describes how people in a society interact with each other. According to Hall and Wellman (1985, p.26) social network theory ``focuses on the characteristic patterns of ties between actors in a social system rather than on characteristics of the individual actors themselves and use these descriptions to study how these social structures constrain network member's behavior''. In other words, a person's behaviour is not just the result of characteristics that person has, but the emphasis is placed on how that person fits in their social environment instead. Originally developed for communication sciences, social network theory has found its usefulness in many different fields of study (for a historical overview, see Liu, Sidhu, Beacom, & Valente, 2017).

Early on, it became apparent that access to jobs, political leaning, or even marital roles could be explained in the context of a person's social group including family members, classmates, co-workers, and neighbours (e.g., Barnes, 1954; Bott, 1957). Over the subsequent years, social networks have been applied in many different contexts, including professional opinion (e.g., Burt, 1987; 1999) and travel behaviour (e.g., Pas, 1985) and more importantly health (e.g., Berkman, 1995). Berkman and Glass (2000) integrate a large body of literature regarding social networks and health into a conceptual model; placing the social network (*Mezzo*) in between societal (*Macro*) and psychosocial (*Micro*) levels (see appendix A). While these studies emphasize the important role social networks can play in describing health related behaviours and outcomes, it is also important to look at which aspects of the social network are important to distinguish. In the context of social support, House (1987; 1988) stressed the relevance of looking beyond the number of members (quantity) in a social network and include their structure (e.g., whether relations are reciprocal) and function (how are the people related) as well. Therefore, the current study aims to look beyond just the size of the social network, and collect some data on the quality of these relationships as well.

The relevance of a social dimension in travel behaviour has been increasing over the past couple of years (e.g., Axhausen, 2006). Moreover, Carrasco and colleagues (2008) note that social factors are more than just an attribute of a trip (like distance, or cost would be). The fact that one is travelling to and from and old lady in a nursing home might not be too important, but if we are talking about a visit to a grandmother this fact becomes the whole reason for the trip in the first place. The implication here would be that information about the social space plays a vital role in describing a person's activity space (and therefore their travel behaviour).

In the elderly, strong social relationships have been consistently tied to positive health outcomes, such as shorter hospital stays and less risk of later readmission (for a review see Valtorta, Moore, Barron, Stow, & Hanratty, 2018). There is even some evidence linking social activities to a reduced risk of dementia (Buchman et al., 2009). In terms of mental health, social networks of older adults (more specifically social interactions and social support) have long been seen as a buffer for emotional stress (Depp, Vahia, & Jeste, 2010). After all, as the Dutch saying goes: Shared sorrow is only half the sorrow. Generally, larger social networks have been found to provide more social support (both emotional and instrumental support; Seeman & Berkman, 1988). This increase in support acts as the aforementioned buffer, which in turn could maintain general well-being in the elderly (Larson, 1978).

Although there is a relatively long history of measuring social networks (for an overview see Marsden, 1990; 2005), it is an ever evolving field. A more recent development attempts to tackle the impracticality of otherwise cheap and easy to use questionnaire data. As this form of data collection can often be unable to canvas a whole social network unless a confined network already exists, such as a classroom or workplace environment (e.g., Burk, van der Vorst, Kerr, & Stattin, 2012; Sparrowe, Liden, & Kraimer, 2001). As an alternative, an 'ego centric' approach has been suggested, focusing on specific individuals and their relationships within the social environment (Marsden, 2005). A common way to measure aspects of a social network in this 'ego centric' approach is using a name generation task (Marsden, 2005). In this simple task, a respondent is asked to make a list of their close social connections. While that list alone would be enough to compute network *size*, it is common to ask some more details for each connection, as types of interpersonal relations tend to vary among contact *frequency*, relationship *closeness* and *nature* of the relationship; e.g. co-workers, friends, neighbours (Burt, 1990). Several studies have shown the relevance of these social factors in the field of travel behaviour (e.g., Axhausen, 2006; Carrasco & Miller, 2006; van den Berg, Aarentze, & Timmermans, 2010; Kowald et al., 2013; Kim, Parent, & vom Hofe, 2018). Additionally, the rise of digital environments has led to a shift in the nature of communication as well. To account for this, Carrasco et al. (2008) suggest a distinction between face-to-face and digital contact while mapping the social network.

In terms of data collection on social networks using the name generation task itself, Carrasco (2018) brings up some general challenges. Firstly, network boundaries are generally hard to define. Additionally, it is not easy for respondents to recall each individual person in their social network, especially if this network is rather large. Lastly, it can be difficult to balance the detail of the required information with the burden it places on the respondent; as required information scales directly with the number of social network names that are generated. To address these challenges, a few steps can be taken.

First, it is important to not only decide on a specific definition of what is required for a person to be included in the social network (e.g., casual acquaintances or only close friends), but also to communicate this clearly to the participants of the task (Carrasco et al., 2008). Following the distinction in closeness adapted from van den Berg, Arentze, and Timmermans (2010, p.1062), the instruction would include a description of what it means to be a very close or reasonably close (a): "Think of the people you are very close to. These are people with whom you discuss important matters or you keep in regular contact with or that are there for you if you need help. Think of relatives, colleagues, neighbours, club members, and other friends. To how many of these people do you feel very close?" and (b) "Now think of the people to whom you are reasonably close. These are people that are more than just acquaintances, but to whom you are not very close. How many people are you reasonably close to?"

Second, the challenges of recalling all members of the social network can be addressed by employing simple memory techniques. For instance, the usage of *cues* can prompt a specific context that make memories (in this case a person) more readily accessible (Humphreys & Bain, 1983). McCarty and colleagues (2001) used a form of recall that was dubbed the "summation method" (p.31); Participants were asked to generate names per type of relationship (e.g., friends, neighbours, etc.) instead of all at once. The type of relationship hereby provided a cue that helped the recall of persons belonging to the

category. It was discovered that this generated network size is a reliable estimate of the actual social network (McCarty, Killworth, Bernard, Johnsen, & Shelley, 2001).

Lastly, we can limit the amount of detailed information to the essentials of what is of interest (here; name, type of relation, face & digital frequency, and closeness) and limit the number of names that can be generated as part of the social network. As past research suggests, the core of a personal network should include somewhere between 5 and 15 members (Dunbar, 1992; Zhou, Sornette, Hill & Dunbar, 2005).

References

Axhausen, K. W. (2006). Social networks, mobility biography and travel. *Arbeitsberichte Verkehrs- und Raumplanung, 343,* 1-23. doi: 10.3929/ethz-a-005226600

Barnes, J. A. (1954). Class and committees in a Norwegian island parish. *Human Relations, 7,* 39-58.

Berkman, L. F. (1995). The role of social relations in health promotion. *Psychosomatic Medicine, 57,* 245-254. doi: 10.1097/00006842-199505000-00006

Berkman, L. F., Glass, T., Brissette, I., & Seeman, T. E. (2000). From social integration to health: Durkheim in the new millennium. *Social Science & Medicine, 51,* 843-857. doi: 10.1016/S0277-9536(00)00065-4

Bott, E. (1957). *Family and social network.* London, UK: Tavistock Press.

Buchman, A. S., Boyle, P. A., Wilson, R. S., Fleischman, D. A., Leurgans, S., & Bennett, D. A. (2009). Association between late-life social activity and motor decline in older adults. *Archives of Internal Medicine, 169,* 1139-1146. doi: 10.1001/archinternmed.2009.135

Burt, R. S. (1987). Social contagion and innovation – cohesion versus structural equivalence. *American Journal of Sociology, 92,* 1287-1335. doi: 10.1086/228667

Burt, R. S. (1999). The social capital of opinion leaders. *Annals of the American Academy of Political and Social Science, 566,* 37-54. doi: 10.1177/0002716299566001004

Carrasco, J. A., & Miller, E. J. (2006). Exploring the propensity to perform social activities: A social network approach. *Transportation, 33,* 463-480. doi: 10.1007/s11116-006-8074-z

Carrasco, J. A., Hogan, B., Wellman, B., & Miller, E. J. (2008). Collecting social network data to study social activity travel behavior: An egocentric approach. *Environment and Planning B: Planning and Design, 35,* 961-980. doi :10.1068/b3317t

Depp, C., Vahia, I. V., & Jeste, D. (2010). Succesful aging: Focus on cognitive and emotional health. *Annual Review of Clinical Psychology, 6,* 527-550. doi: 10.1146/annurev.clinpsy.121208.131449

Dunbar, R. I. M. (1992). Neocortex size as a constraint on group size in primates. *Journal of Human Evolution, 20,* 469-493. doi: 10.1016/0047-2484(92)90081-J

Hall, A., & Wellman, B. (1985). Social networks and social support. In S. Cohen, & S. L. Syme (Eds.), *Social support and health* (pp. 23-41). Orlando, FL: Academic Press.

House, J. S. (1987). Social support and social structure. *Sociological Forum, 2,* 135-146. doi: 10.1007/BF01107897

House, J. S., Landis, K. R., & Umberson, D. (1988). Social relationships and health. *Science, 241,* 540-545. doi: 10.1126/science.3399889

Humphreys M. S., & Bain, J. D. (1983). Recognition memory: A cue and information analysis. *Memory & Cognition, 11,* 583-600. doi: 10.3758/BF03198283

Kowald, M., van den Berg, P. Frei, A., Carrasco, J. A., Arentze, T., Axhausen, K., ... Wellman, B. (2013). Distance patterns of personal networks in four countries: A comparative study. *Journal of Transport Geography, 31,* 236-248. doi: 10.1016/j.jtrangeo.2013.06.006

Larson, R. (1978). Thirty years of research on the subjective well-being of older Americans. *Journal of Gerontology, 33,* 109-125. doi: 10.1093/geronj/33.1.109

Liu, W., Sidhu, A., Beacom, A. M., & Valente, T. W. (2017). Social network theory. In P. Rössler, C. A. Hotfner, & L. van Zoonen (Eds.), *The international encyclopedia of media effects* (pp 1 – 12). Hoboken, NJ: John Wiley & Sons, Inc. doi: 10.1002/9781118783764.wbieme0092

McCarty, C., Killworth, P. D., Bernard, H. R., Johnsen, E. C., & Shelley, G. A. (2001). Comparing two methods for estimating network size. *Human Organization, 60,* 28-39. doi: 10.17730/humo.60.1.efx5t9gjtgmga73y

Marsden, P. V. (1990). Network data and measurement. *Annual Review of Sociology, 16,* 435-463. doi: 10.1146/annurev.so.16.080190.002251

Marsden, P. V. (2005). Recent developments in network measurement. In P. Carrington, J. Scott, & S. Wasserman (Eds.), *Models and methods in social network analysis* (pp 8-30). Cambridge, UK: Cambridge University Press. doi:10.1017/CBO9780511811395.002

Pas, E. I. (1985). State of the art and research opportunities in travel demand: Another perspective. *Transportation Research Part A: Policy and Practice, 19,* 460-464. doi: 10.1016/0191-2607(85)90048-2

Seeman, T. E., & Berkman, L. F. (1988). Structural characteristics of social networks and their relationship with social support in the elderly: Who provides support. *Social Science & Medicine, 26,* 737-749. doi: 10.1016/0277-9536(88)90065-2

Sparrowe, R. T., Liden, R. C., Wayne, S. J., & Kraimer, M. L. (2001). Social networks and the performance of individuals and groups. *Academy of Management Journal, 44,* 316-325. doi: 10.2307/3069458

Valtorta, N. K., Moore, D. C., Barron, L., Stow, D., & Hanratty, B. (2018). Older adults' social relationships and health care utilization: A systemic review. *American Journal of Public Health, 108,* e1-e10. doi: 10.2105/AJPH.2017.304256

van den Berg, P. E. W., Arentze, T. A., & Timmermans, H. J. P. (2010). Location-type choice for face-to-face social activities and its effect on travel behavior. *Environment and Planning B: Planning and Design, 37,* 1057-1075. doi: 10.1068/b36019

Zhou, W. X., Sornette, D., Hill, R. A., & Dunbar, R. I. M. (2005). Discrete hierarchical organization of social group sizes. *Proceedings of the Royal Society B: Biological Sciences, 272,* 439-444. doi: 10.1098/rspb.2004.2970

J.4 Physical Activity

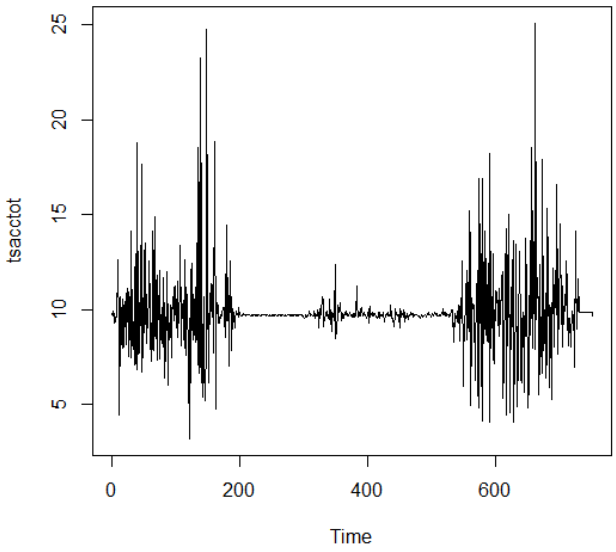
There are several ways in which physical activity can be measured. In their practical guide, Sylvia et al. (2014) describe the most common measurements; questionnaires, diaries, direct observation, accelerometers, and pedometers. While questionnaires (such as the International Physical Activity Questionnaire, IPAQ; Craig et al., 2003) tend to be cheap and efficient, they often rely on recall and can easily fall prey to social desirability, opening the data to personal bias (Durante & Ainsworth, 1996). Diaries and direct observation are more resilient to these forms of bias, but are very time intensive and can be quite a burden on participants and experimenters respectively (Rachele et al., 2012).

In terms of objective measurements, a pedometer is a relatively simple device that can measure the number of steps (i.e. vertical movements) a person takes. While objective, easy to use and on the cheaper side, pedometers are unable to measure activity in more than one direction and cannot measure the intensity or duration of an activity (Freedson & Miller, 2000; Trost, 2001).

On the contrary, accelerometers can measure intensity and duration of activity (Matthews et al., 2008), although they tend to be more expensive and require more technological expertise. Usually a triaxial sensor, an accelerometer measures differences in acceleration over these (three) axes x, y and z. As a total measure of physical activity, these accelerations are usually combined into one total acceleration score for each measurement period (e.g., Cabrita et al., 2017). This way, orientation of the sensor and direction of the movement are no longer an issue (which would complicate things for a single axis sensor).

While specialized accelerometer sensors are generally used (e.g., op den Akker et al., 2012), most modern smartphones contain accelerometers as well. Several available applications (such as AndroSensor) can record data collected by sensors in a mobile phone device and write it to a data file. This data can then be processed to give an indication of activity per any given time period, for an example see Figure 1.

Additionally, algorithms can be used to recognize specific activity behaviors (e.g., Kwapisz, Weiss, & Moore, 2010). In this study, activity recognition was able to distinguish between sitting, standing, walking, and jogging with over 90% accuracy.



Appendix Figure 1. Example of accelerometer sensor data, collected using the Androsensor application on a smartphone.

Considerations:

Use of specific sensors vs. on-phone data collection; while using smartphones seems to be convenient (the SOULMATE app would run on a smartphone anyway), it would mean that the phone (and therefore the app) needs to be running the whole time to collect the data. Additionally, while the AndroSensor app (for instance) has a pretty straight forward way to send the data, this is something that has to be done manually by participants. Discussion with the technology partners of the project brought up another good point; battery use. Running both the SOULMATE application and a separate accelerometer app will most likely drain the phone's battery very rapidly. This would make the on-phone recording of physical activity most likely not feasible.

Specific sensors, on the other hand, would need to be acquired/purchased. It does appear that using a system like this would be more convenient for the participants, as the data transfer would be automatic (at least in the study mentioned above) and starting/stopping the measurement would not be much more than switching the device on or off. One of the studies mentioned above (Cabrita et al., 2017) was done by Roessingh, using specific sensor equipment. They report that using dedicated activity sensors in addition to the SOULMATE app is most likely unfeasible for our project.

'Just' categorizing intensity of the activity vs. activity pattern recognition; processing thriaxial accelerometer data is pretty straightforward, the figure above was generated using an R (software) script that I wrote to process the data from the AndroSensor app as an example. After figuring out thresholds for sedentary or active behavior, we could classify each time period as such and use this as a measure for the amount of active behavior. Pattern recognition is more complicated but could provide more specific information about actual activities that participants do, rather than just the intensity.

References

op den Akker, H., Tabak, M., Marin-Perianu, M., Huis in't Veld, R., Jones, V. M., Hofs, D., ... Hermens, H. J. (2012). Development and evaluation of a sensor-based system for remote monitoring and treatment of chronic diseases. In *Proceedings of EHST: The Sixth International Symposium on e-Health Services and Technologies*, Lisbon, 2012. Lisbon, Portugal: SCITEPRESS – Science and Technology Publications.

AndroSensor. (2015). AndroSensor (Version 1.9.6.3) [Mobile application software]. Retrieved from https://play.google.com

Cabrita, M., Lousberg, R., Tabak, M., Hermens, H. J., & Vollenbroek-Hutten, M. M. R. (2017). An exploratory study on the impact of daily activities on the pleasure and physical activity of older adults. *European Review of Aging and Physical Acitivty, 14,* 1 – 11. doi: 10.1186/s11556-016-0170-2

Craig CL, Marshall AL, Sjostrom M, et al. International physical activity questionnaire: 12-country reliability and validity. Med Sci Sports Exerc. 2003; 35(8):1381–95. [PubMed: 12900694]

Durante R, Ainsworth BE. The recall of physical activity: using a cognitive model of the questionanswering process. Med Sci Sports Exerc. 1996; 28(10):1282–91. [PubMed: 8897386]

Freedson PS, Miller K. Objective monitoring of physical activity using motion sensors and heartrate. Res Q Exerc Sport. 2000; 71(2 Suppl):S21–9. [PubMed: 10925821]

Kwapisz, J. R., Weiss, G. M. & Moore, S. A. (2010). Activity recognition using cell phone accelerometers. *SensorKKD, 12,* 74-82. doi: 10.1145/1964897.1964918

Matthews CE, Chen KY, Freedson PS, et al. Amount of time spent in sedentary behaviors in the United States, 2003–2004. Am J Epidemiol. 2008; 167(7):875–81. [PubMed: 18303006]

Rachele JN, McPhail SM, Washington TL, et al. Practical physical activity measurement in youth: a review of contemporary approaches. World J Pediatr. 2012; 8(3):207–16. [PubMed: 22886192]

J.5 Physical Performance

Standardized performance test have long been used to indicate physical limitations (Verbrugge & Jette, 1994), and have even been shown to be able to predict gradients of disability in the future (Guralnik et al., 1995). So, even if a person does not suffer from any disability yet, their current physical performance can give an indication of how much they are at risk. While performance tests can be time-intensive and often require trained instructors, they are still generally preferred to (or used in combination with) self-report measures (Reuben et al., 2004). As more objective measures of performance these tests do not suffer from participant overestimation of skill or language barriers, two common challenges of self-report instruments (Reuben, Valle, Hays, & Siu, 1995; Glass, 1998).

Measured with the Short Physical Performance Battery (SPPB; Guralnik et al,. 1994), lower extremity performance can be assessed through a few simple exercises. Repeated chair stands, balance, and gait speed are investigated, each after a short instruction and demonstration. Example protocols for the tests can be found below. For each activity a score from 0 to 4 can be obtained, resulting in a total performance score between 0 and 12. A higher score is therefore consistent with a better physical performance. For more detailed information about scoring, see appendix. The SPPB has shown to have a high test-retest reliability (e.g., Ferruci et al., 1996) and strong criterion validity (e.g., Guralnik et al., 2000). Because of this predictive capability it is recommended to use the flexible and easy to use SPPB as a precursor for, and in addition to clinical diagnosis of disability in older adults (Guralnik et al., 2000). A recent meta-analysis by Pavasini and colleagues (2016) investigated the predictive quality of the SPPB for mortality. Through the combination of the results of 17 different studies, it was found that indeed, lower SPPB performance (scores under 10 out of 12) is consistently related to mortality of any cause.

References

Ferrucci, L., Guralnik, J. M., Salive, M. E., Fried, L. P., Bandeen-Roche, K., Brock, D. B. … Zeger, S. L. (1996). Effect of age and severity of disability on short-term variation in walking speed: The women's health and aging study. *Journal of Clinical Epidemiology, 49,* 1089-1096. doi: 10.1016/0895-4356(96)00231-4

Glass, T. A. (1998). Conjugating the "tenses" of function: Discordance among hypothetical, experimental, and enacted function in older adults. *Gerontologist, 38,* 101-112. Retrieved from https://academic.oup.com/gerontologist

Guralnik, J. M., Ferrucci, L., Pieper, C. F., Leveille, S. G., Markides, K. S., Ostir, G. V., … Wallace, R. B. (2000). Lower extremity function and subsequent disability: Consistency across studies, predictive models,

and value of gait speed alone compared with the short physical performance battery. *Journals of Gerontology Series A - Medical Sciences, 55,* 221-231. doi: 10.1093/gerona/55.4.M221

Guralnik, J. M., Ferrucci, L., Simonsick, E. M., Salive, M. E., Wallace, R. B. (1995). Lower-extremity function in persons over the age of 70 years as a predictor of subsequent disability. *New England Journal of Medicine, 332,* 556-561. doi: 10.1056/NEJM199503023320902

Guralnik, J. M., Simonsick, E. M., Ferrucci, L., Glynn, R. J., Berkman, L. F. Blazer, D. G., … Wallace, R. B. (1994). A short physical performance battery assessing lower extremity function: association with self-reported disability and prediction of mortality and nursing home admission. *Journal of Gerontology, 49,* 85–94. doi: 10.1093/geronj/49.2.m85

Pavasini, R., Guralnik, J., Brown, J. C., di Bari, M., Cesari, M., Landi, F., … Campo, G. (2016). Short physical performance battery and all-cause mortality: Systematic review and meta-analysis. *BMC Medicine, 14,* 215. doi: 10.1186/s12916-016-0763-7

Reuben, D. B., Seeman, T. E., Keeler, E., Hayes, R. P., Bowman, L., Sewall, A., ... Guralnik, J. M. (2004). Refining the categorization of physical functional status: the added value of combining self-reported and performance-based measures*. Journals of Gerontology Series A - Biological Sciences and Medical Sciences, 59,* 1056-1061. doi:10.1093/gerona/59.10.M1056

Reuben, D. B., Valle, L. A., Hays, R. D., Siu, A. L. (1995) Measuring physical function in community-dwelling older persons: a comparison of self-administered, interviewer-administered, and performance-based measures. *Journal of the American Geriatrics Society, 43,* 17–23. 10.1111/j.1532-5415.1995.tb06236.x

Verbrugge, L. M., Jette, A. M. (1994). The disablement process. *Social Science & Medicine, 38,* 1-14. doi: 10.1016/0277-9536(94)90294-1

SPPB Protocol examples:

English:

https://research.ndorms.ox.ac.uk/prove/documents/assessors/outcomeMeasures/SPPB_Protocol.pdf

Dutch:

https://meetinstrumentenzorg.blob.core.windows.net/test-documents/Instrument388/508_3_N.pdf

Scoring:

"For tests of standing balance, participants attempted to maintain the side-by-side, semi-tandem, and tandem positions for 10 seconds. Participants were scored 1 if they could hold a side-by side stand for 10 seconds but were unable to hold a semi-tandem stand for 10 seconds, 2 if they held a semi-tandem stand for 10 seconds but were unable to hold a full tandem stand for more than 2 seconds, 3 if they held the full tandem stand for 3 to 9 seconds, and 4 if they held the full tandem stand for 10 seconds. A usual pace, 8-ft walk was timed from a standing start, and participants were scored according to quartiles of performance. Time on the faster of two walks was used to define scores: score of 1: ≥ 5.7 seconds (≤ 0.43 m/s); score of 2: 4.1–5.6 seconds (0.44–0.60 m/s); score of 3: 3.2 to 4.0 seconds (0.61–0.77 m/s); score of 4: ≤ 3.1 seconds (≥ 0.78 m/s). Participants were asked to fold their arms across their chest and to stand up once from a chair. If successful they were asked to stand up and sit down five times as quickly as possible. Quartiles of performance for the repeat chair stands were used to define scores as follows: score of 1: > 16.7 seconds; score of 2: 16.6–13.7 seconds; score of 3: 13.6–11.2 seconds; score of 4: ≤ 11.1 seconds." (Guralnik et al. 2000). Based on these three components, a total score ranging from 0 – 12 can be obtained, with higher scores corresponding to a better physical performance.

Appendix K.1 Internal Choice Communication

“Willingness-to-pay: How and why

As part of the survey within the SOULMATE project, the proposal has included a willingness-to-pay experiment. This document briefly describes what such an experiment is and what the reason is for including it in a survey.

Our brains can do many amazing things, but giving accurate estimations of numbers is sadly not one of them. We are probably able to say (on a scale of 1 to 10 for instance) how much we like or dislike a chicken sandwich. But how does that evaluation change if we change out the chicken for turkey? How much higher or lower does the evaluation become if we take the lettuce out of the sandwich? The more complicated a situation becomes, the harder it is for us to give a good estimation of how all ingredients add to our final opinion. As a way to help us evaluate complicated (and even fictional) evaluations, choice experiments have been developed. Instead of asking us to evaluate different sandwich ingredients on scales, these experiments ask us to make a choice between some (slightly) different sandwiches. Instead of asking us to make a total sum of positive and negative aspects of the sandwich, these experiments ask us to just choose the option we prefer, just like we would in the supermarket. In the example below, two profiles are put together for us to make a choice:

	Sandwich A	**Sandwich B**
Meat	**Fried Chicken**	**Grilled Turkey**
Condiments	**Mayo & Pickles**	**Mayo & Pickles**
Lettuce	**None**	**Crisp Iceberg Lettuce**
Price	**€ 3**	**€ 5**

The only thing the participant has to do now, is choose whether they want Sandwich A, Sandwich B, or neither.

Here, the profile contains 4 attributes; *Meat, Condiments, Lettuce, and Price*. Each profile can contain different scores on each of these attributes, making many different combinations possible. When a lot of choices have been made, we can estimate the importance of each attribute; do people think a grilled turkey sandwich is tastier than a fried chicken sandwich? Do they value lettuce options above all other things? How much money are people willing to spend on a sandwich at all? These kinds of questions can be answered with a choice experiment. If price is chosen as one of the attributes, we can also tie it back to the other attributes. Then we can see how much people are willing to pay for adding lettuce to their sandwich, for instance.

==

Some of the challenges of a willingness-to-pay experiment like this are the total number of participants that are needed and how easily the profiles can be understood. Because the experiment includes a lot of combinations of attributes, we need a lot of choices to be made. With our participant group in mind, we would limit the number of choices each individual person has to make. Since we already ask a lot of other questions, my suggestion would be no more than 10 choices per person.

Secondly, the above profiles with the sandwiches might be understood easily, we could even use different pictures instead of tables with words to make it even more realistic. Sadly, for the SOULMATE app that we are developing it making profiles will be a bit more difficult. Enclosed, I will include some of the different versions of profiles I've made so far (please enlarge them to a readable size yourself). Of course, these are all still tables with words in them. If we can figure out some way of representing the different features our app could have in an image or something, that would be even better.**"**

Appendix K.2 Attribute Explanations

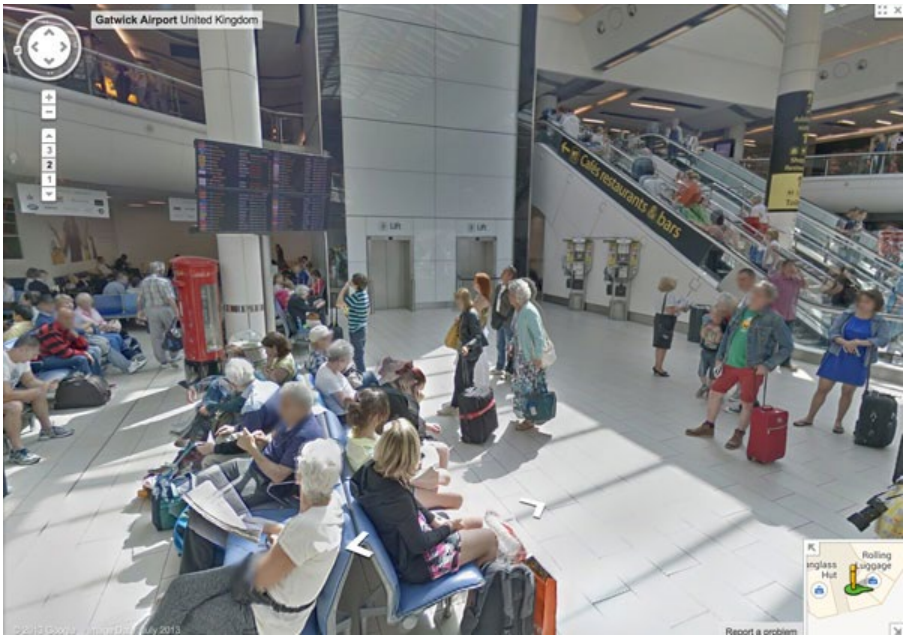
The three most important aspects of the SOULMATE solution are represented in the willingness-to-pay experiment in the form of attributes. Since the final features of the SOULMATE application are not set in stone (yet), the more general aspects are used instead of specific features. Through **Discovery**, **Navigation**, and **Assistance**, all potential features of the application should be described. A higher level of an aspect (*Small* (☆) *Medium* (☆☆) *Large* (☆☆☆) means the inclusion of more of this kind of feature. See the tables and examples below for what features can be described by each aspect.

Discovery		
Before a physical trip is made, the route discovery and practice can happen using the virtual tool included in SOULMATE. Step-by-step, users will be able to move from their virtual starting position all the way to their virtual destination. By showing the actual streets (à la Street View, with route indicators), users will be able to familiarize themselves with the route they plan to take for their trip, explore their surroundings, and look for recognizable landmarks in the environment		
Small (☆)	**Medium** (☆☆)	**Large** (☆☆☆)
virtual discovery	virtual discovery + points of interest	virtual discovery + points of interest + indoor discovery
Streetview style virtual exploration of area and route.	Points of interest (landmarks, shops, etc.) are highlighted and can be saved.	Virtual exploration within public spaces (parks, train stations, government buildings)

Discovery Small (☆) feature: Virtual discovery

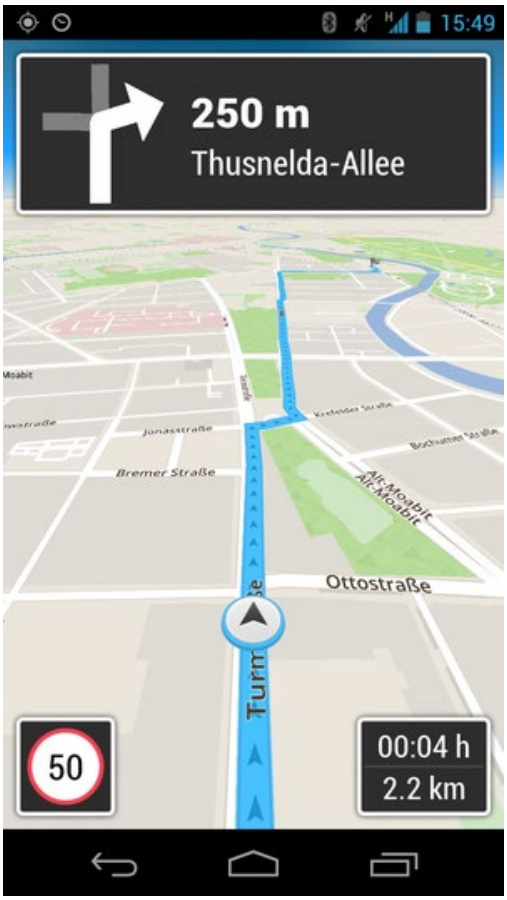
Discovery Medium (☆☆) features ADD: Points of interest (+virtual discovery)

Discovery Large (☆☆☆ atures ADD: Indoor discovery (+virtual discovery + points of interest)



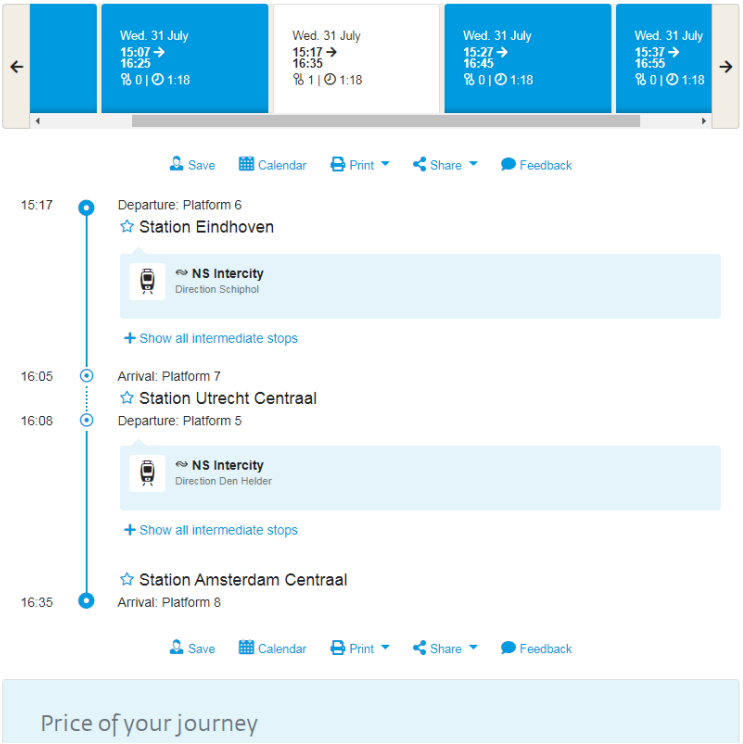
Navigation		
Navigation functionality regards information provided to users **during** their trips.		
Small (☆)	**Medium** (☆ ☆)	**Large** (☆ ☆☆)
directions	directions + facilities	directions + facilities + transition information
Standard route navigation on a map during trips.	Navigation can show routes to nearby facilities (toilets, benches, etc.).	Up-to-date public transport timetables and traffic information are shown during trips.

Navigation Small (☆) feature: Directions



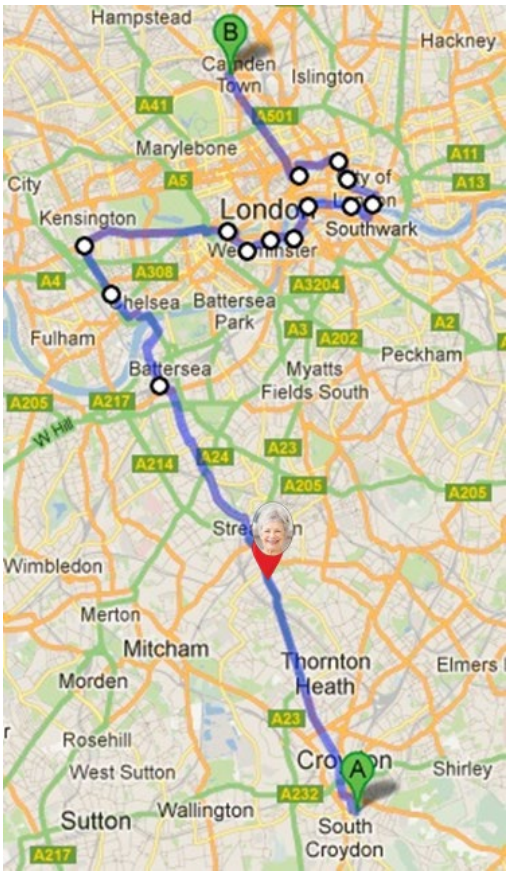
Navigation Medium (☆☆) features ADD: Facilities (+ directions)

Navigation Large (☆☆☆) features ADD: Transition information (+ directions + facilities)



Assistance		
Assistance during trips is provided through the ability for caregivers (‘coaches’) to keep track of, and stay in close contact with the user.		
Small **(☆)**	**Medium** **(☆ ☆)**	**Large** **(☆ ☆☆)**
following	following + interaction	following + interaction + geo-fencing
Requested person (‘coach’) can follow the planned route and user progression on a map.	User and ‘coach’ can communicate through voice/video calling during the trip when needed.	Automatic alert is sent to user and ‘coach’ when user deviates too far from planned route.

Assistance Small (☆) feature: Following



Assistance Medium (☆☆) features ADD: Interaction (+ following)

Assistance Large (☆☆☆) features ADD: Geofencing (+ following + interaction)

Appendix L SOULMATE Project Consortium Partners

1. Abeona Consult: A young & dynamic company specialized in developing smart products, software and services in the domains of transportation and traffic safety. ABEONA Consult is a spin-off from the Transportation Research Institute (IMOB) at Hasselt University in Belgium. The mission of Abeona is to identify transportation problems and to try to find solutions through research. In their research they use both knowledge and technology to tackle the transportation challenges of tomorrow. The shareholders of Abeona carried out many national and international projects over the last fifteen years. During their time at IMOB they developed extensive expertise in the field of transportation and traffic safety. The company focuses on collecting data from the crowd (= crowd-sourcing), to create applications (mobile or web) and to provide innovative solutions in the domain of mobility and travel behavior. The specialization of the company is to collect data and extract useful information from mobility and movement data. The main applications of the company currently are the route2school program, the Viamigo travel coaching prototype, the Feathers activity-based transportation model and the Sparrow activity-based data collection tool. In this project, SOULMATE benefits the commercial operation of Abeona as it allows the valorization of the base Viamigo technology as a component of a holistic solution being offered to the elderly population. As SOULMATE can cater much better to the needs of the users than any individual component (including competitor) can, Abeona can bring the Viamigo functionality to a new and complementary user base. Thus, Abeona Consult brings the existing Viamigo technology to the SOULMATE project.

2. Activ84Health: Activ84Health is a young and innovative start-up that develops technology to allow individuals with a physical, cognitive or logistic restriction to remain physically active in a fun, motivating yet safe environment. What started as an idea in the mind of Jan Smolders, director of nursing home Witte Meren in Mol (Belgium), evolved into an award winning innovation. Since its establishment in December 2015, Activ84Health has successfully launched its first product, the Activ84Health Explorer, which has already been deployed in over 35 nursing homes, hospitals and rehabilitation centers across Belgium and the Netherlands. In September 2016, the Activ84Health Explorer received the Smart Ageing Challenge Award from the European Commission's AAL-program for most innovative technology for Active and Healthy Ageing. Winning this award has accelerated the international scaling of the company. With the SOULMATE project, users are offered the opportunity to generate new memories and trips in the outside world, increase their independence by offering a unique training platform in which they build confidence and motivation in all safety, and to go outside and explore the world with renewed vigor. This will greatly contribute to renewed quality of life, exploration, and independence. Activ84Health brings their existing Explorer technology to the SOULMATE project.

3. Happy Aging: In4care (Brand-name: "Happy Aging") is a non-profit cluster organization located in Belgium, at the heart of Europe. Within In4care, there is a strong network of all-size healthcare companies, healthcare providers and hospitals, knowledge institutes, and local and regional governments. The living lab for elderly care 'Happy Aging' consisting of more than 1200 elderly and professional caregivers is one of In4care's strongest assets. This living lab is an initiative of the cities Hasselt and Genk (Limburg) and involves a partnership with a diversity of stakeholders (home care, pharmacists' organizations, hospitals, businesses). The Happy Aging Living Lab is active in the user centered development of products and services aiming at an elderly population. Furthermore, Happy Aging facilitates companies in bringing their

solutions to the market through our strong local and international stakeholders network (Aging 2.0) On an international level, In4care is partner in various European projects, such as AAL Follow.me (subcontractor) and Interreg Vlaanderen-Nederland, where three Flemish living labs (LiCaLab, Innovage and Happy Aging) join forces with three Dutch living labs in the CrossCare project. The goal of this project is to stimulate innovation in care and to facilitate "go-to-market"; as such, it is clear that In4care has valuable experiences in supporting the valorization of projects which aim in particular to contribute to the well-being of older adults. In4care and the province of Limburg have been recognized by the European Commission as international top region where innovations in healthy aging are developed, applied and commercialized (reference site for EIP on AHA and partner of the European Network of Living Labs (ENoLL)).

4. TU/e: The Urban Systems and Real Estate group is part of the department of the Built Environment of Eindhoven University of Technology (TU/e) and contributes to research and education programs in urban planning, real estate management and information systems in urban planning and real estate management. The group has extensive experience as a leading research group in areas of consumer research, urban planning, real estate management, and transportation research. Astrid Kemperman is associate professor of Urban Planning and Quality of Life and Pauline van den Berg is assistant professor of Urban Systems and Real Estate in this group. They both have published widely in the areas of healthy aging, social participation, active mobility, and quality of life of the aging population. Moreover, they have participated in a variety of funded projects, among others within EU FP7 and NWO programs. Furthermore, there is a long-standing tradition in collaborations with regional companies and public bodies, often also coaching students on projects which address societal challenges. Joining these professors are Floor Luub and Jaap van der Waerden, PDEng trainees of the Smart Buildings and Cities program at the TU/e.

5. RRD: Roessingh Research and Development (RRD) is a research and development SME in the area of rehabilitation technology and tele-medicine with strong formalized links to one of the largest rehabilitation centers in the Netherlands (Roessingh Rehabilitation Centre) and the University of Twente. The mission of RRD is to carry out scientific research and contribute to its commercialization and implementation in clinical practice. RRD develops innovations in a multidisciplinary team and in close collaboration with all stakeholders (patients, informal and formal caregivers, academia, health care organizations and industry). RRD has extensive experience in many aspects of the development of innovative technology supported health and care services from initial scenario development and requirements elicitation with all stakeholders, technology development (ambulant sensing, IT services platform, Decision Support, personal context aware coaching systems). RRD has built up a lot of knowledge and experience in clinical studies in many European projects, often as work package leader. This involves user studies focused on usability, acceptance and user satisfaction, and the design and execution of large-scale clinical evaluation studies up to implementation of new services in daily clinical practice. Due to its role as linking pin among research, industry, and care, RRD has strong ties with all relevant players in rehabilitation care in the Netherlands, and particularly in region of Twente, where RRD has a long history in developing and evaluating eHealth technology in a real-life context. Results of such research projects have been transferred to the market by means of spin-off companies and are being used extensively in clinical practice.

6. Coöperatie Slimmer Leven: Coöperatie Slimmer Leven is a connector of caregivers, care receivers, knowledge institutions, business, and government. Located in the southern part of the Netherlands, Slimmer Leven aims to future-proof the current system regarding health and vitality. With their almost 60 member organizations, the cooperation helps to realize projects that try to improve care, living and wellbeing through innovation. These projects fit with the various themes within Slimmer Leven, including Mobility and Vitality, the Digital Care Information Exchange, and E-health Innovation. An example of these projects is CrossCare, where Slimmer Leven coordinates and facilitates a testing ground for care innovators. This testing ground allows SMEs in the field to co-develop their innovations together with the people who would be using those in the future. Slimmer Leven thus brings the value of easily connecting different research, commercial and end-user parties in a project such as SOULMATE. Specifically allowing senior end-users from cooperation's network to be included in the design and development process.

7. FH Joanneum: The highly qualified and experienced staff of FH Joanneum is involved in a wide range of research projects, continually generating knowledge for the university, business and society. FH Joanneum takes an inter- and trans-disciplinary approach in tackling key research issues of the future in cooperation with partners from business, industry and public institutions. As the developer of one of the three basic components for SOULMATE (Ways4all) they gained a lot of experience in App-development, routing and user interfaces on mobile phones. The project team includes people with transport, health, IT and marketing backgrounds. Since the beginning of the projects, several primary, secondary and tertiary end-users and end-user organization were included as an essential part of the project team and the development process as a whole. Including these groups allowed setting up the needed operational requirements in such a way that the app would be usable for all the different end-user groups with their different impairments. Within the project, several public transport firms and city councils were also included to guarantee that the solution is in line with the market requirements. FH Joanneum brings their existing Ways4All technology to the SOULMATE project.

8. CCCOM: C.c.com Moser GmbH is a specialized software development company with customers in the area of Telematics applications. With the product 'BLIDS' (www.blids.cc), an innovative travel-time measurement solution for city government traffic managers as well as highway traffic situation managers, it has customers all over Europe. The software-specialists and researchers are well connected with Austrian and German research institutions and universities. Thus, knowledge is at the edge of newest AAL software-technologies. The main focus of the research and development activities are in Linux-Embedded Systems, NoSQL databases, VR/AR-technology, 3D, Low-level firmware. International experience includes activities such as the EUREKA project Power2SME which is done together with Spanish and Romanian project partners.

9. FRAISS: FRAISS is a Full-Service-IT-Partner that specializes in the development of high-quality software- and IT-systems. The service portfolio includes systematic IT-Concept-Consulting, the development of database- and individualized software, app development, as well as the implementation of web-based solutions. As a computer retailer FRAISS takes care of the planning and deployment of specialized server- and IT-systems. Additionally, the existing in-house digital agency ensures that requirements in the fields of User- Interfaces & Usability, Aesthetics and Design are met efficiently. With more than ten years of experience, a powerful network, and international customers from the sectors of Health & Medical, Automotive & Transportation, Aviation, Finance, Public & Government, FRAISS offers the required Know-How to successfully complete even highly demanding IT-projects.

10. GEFAS: GEFAS Steiermark - Society for active aging and solidarity between generations - is a 25 year old independent association in Graz / Styria which creates awareness and knowledge of processes of aging with quality of life and joy. The organization consists of a representative board, project managers, and sports trainers with members around 70 years of age. The target group of GEFAS are thus elderly people, for which the organization represents their needs and desires in various social initiatives and projects. These can be related to the main fields of the organizations' activities: Lifelong and life-wide learning, active citizenship, empowerment and gender, sports and health, diversity and inter-generationality. GEFAS is an acknowledged project and network partner on local, national and European level. The project managers of GEFAS have long-term experience in integration of elderly people in project activities and they are working in familiar collaboration with the target group. The members of GEFAS and other organizations (Migrants' Advisory Board of the City of Graz) represent diverse groups of elderly, who will participate in project development and testing out SOULMATE and be of use for them now and in the future. With their explicit interest in technological development, the seniors have the possibility to co-create their own future.