WP3 Pilot Synthesis Report

Lead Partner:	TU/e
Authors:	Dr. Rens Brankaert
Contributors:	Pilot Partners, with support from all partners
Date:	Juli 2018
Revision:	V1.2
Dissemination Level:	Private

ENSAFE

Project Acronym:	ENSAFE
Project full title:	Elderly-oriented, Network-based Services Aimed at independent liFE
AAL project number:	AAL 2014-1-112
With support of:	

Content

1 Introduction

This document describes the synthesis of the user involvement and pilots as part of WP3 of the ENSAFE project. In the project we aim to develop a health support system for elderly users that allows different systems and service to connect to each other to deliver a complete service package towards them. ENSAFE intends to gradually grow in a person's increasing needs when they age, meaning that it will offer easy access and low-threshold services for early stage or low-care need elderly. However, as the person ages, and care needs might rise, the system is easily extendable with products and services to address the user's more severe and more complex health needs. See the WP2 report for more insights in the details of the system.

Three main activities took place during the project as part of WP3 user involvement. These activities built up naturally from WP1, understanding the target group (survey in separate deliverable of WP1). The activities are 1) focus groups, to understand the user in a qualitative way and ask follow up questions to the WP1 survey, 2) co-creation sessions, to generate new ideas for ENSAFE and discuss existing concepts, and 3) Pilot evaluation, testing the final ENSAFE systems in the field with real-life users. This pilot evaluation is entails the largest part of WP3, and contained 2 iterations. Meaning an initial version of the technology was tested in a first pilot (iteration 1), then the technology was improved and tested in a second pilot (iteration 2).

The perspective on in-context Living Lab evaluation is based on work from Almirall et al. (2011). This prescribes an active role for users in the development of technology for them (as opposed to passive evaluation). And an evaluation in context (rather than in a lab-like environment). This improves the innovative potential and likeliness of acceptance by the users. Additionally, such an in context evaluation increases the ecologically validity of the ENSAFE system (Koskinen et al. 2011). Additionally, because a real-life context is highly uncertain and versatile, the multi-stakeholder perspective needs to be thoroughly considered through an inclusive evaluation protocol (Brankaert et al., 2015).

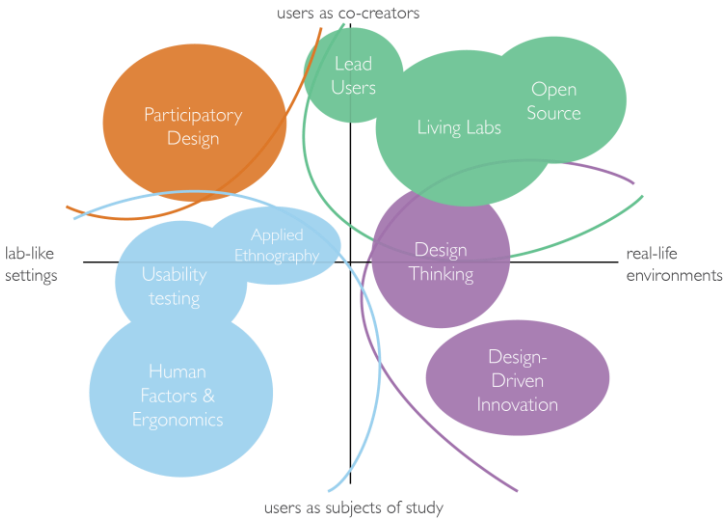

Figure 1 – Living Lab theoretical positioning, showing an active role of the user and a real-life environment.

This report describes a synthesis of the pilot activities conducted as part of ENSAFE over two iteration involving various types of users, including the elderly users of the system, family members, caregivers, nurses and so forth. The involvement of these stakeholders aims to make sure the ENSAFE systems address existing and important needs that are currently experienced, and not addressed by technology, and second the stakeholders evaluate the systems on their usability, usefulness and potential impact on the care system.

This report is build up in several chapters to guide the reader through this process. First the technology is briefly described (chapter 2), and the pilot set-up is explained (chapter 3). After this the pilot results are covered for all four partner countries: the Netherlands (NL), Italy (IT), Sweden (SE) and United Kingdom (UK) in chapter 4. More detail, and a synthesis of results is provided in the following section (chapter 5). And the report is closed with discussion and conclusions (chapter 6).

2 Technology used

As part of the AAL program, the project ENSAFE aimed to support older adults to live more independent by the use of technology. Next to developing specific solutions for different stages of the ageing process, the vision behind ENSAFE is the connectedness between the different technologies the partners brought into the project. In this section we will explain the technology used as a context to the pilot evaluations.

The ENSAFE platform

As the biggest contribution from the ENSAFE project is the networked approach to providing services and technology for older adults, this platform will be explained first. Figure 2 portrays the different elements that each communicate through the ENSAFE platform.

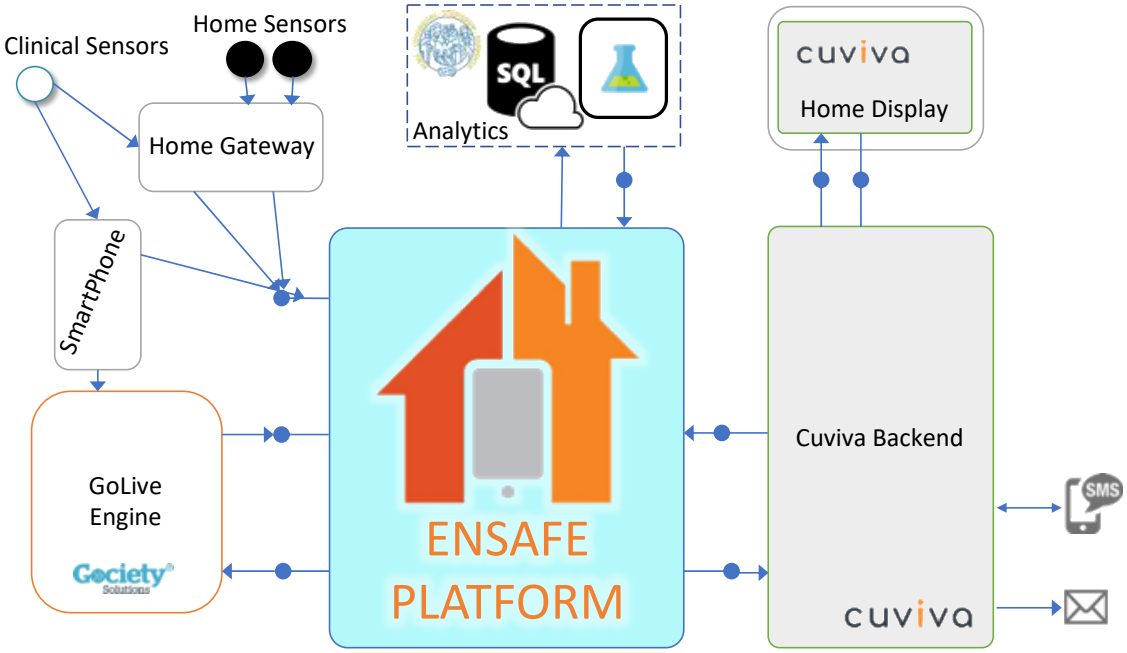

Figure 2 – The ENSAFE platform, a network overview.

The platform contains the following elements:

- **Home Sensors** - A range of home sensors can be used, they each collect data about the user pass it to the home gateway via Bluetooth and/or BeeZee. Currently the range of sensors available includes Motion (Passive Infrared - PIR), Bed Occupancy, Door/Window, Appliance Power, Toilet, and Chair Occupancy (Figure 3).
- **Clinical Sensors** – The sensors are designed to be simple to use, gathering data about the user and pass it onto either the Home gateway or Smart Phone via Bluetooth and/or BeeZee. Currently this includes blood pressure monitoring, weight scales, blood glucose monitoring and Blood oxygen monitoring. Note: Medical sensors will only be used in a formal care setting (Figure 3).

- **Home Gateway** – The home gateway collates information from Clinical and home sensors, and passes it to the ENSAFE platform.
- **Smart Phone (GoLive Smart Phone and Wearable Sensors) –** This is a custom phone interface that is geared toward the specific needs of independent older adults. This functionality includes activity monitoring, fall risk analysis and detection with informal or formal caregiver integration and personal emergency response (Figure 3).
- **GoLive Engine –** The accumulation of data for the GoLive environment (see above) is gathered and calculated in the GoLive Engine. In addition to this does the GoLive enginge provide an informal caregiver interface that allows them to monitor, guide and support the elderly users using the GoLive Smart Phone.
- **Analytics** – Data Analytics translates the data collected by the Smart Phone and home sensors into useful information. This information shows trends and will also detect anomalies.
- **Cuviva Home Display** – Is a care-centred display that allows elderly users with a more severe care need to access their safety and security systems. Users can use it to communicate with informal/formal caregivers, but also to access their home sensors or the screen provides feedback from detected anomalies (Figure 3).
- **Cuviva Backend** – Provides a similar role as the GoLive Enginge did to the GoLive Smart Phone, it accumulates and calculates the input and output factors for the Cuviva display.

Figure 3 – Some of the technology parts showed during an exhibition by RISE (SE) – Clinical sensors, home sensors and the Cuviva display.

The ENSAFE levels

As the system is a complex platform, with multiple technologies and services connected to each other the ENSAFE project team divided the ENSAFE system in different hypothetical “levels”. These levels are a tool to formulate different technology scenarios, varying from level 1 (low to no care need) up to 4 (intensive care need). These levels were also used to formulate our user persona’s resulting from the data gathered as part of WP1 (for example figure 4).

Dividing the ENSAFE system in different levels provides us with different advantages. First, this allowed us to test different configurations of the ENSAFE systems with users, a complete installation would 1) cause us to over offer services to a specific user, and 2) be too costly to install in all user’s houses. Second, the different ENSAFE levels, fall in different legislations, which is differently organised per country. The levels allow the business case to be developed for specific funding mechanisms in each of the different areas (for which the WP4 deliverables can be reviewed).

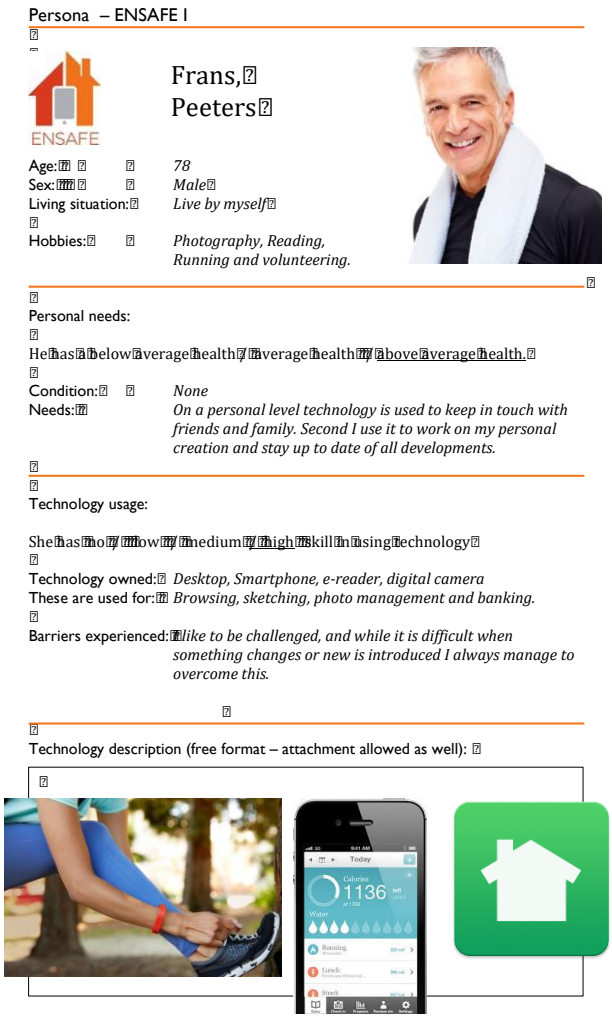

Figure 4 – example persona for ENSAFE level 1.

Technology for ENSAFE 1 and 2

For the user involvement we decided that the Netherlands and the United Kingdom would focus on ENSAFE levels 1 and 2. The technology used in these levels is from a low to maximum a medium care need. The context for these technology levels is always the home environment, sometimes people receive formal care and sometimes they still live completely independent.

In the consortium team we specified ENSAFE level 1 as being focused on the smartphone use, with specific service applications. For the ENSAFE level 2, we extend this service with clinical sensors such as the blood pressure meter, weight scale and glucose meter. In this level the users engage with more medical oriented devices for the first time, and we can relate this to their current technology level and experience.

Technology for ENSAFE 3 and 4

For the user involvement we decided that both Italy and Sweden would focus on ENSAFE level 3 and for, designed for a more severe and complex care need. ENSAFE 3 would focus on people who would still be able to interact with modern technology, and in this stage the users would operate a series of systems through a tablet (screen based) interface, and have clinical and home monitoring sensors, the use of smartphone technology is optional if feasible. This level takes place still at home, or in a home situation with care support nearby. For level 4 we focus on elderly with a higher care need, and don't expect active interaction with the system, in way this system needs to focus more on the nurses as its primary user rather than the patients. This level 4 is not situated in the home, but in a dependent care environment.

Figure 5 – Example of an introduction session for ENSAFE pilot.

3 Pilot setup

For the ENSAFE pilot (started Early 2017) we developed an evaluation protocol for ENSAFE levels 1 to 4 (see figure 6). The overview shows the overall narrative of the ENSAFE evaluation plan for the in context user evaluation. In the development of the ENSAFE system, four levels of ENSAFE were defined, with each serving an increasing care need.

The early stages, ENSAFE level 1 and 2, which will be mainly evaluated in NL and UK, will have more users. Later, in iteration 2, these levels were intended to be evaluated in SE and IT. For ENSAFE 3 and 4 this is the other way around (first in SE and IT, and later in NL and UK). Overall ,we will include more users for ENSAFE 1 and 2 as this is an easier to access target group, and the intervention is easier to implement and scale up (a smartphone with extended services and sensors). The protocol shows the envisioned plan, the realisation of the pilot will be displayed in chapter 4.

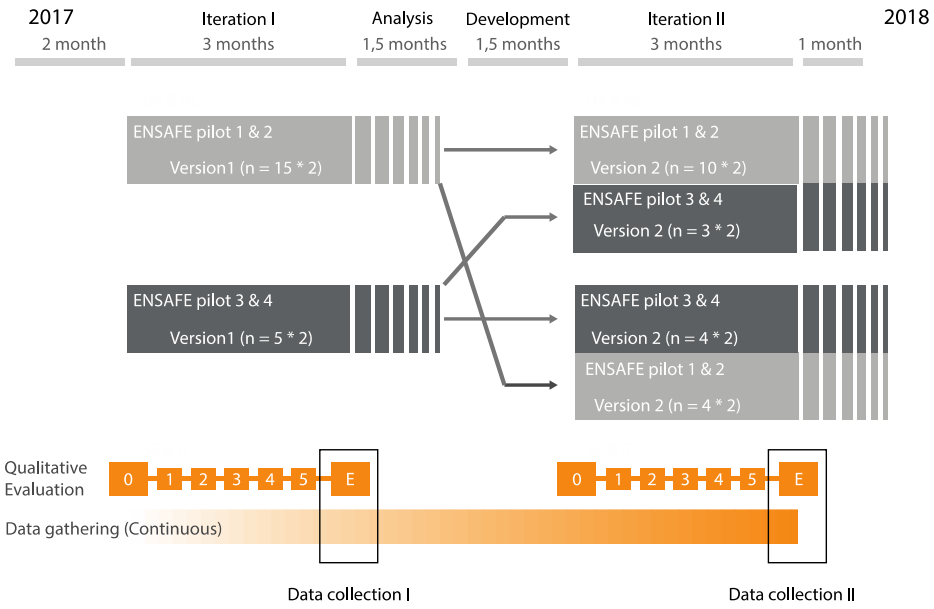

Figure 6 - The evaluation protocol plan

The protocol (figure 6) mainly contains the following elements: *Preparatory actions*, *two iterations of each +/- 3 months*, *Qualitative measurement* and *data gathering.*

1. Preparatory Actions

To prepare the pilot four actions have been taken. The consent form has been finished (see separate file in appendix A). The ethical considerations have to be taken into account, and if necessary an approval has to be admitted to an ethical board, this has to be determined on a regional level, as legislation is country based. In addition, the research method has to be selected and adapted to the

specific context (see 3 and 4). Finally, general preparations have to be done such as recruiting participants and finishing the ENSAFE (level 1,2,3 and 4) system prototypes hardware and software.

2. Two iterations

The pilot started Early 2017, over two iterations. In each of the iterations the version of the ENSAFE system will be improved based on new insights from within the pilot and technical advancements. This is based on an iterative development approach (Hummels et al. 2012). As such an iterative way of working is established between WP3 (User involvement and in context evaluation) and WP2 (Technology development and interoperability). In total, we will evaluate Version 1 and 2 of the ENSAFE interconnected systems in sessions of three months (consolidating as a mid-long term evaluation, Almirall et al. 2011).

In iteration I ENSAFE pilot 1 and 2 will take place in the Netherlands and the United Kingdom, in Italy and Sweden the focus will orient on ENSAFE 3 and 4. These pilots will continue into iteration II where the other parts of the ENSAFE levels will be addressed in each country.

Based on the results of the pilot evaluations a final concept proposal of the ENSAFE system(s) is formulated as a final deliverable of the project, and continued by the partners.

3. Qualitative measurement

In the bottom section of the pilot protocol the measurement methods for the pilot are covered. This will consist of one part qualitative measurement and one part quantitative data gathering.

The qualitative method consists of two parts: Firstly, a short two-week questionnaire is used to evaluate the user perspective over time. To see if their experience with the system, and perceived benefit, improves or declines with respect to the system. See appendix B for this questionnaire.

Finally, a group evaluation is scheduled were (similarly to the focus groups) a discussion is organised with the users to discuss: (1) the system- and all its facets, (2) the user experience and (3) the research itself. The discussion guideline for this session can be found in Appendix C.

The results of both the questionnaires and the focus groups have been analysed in a qualitative way by all pilot partners, and described in terms of themes.

If necessary, data records were used to amend this data from continues data gathered. This data is recorded and dealt with by the technical pilot partners in the ENSAFE project. Some cases are used to illustrated user behaviour in this report.

Evaluation guidelines

General organisation of the in context pilot is described here. The methods are kept general, and each country are allowed to adjust were needed for their region.

1. Informed Consent

The evaluations are in line with European standards for scientific code of conduct. This means the users (often elderly persons) are asked to join the test on a voluntary basis. In some outlier cases we will include people with a high care demand that are not allowed to provide consent by themselves, and in this case the legal representative is asked to comply with the guidelines of the study.

If the participants agree to join the study, they will sign an informed consent (See appendix A) this is translated for all the pilot sites.

2. User participation

The total amount of users we intend to include in the ENSAFE pilot is aimed at 80, as distributed over the four partner countries as following:

	NL	UK	IT	SE
1	15	15	2	2
2	10	10	2	2
3	2	2	5	4
4	1	1	5	4

3. Exit strategy

For all the ENSAFE levels, people can always drop with the study and give the intervention technology back to the pilot partner (as agreed upon in the informed consent). If the user benefits from the technology over the test period, thy are allowed to keep the technology however for the running services a fee has to be paid as specified by the companies involved.

4 Pilot results

In this section we will describe the pilot execution results. As with all real-life studies small deviations from the setup plan occurred, these will be described here. Main reasons for not executing the pilot evaluation exactly as planned, where challenges with realizing the technology scenarios, acquiring users that fitted in each of the ENSAFE areas and the available technology in each region.

The final pilot execution narrative can be seen in figure 7, as you can see some of the ENSAFE level exchanges across countries were downscaled and removed. Nevertheless, there were also some positive developments, where we operated better than planned beforehand, for example the total number of users in NL and UK were higher than estimated due to high popularity of the technology. Eventually we involved more users than planned.

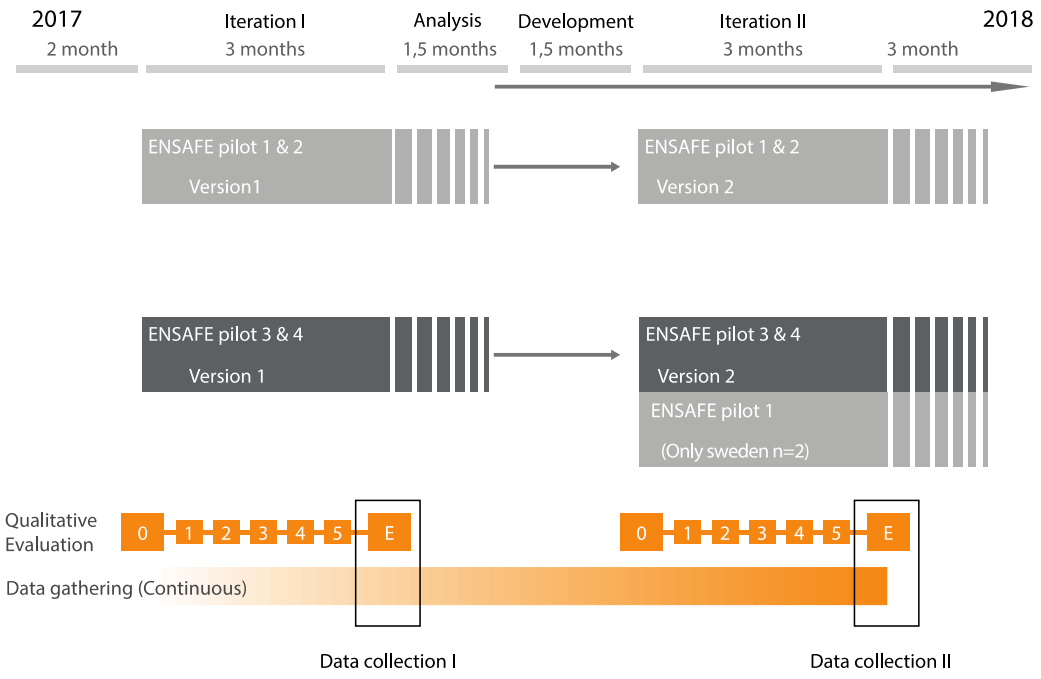

Figure 7 - The evaluation protocol as realised during the project

The total number of people eventually involved in the pilot was 97, in addition to this formal and informal caregivers were involved during the pilots as well. Their role was larger in the higher ENSAFE levels of 3 and 4.

	NL	UK	IT	SE
1	26	25	0	2
2	8+16*	5	0	0
3	0	0	0	3
4	0	0	8	4

*The ommetje study group (see technology description WP2) as addition third iteration in NL.

In the following section we will cover the pilot evaluation results from all the different pilot areas (UK, NL, SE and IT) following the execution as described above. The pilot evaluation will be cover both iterations. These results are covered in systematically in a similar reporting structure, focused around the themes, as following:

1) Technology
2) User experience
3) Pilot organisation & Evaluation

The results are reported as delivered by each of the pilot partners. Resulting in a different writing style and reporting structure.

4.1 The ENSAFE pilot 1 and 2 in the United Kingdom

Evaluation period: February 2017 to March 2018

Total number of users: 30

Responsible coordinator: Lindsay Sharples, Innovation agency

1) **Technology**

Preparation

In November and December 2017, workshops were held with the two UK groups to distribute the blood pressure monitors and the weight scales to those users interested in receiving additional devices. An additional device was demonstrated to the users – KardiaMobile,a phone clip to produce medical grade ECG readings in 30 seconds.

Installation

None of the users felt able or confident enough to pair the devices with their phones, even the most technically able. A group session approach was initially tried but proved unsuccessful so the devices were paired individually with minimum input from the users. An additional device (AliveKor) was demonstrated to the users – a phone clip to produce medical grade ECG readings in 30 seconds.

Operation (errors/bugs/connection etc.)

Unfortunately, it did not prove possible to connect both the blood pressure monitor and the weight scales simultaneously. In fact, the scales were not paired and used successfully via the app by any of the users. This was reported to Meteda who could not replicate the synchronization issues that we had experienced. It was proposed that we provide the "ENSAFELog.txt" file which is stored in the internal memory of the phones inside the ENSAFE folder. However, it has proved difficult to access this, certainly beyond the capabilities of the intended users. Accessing this information required an additional app to be downloaded; even this has not revealed the log file Meteda require. Further development is essential to improve the functionality and stability of the app. Users compared the ENSAFE devices to the simplicity and effectiveness of AliveKor, which also allows for guest users.

Furthermore, after a number of weeks, the ENSAFE app failed and despite being deleted and reinstalled, and the blood pressure monitor being uninstalled and reinstalled, it could not be reinstated effectively. However, one user managed to collate three weeks of blood pressure readings which she was able to share with the GP.

2) User experience

Results questionnaire

Due to the operational issues reported above, there was little to no benefit in providing the weight scales. The scales measure in kilograms or pounds; in the UK weight is traditionally measures in stones and pounds so this particular model is not ideal for the UK market. The blood pressure monitor on the other hand was very well received and considered useful and beneficial. When initially provided, the users had a limited understanding of a normal range; they quickly moved to appreciating the value in the data and the point at which medical advice/attention was required. Users were provided with guidelines produced for blood pressure testing outside use of general practice – this was produced for British Heart Foundation projects. However, this was made available in the latter stages of the pilot.

Learning curve

Users reported improved usage of the phone with many using the smart phone on a daily basis for a wide range of functions. The peripherals received a mixed reception due to the technical issues but with significant improvements, users could see a clear value in having these. The majority of the University of the third age users (one of the user groups containing 15 users) joined the project due to having experienced at least one fall.

End evaluation with users (focus group)

The majority of users expressed a greater sense of social connection- “although any phone would do this”

The ENSAFE falls device (GoLiveWear) was perceived as obtrusive and does negatively impact on daily life.

Ease of use was critical – “Frustrating – not being able to sync scales, difficult to sync blood pressure machine initially but then not able to enter results after contract was prematurely ended”.

The GoLive environment was not considered user friendly “even my daughter thinks it is difficult to use”. The Samsung quick guide was considered “inadequate”.

Suggested improvements included having the scales and blood pressure monitor working and to have them for longer to better test them.

The blood pressure monitor was considered empowering and reassuring, although it was problematic for users to pair. The guide provided was clear but users lacked confidence and were reluctant to attempt pairing procedure. One user described feeling safer by having “more information about my blood pressure”.

A small number of users reported a behaviour change – “using the blood pressure monitor made me more aware of needing to try harder living a healthy lifestyle” and “I’m more aware of the things

that affect my health and has encouraged me in working to achieve a better fitness level". Also, "my ENSAFE device made me more aware of dangerous situations surrounding mobility".

All users preferred an upfront payment for the smartphone rather than entering a contract requiring a monthly rental. There was a distinct lack of interest (if not fear) in a monthly rental arrangement.

Most users stated they would pay £100 - £150 for the smart phone- "the cheapest that meets my functional needs" -with only a handful being prepared to pay £250 - £300. Users reported the social side of taking part in the project had been important in securing their continued involvement with the technical aspects being 'interesting' and 'enlightening'.

Users asked if they could participate in other studies and were disappointed that there are no further phases of ENSAFE activity. The sessions had an almost 100% attendance rate and users were sorry to see the pilots end.

Technical issues have caused problems throughout the project and these continued during the handover. These related to the handsets being purchased through a corporate account (locked to EE) and the failure of the ENSAFE app part way through iteration II.

3) pilot organisation and evaluation

Recruitment process

No new recruitment requires as Iteration II followed iteration I with the same users. All were offered the blood pressure monitors and weight scales and even those not in receipt of either continued to attend the regular sessions. Eventually 5 chose to do so.

No further data collected as part of the pilot evaluation.

4.2 The ENSAFE pilot of level 1 and 2 in the Netherlands

Evaluation period: December 2016 to February 2018

Total number of users: 50

Responsible coordinator: Rens Brankaert, TU/e

1) **Technology**

Preparation

In total four separate iterations took place as part of the ENSAFE pilot activity in the Netherlands. The first one took place in Leende, with the Cuviva technology (ENSAFE 1) from December 2016 – February 2017 as a pre-pilot for the other regions. The second took place in Someren, with the Cuviva technology (ENSAFE 1) from April 2017 – Juni 2017, the third took place in Someren, with added blood pressure monitors and weight scales (ENSAFE 2) from October 2017 – November 2017 and the final study (iteration 3) took place in Someren, with the walking app technology (ENSAFE 2) from November 2017 – February 2018.

Leende, Cuviva (study 1 – ENSAFE 1 pre-pilot):

Eleven users aged between 66 and 86 years old participated in the Cuviva studies. Four males and seven females participated for twelve weeks. They filled in a bi-weekly questionnaire and in the end conducted a final evaluation session. In addition, a design probe was used to learn about people's daily life and particularly their leisure activities.

Someren, Cuviva (study 2 – ENSAFE 1):

Fifteen users aged between 61 and 78 years old participated in the Cuviva studies. Eight males and five females participated for eight weeks. We used user diaries with four data entry moments, to experiment whether or not people would be more likely to explain themselves in the comment boxes than they were in the previous study with the questionnaires. As we did not have multiple-choice questions anymore, but only four open comment boxes, namely: advantage, disadvantage, easy and difficult. In the end we conducted a final evaluation session. In addition, a design probe was used to learn about people's daily life and particularly their leisure activities.

Someren, blood pressure monitors and weight scales (study 3 – ENSAFE 2):

Eight users aged between 62 and 78 years old participated in testing the blood pressure monitors and weight scales. Four males and four females participated for about six weeks. Two out of eight participants were super-users. These users were part of the Cuviva study and interested to receive these additional devices. In the beginning of October, we installed the devices on people's phones, at the end of October we asked about their experience via email, in the beginning of November there was a focus group session in which people shared their experiences and suggestions for

improvement. After that people continued using the devices and were very motivated to keep on using the devices, even though for most people they did not connect properly with the app.

Someren, walking app (study 4 – ENSAFE 2):

In our previous study we found that walking is the most dominant hobby and a strong motivator behind this is the social component of people in your surroundings. Therefore, we co-designed a walking application with seniors to record walked routes and share these with peers in a community, to motivate each other and share interesting experiences.

Before testing the application on people's phones, we tested a prototype of the walking app by walking along with the senior citizens using the prototype on a test phone (findings can be found in 'operation' section – figure 8). There were three reasons to do so:

1)To see how the participants interact with the application (contextual inquiry)

2)To test if the app works technically and were it needs improvement

3)To discuss with the participants if they can imagine future use of the application

Sixteen users aged between 63 and 83 years old participated in testing a co-designed walking application. Eight males and eight females participated for three months. We installed the walking application on their own smartphones and guided them in learning to use the app via training classes and a manual. In total 5 focus groups were held to give people a podium to vocalize their opinion. At the end of the test period individual interviews were conducted.

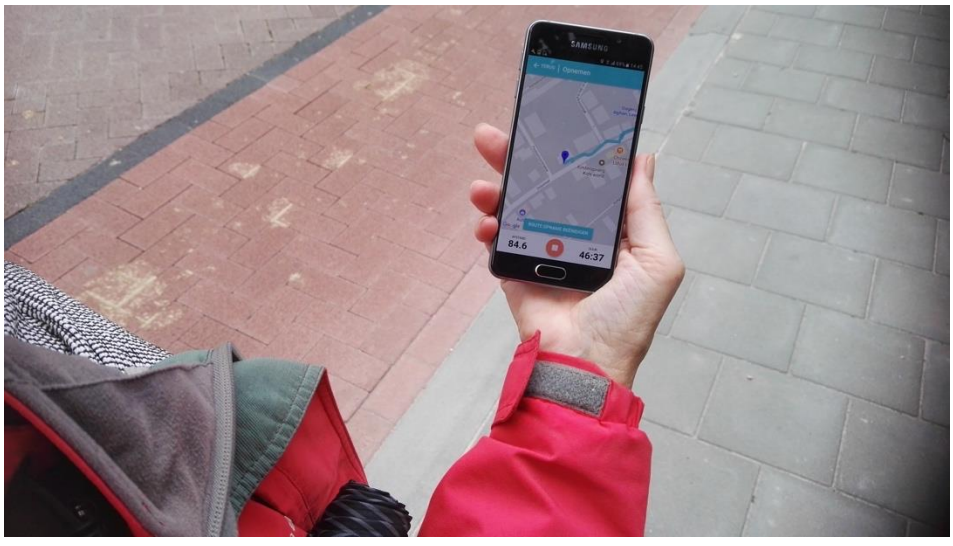

Figure 8 - The walking application 'ommetje' in context

Installation

Leende and someren (study 1 and 2):

The installation was taken care of by GocietySolutions who instructed super-users to teach users how to use the Cuviva, which as a partner had experience with this approach. Through several courses and a manual, users were taught in an informal setting how to interact with the applications on the phone. In both communities there was one facilitator as main point of contact both for the researchers and for the users.

Someren, blood pressure monitors and weight scales (study 3):

A presentation was created to be able to step-by-step demonstrate how to install the ENSAFE app and connect the devices with the individual smartphones. It proved to be challenging to turn this procedure into a fit-for-all as some different notifications or pop-ups were experienced by several people, such as installing the latest app store update. However, one person helped out in being an active facilitator and repeated the steps that had to be taken to the people who were lacking behind. All in all, we mentioned to connect most blood pressure monitors, but only one weight scale was functioning after repeatedly trying to solve the issue.

Someren, walking app (study 4):

A similar approach as connecting the blood pressure monitors and weight scales was conducted to install the walking application.

Operation (errors/bugs/connection etc.)

Someren, blood pressure monitors and weight scales (study 3):

•7 participants have a blood pressure device which works (though measurements are not always sent to app)

•Only 1 participant has a working weight scale

(this person has a samsung galaxy x cover 3, others have samsung a3)

•One person does not use the ENSAFE app, but only the products, because she has an iphone

•One person quit the test because the products don't connect with her ENSAFE app, another person is now installing her products on his phone

A lot of effort has been taken to try to connect the devices to the app on people's phones, but it did not work out. Removing and reinstalling, testing different devices, interacting differently with the buttons on the screen, testing it on different phones.

Someren, walking app (study 4):

The findings of the contextual inquiry were the following:

People pressed the save button without naming the route. Therefore, we made the keyboard visible immediately instead of when pressing in the text box. Also, we added a short text explaining you should create a name for your route.

There were some technical difficulties, examples are: 1) incorrect GPS coordinates leading to a wrong number of kilometers in total and 2) lack of internet connection leading to unsaved walking routes. The solution for the first problem was found by narrowing down the range of GPS coordinates by no longer including coordinates further away than 35 meters. The solution of the second problem was found in allowing the software to save a route on a later time when a Wi-Fi connection was made again, and cashing the route in the meantime.

2) User experience

Result questionnaire

Leende, Cuviva (study 1):

Over time users were positive and their grade of judging the system increased a bit, it became a little easier to use according to their data.

The results of the questionnaire are merged together with the evaluation sessions and are presented in the section learning curve and end evaluation.

Someren, Cuviva (study 2):

For study two the questionnaire was simplified to comment boxes Advantages, Disadvantages, easy and difficult. In total 100 quotes from fourteen participants were collected in the four different comment boxes.

- 30 comments in 'advantage', e.g. *"It is fun to do."*

- 25 comments in 'disadvantage', e.g. *"For fall prevention you need to wear your smartphone in your pocket. I think this is difficult while bending and cycling."*

- 24 comments in 'easy', e.g. *"It is easy after a good explanation."*

- 21 comments in 'difficult ', e.g. *"I think it is quite difficult. I cannot concentrate very well."*

Showing an medium reception, with an even distribution of comments over the four boxes.

Expressing familiarity with technology

When comparing the different themes over time, the data entries of the first and second show a trend in expressing familiarity with technology. For example, by comparing the current Cuviva to their previous phone: *"It's more the advantage of the new phone. It's faster than my previous one*." and *"I am an advanced smartphone user."* Interestingly, these comments are written in all four different categories.

Difficulty to memorize the interaction steps

Furthermore, in the data entries of box one and two we see a trend in the difficulty to memorize the interaction steps. Seven out of eight comments about memorizing were mentioned in these sections, five in the category disadvantage and three in the category difficult. However, they also mention *"An advantage is the many possibilities and because of the manual it is not difficult for me to use the smartphone."* Thus, indicating that this outlier of mentioning the memorizing theme in these boxes actually could be interpreted as not limiting.

Unintendedly informing the caregiver

Then the data entries on the second and third box express the theme unintendedly informing the caregiver. Four participants all communicated the same problem: *"Even with putting the settings of the caregivers gradually, they all received an email about a possible event of falling."* However, one participant expected it to be his/her fault: *"I sent my three caregivers messages which was not my intention. I still do not know what I did wrong."*.

Learning support

At last we see in all data entries over time the theme learning support, consisting of 1) practicing in class, 2) practicing at home, 3) learning from the facilitator's guidance and explanation and 4) exploring the manual. We will provide examples of every subtheme.

First of all, practicing in class, which is generally perceived as comforting, necessary and handy, but can also be noisy: *"Sometimes it is noisy because we are not on the same level, but that is logical."*

Secondly, it is experienced pleasantly that the manual enables the user to practice and repeat their knowledge at home: *"It is nice you can read it [manual] again and try it [Cuviva] out. It is very clear."*

Learning curve

In our studies, we found two elements are key while facilitating learning: step-by-step introduction and repetition. In the literature, we find that senior citizens are not confident in learning technology, as opposed to learning about health, safety, leisure or transportation. Interestingly, in our crossover findings we see that the introduction of super-users and the manual, did give them the motivation and confidence to learn about the technology.

Pairing the devices with the user's phone was challenging, but using the devices and the application was relatively simple. The users could have benefited from a better medical instruction on a good body posture while measuring the blood pressure, this was given after errors were observed.

Installing Ommetje consisted of too many steps to let the users do this independently. However, with the guidance in class we managed to install the walking application on all phones. What we would do differently next time in the learning process is explain less functionalities at once and instead practice more in between. So checking whether everyone achieved the expected level and then continue in addressing new functionalities.

End evaluation with users (focus group)

Leende and Someren (study 1 and 2 – ENSAFE 1):

Three elements related to technology were found, namely: awareness, acceptance and applications. Two participants gave an example of how the smartphone interferred too much: *"I did not like that people were only talking about the Cuviva during a birthday party. When you are together, you should not be watching your phone."* In addition, our participants stated having limited time to practice, for example because of doing voluntary work. Therefore, some were not as familiar with the technology as they would like to be. However, a possibility is that they are not comfortable with sharing their difficulties or having other activities as priority.

We found that the trigger to start using a new technological device, is mainly preparation-focused. Although some participants saw the Cuviva as '*necessary evil*', over time this changed towards *'I see activity tracking and WhatsApp as an enrichment*'. These examples relate to existing literature saying that in addition to the willingness in using technology which is well-designed, it is about expanding this experience towards an emotional response instead of purely functional (Barnard et al. 2013). However, overall the social aspect of the Cuviva seems to be the biggest influencer, since WhatsApp brings them in direct contact with their children and grandchildren: "*I can see how my kids are doing without them picking up the phone!"* In addition to this social aspect, it is not only the product itself enabling to be social, but also the learning community as a service by the super-users: *"We get to know each other better."* and "*It is a nice community."*

Our participants requested a manual shortly recapping the steps they need to take for features they use in their daily life. For example, sending a message on WhatsApp and taking a picture. In this way, they feel it is a pleasant back-up which they can trust if they are uncertain about something outside the class and moreover they can repeat and practice more easily at home. All in all, WhatsApp and calling are the features which are used most, which sets out a new design space to create applications that trigger the interest of senior citizens. Therefore, we created an example manual as an illustration how they could make it themselves. This example manual is created in Microsoft Word to enable and invite the super-users to develop the manual further. It was used in the next Cuviva class and was considered *"pleasant to work with the elaborate user manual".* From a design point of view, it can be relevant to include pieces of the manual as reminders in an application or in the Cuviva. In this way, participants have the relevant information in the right place.

Participants again mention the Cuviva will be helpful in a later stadium: *"It is comforting that it is easy to reach for help if necessary. Luckily this is not applicable yet."* and thereby supported preparation. However, in contrast to our participants in Leende, there are two participants who talk about the medical functionality as an advantage: *"Care, fall prevention etc. It also stores my medical information."*

Also participants mention examples about the performance of the Cuviva, such as: *"The advantage at the moment is the Cuviva is faster than my old phone."* This could be explained by the fact that some of our participants have some prior knowledge, because they used a smartphone before: *"I am already familiar with a mobile phone. I am going for the Cuviva to get used to it."*

Someren (study 3 – ENSAFE 2)

Blood pressure monitor and weight scale:

Written feedback:
•"I use both frequently, but you sometimes need to change the batteries a bit. Sometimes the measurements are only displayed on the devices and not send to the application on the phone"
•"After reinstalling the ENSAFE app the blood pressure device is working"
•"We use the blood pressure device once a week, the weight scale is not working"

Discussion:
•Senior citizens were interested to keep on using it
•They mentioned a preference for all in one system (GLP), rather than a separate ENSAFE app
•People would be interested to be able to use the app with 2 persons (not buying multiple products for one household)
•People would like to be able to delete (wrong) measurements, especially when another person used it to try it out

Someren, walking app (study 4 – ENSAFE 2):

Ommetje currently is designed to track everyday walks, and allow to share these with peer users from the same age and social environment. With this we aimed to motivate seniors to move more, track their walking behaviour and to use social pressure as motivation.

We found that we should rethink the purpose of the application, by focusing more on special routes with nice scenery, rather than tracking the total number of kilometres. People do not want to capture a simple route for example to the supermarket, because they are already familiar with it and did not value it as a shareable route to others. Participants suggested they would use it more when making a day trip: 'I would like to take pictures showing people what they can see in the neighbourhood when visiting a museum'.

We found that senior citizens compared their current experiences of using the application with their previous ones. Currently this application shows a twitter-like list of routes from others, in which the seniors can select favourites to place on a separate to-do list. However, they felt it would be better to remove the unneeded walks, similarly to being able to remove pictures from a gallery in a picture app which they were familiar with. Designers intend to create simple applications, but often complex and detailed manuals are needed to explain every interaction possibility in a screen. It is therefore important for designers to relate the new interface design to previous experience with the old familiar interfaces to the seniors.

We found that senior citizens often forget to use the walking application. They intended to use it for example during the weekend while playing golf, but when coming home they realized they did not use it. It may be interesting to focus on preparatory behaviour to make it part of the routine to turn on the walking application.

We found that senior citizens have diverse motivations to start using an application and we should design towards meeting their goals to keep people engaged over time. For example, enjoy walking, participate in research and experience that walking application is too difficult.

We found that during the final individual evaluations, people asked whether or not they could still use the application on their phones. This indicates they valued using the application, even when the test period was finished. There were several active users, who recorded a route every week and a few users who intended to try it out in the future during cycling as well.

3) Pilot organisation and evaluation

Recruitment process

Our participants in the first study with the Cuviva were recruited by GocietySolutions as this was one group in the Cuviva class. The team consisted of a facilitator who guided the classes around an informal coffee table, three super-users and several users. Everyone in this community in Leende was a senior citizen educating and learning from each other.

Our participants in the second study with the Cuviva were also recruited by GocietySolutions as this was one group in the Cuviva class. The team consisted of a facilitator who guided the classes in a teacher-student structure, two super-users and several users. Everyone in this community in Someren was a senior citizen educating and learning from each other.

Our participants in the third study with the blood pressure monitors and weight scales were recruited by the TU/e during the second study. They were offered these devices and people who were interested could sign up for the device they wanted to test.

Our participants in the fourth study with the walking application ommetje were recruited by the TU/e during the second study as well. They were offered to test the walking application and could join the kick-off session to install the application on their smartphones.

Questionnaire experience

The multiple-choice sections were mostly filled in by participants, but the 'please elaborate' sections were mostly left blank. Therefore, we experimented with the user diaries with open comment boxes only, as the page would be left completely blank when skipping this section. However, people mentioned they wanted more guidance in what was expected from them and what type of information would be meaningful to write about. Therefore, they suggested to give some statements of which they can decide to disagree or agree with, rather than a completely open comment box.

When asked about their preference of questionnaires, focus groups and individual interviews, the main consensus was they preferred the focus groups. The main reason for this was to know what other people's opinions were and to turn it into a discussion in which different opinions can bring new insights and perspectives.

However, it could be interesting to explore the written individual feedback more by for example testing whether or not it would work to fill in a questionnaire form digitally. In this way, it may be more likely the user provides feedback closer to the moment of experiencing. Also, the feedback may be easier to analyse as it answers a specific question, rather than a conversation which leads to a new discussion. That being said, the focus group may bring more unexpected results in experiences people want to share, rather than are triggered to share by answering one specific question in a questionnaire. Therefore, we argue to keep using both tools to grasp all important user stories and values.

Data Collection

During the first study the steps data provided us with meaningful insights about how often participants took their phones with them. In the user's steps graphs some showed a steady average number of steps every day of for example most often a minimum of 6000 steps each day (figure 9a). However, in some user's steps graphs a number of 0 steps could be seen (figure 9b), sometimes even for several days. In the final evaluation indeed people confirmed they sometimes left their smartphone on the table, because they experienced it as unhandy to bring the device with them at home. Eventually the step data was therefore not included in the study after the pre-pilot (study 1), as it did not log the step data correctly always, and it did not support in evaluating the technology.

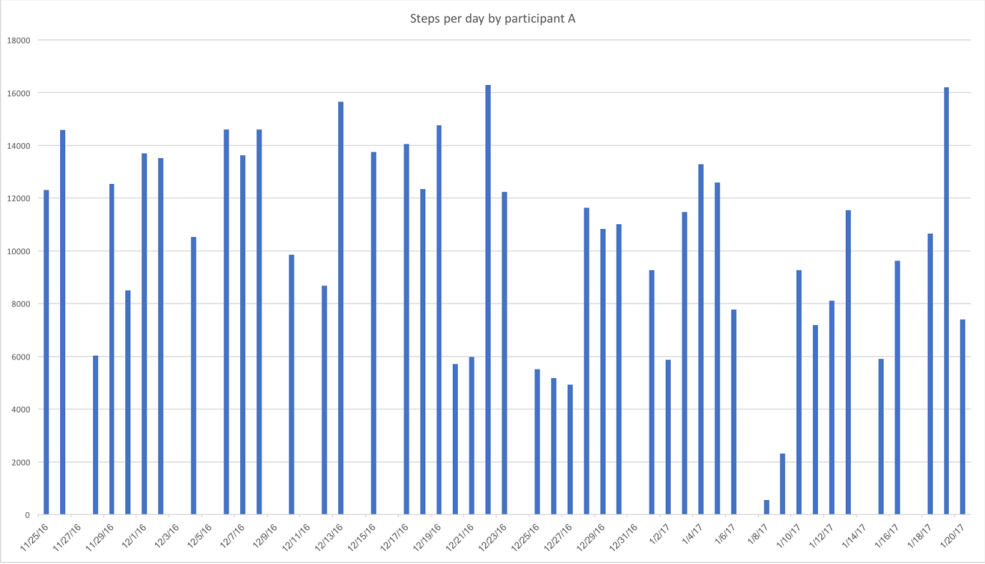

Figure 9a - The step data profile of a user in the pre-pilot

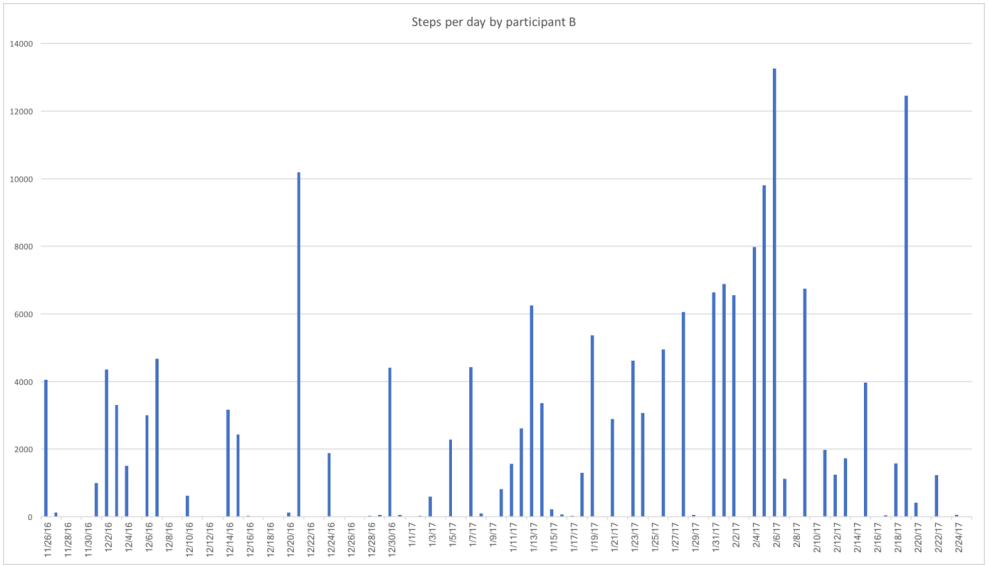

Figure 9b - The step data profile of a user in the pre-pilot

4.3 The ENSAFE pilot of level 3 and 4 in Italy

Evaluation period: May 2017 to March 2018

Total number of users: 8

Responsible coordinator: Lorenzo Lasagna, Proges

The first iteration had as a main purpose to gather behaviour patterns, and was mostly passive for the users (May 2017 – November 2017). Therefore this sections focusses on the second iteration, which took place between December 2017 and March 2018. Technical aspects are discussed, as well as user experience and the probes for impact assessment.

1) ***Technology***

Iteration 1:

Iteration 1 in Italy involved 3 different services (see below for details) and 8 people. Despite some minor issues, it provided some largely positive feedbacks and relevant information about the service and the devices reliability.

The whole research project has been approved by all the Public Administartions holders (where existing), and the users' cooperation has been satisfactory. Only one end-user (affected by psychic issues) withdrew from the project because of generic concerns about electro-magnetic interferences. No interaction was requested, at this stage, to the formal caregivers operating within the aforementioned services.

Nevertheless, it must be noted that Iteration 1 has been has a mainly technological one, and it did not provide any significant qualitative feedback. This was due to a combination of (at least) 2 factors. First of all, the ENSAFE 4 target, characterized by low or null technological skill; secondly, a strong disruption in postal service, that delayed the delivery of Cuviva displays from Sweden, forcing to start the pilots without an important part of the technological layout.

For all these reasons, the pilot staff decided to postpone the iteration's end a couple of moths (November), to gather more information after completing Cuviva displays installation.

Anyway, it is clear that a full qualitative analysis will be carried out only in Iteration 2, and that – due to the specific needs of ENSAFE 4 and sometimes ENSAFE 3 cases – the actual end-user will be the formal caregiver; so, no real impact on the use-case scenario may be evaluated without a full involvement of the professional caregiving team.

Pilot installation:

Pilots were installed by UniPR and Proges staff. Each installation took about 1 hour, in order to lay down the sensors and make functional tests.

Pilots were kept as uniform as possible; however, due to specific home/living environment characteristic, some sensors were repurposed. Examples include:

- Kitchen PIR: whenever a kitchen was not available, the motion sensor was installed in the bathroom, to track usage of the shower and/or sink.
- Appliance Plug: in case no TV or reading light were present, the plug sensor was not installed.
- Medical cabinet magnetic contact: if no medical cabinet was used, the magnetic contact was installed on a different furniture, e.g. the wardrobe

Iteration 2:

Second iteration tests were performed on a subset of initially recruited persons, since a few dropped for personal reasons. Having the same subjects participating in both iteration phases is beneficial from the analytics point of view, since longer periods can be observed, for the same person, thus providing more meaningful insights on his habits. Details on the recruiting are provided below.

All pilots underwent preventive maintenance, by having all batteries replaced with fresh ones, and by checking for adequate signal strength for all sensors. No major issues were found.

Three Cuviva displays were added to selected pilots, implementing the possibility of checking and logging user's mood each day.

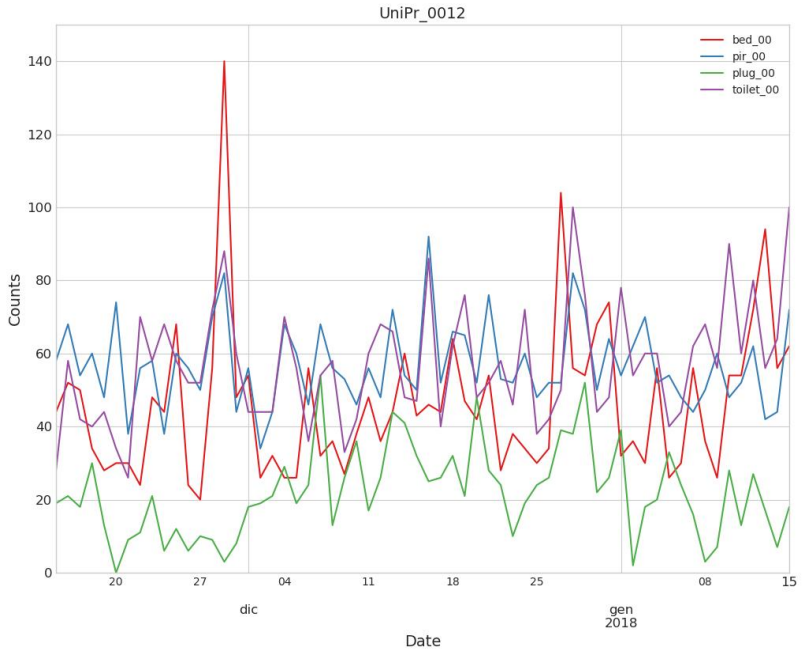

Figure 10 - Example of data continuity for pilot "UniPr_0012"

The ENSAFE sensor networks installed in Italy functioned as intended, without major errors. Most of the pilots produced regular streams of data each day. An example of data continuity over 3 months is shown in Fig. 10. Here, the number of detected sensor events is plotted, on a daily aggregation base. As can be seen, information flow is stable.

Technology: Case study UniPR_0013

This section aims at showing the patterns gathered by the ENSAFE system in a Level-3 pilot, UniPR_0013, to give some context to the system. The user is a 75-year male, living in a sheltered home in Milan. He has a single bedroom and toilet, and shares common spaces (e.g. dining room and hall) with other residents.

We begin by observing some historic trends on bed usage during evening and night hours (19:00-09:00), visible in figure 11.

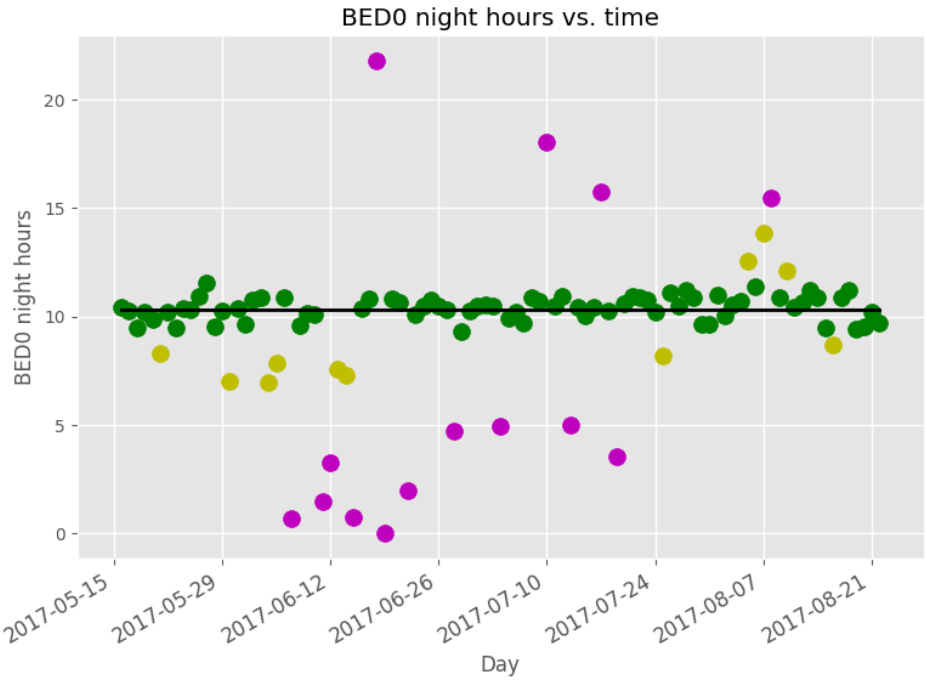

Figure 11 – Bed behaviour as measured by bed monitoring system.

The explanatory model does not detect, during the observed period, any presence of linearly increasing trends, nor any effect induced by weekend or week days. Instead, night presence in bed is quite stable, approximately 10h20' per day: only a few points were detected as gross outliers (purple points in the scatter plot), and some "unusually distant" points were observed (marked as yellow points). Values above the observed window (14 hours, from 19:00 to 09:00) suggest continuative bed use, extending over the window. Such observations are quite rare.

Bed usage through the whole day, instead, shows a linearly increasing trend, as reported in the plot below (Figure 11). Overall, the person spends 13h45' a day in bed, with a linearly increasing trend of 1h45' during the observed period. Still, no difference was noted between weekend and week days.

Daily bed presence is more stable than night presence (less outliers or potential ones), suggesting an overall adjustment through the day in case the evening-night period was not satisfactory to the user.

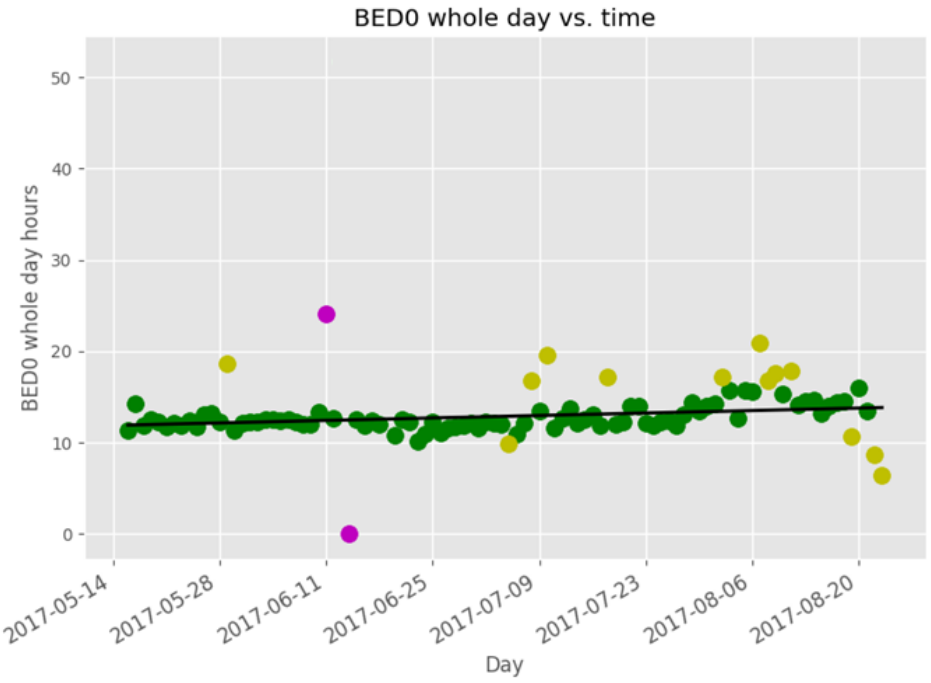

Figure 12 – Plot of bed behaviour of whole day.

Interestingly, the increase in bed presence throughout the day can be explained by and opposite decreasing trend in chair usage (figure 13), approximately -2h30' over the period. Average presence is around 2h45' per day. Some gross outliers are flagged, probably due to a heavy bag or item being left over the chair. The figure below summarizes such findings.

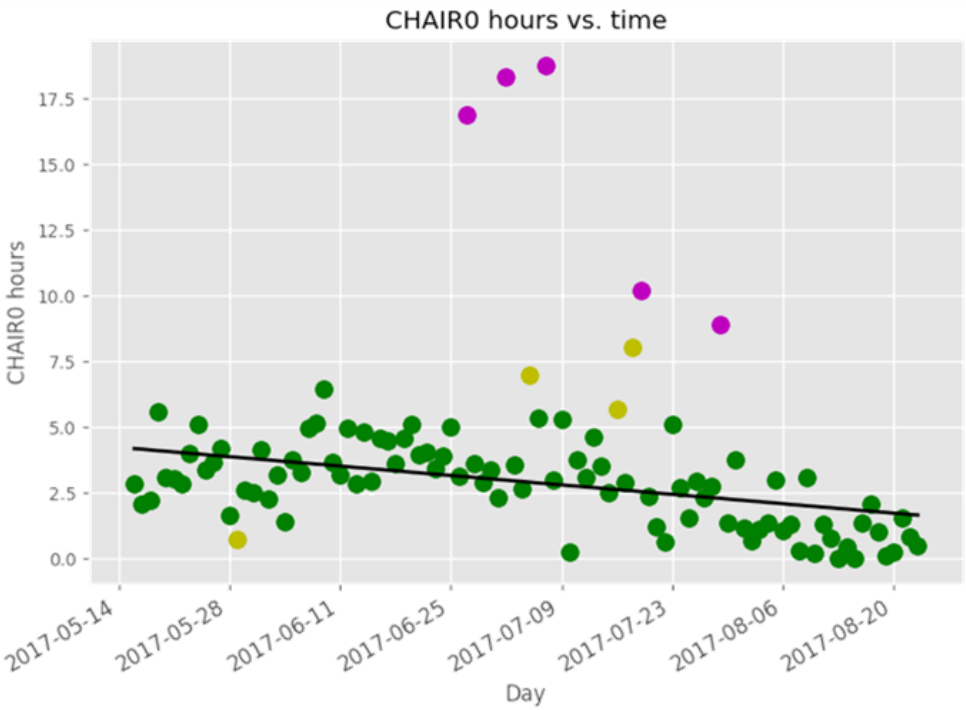

Figure 13 – Plot of chair use of whole day.

The same information may be looked from a different perspective, using sensors' characteristic profiles. Such curves represent the likelihood of the user interacting with the sensor throughout the day. An example of such curve is reported below: solid lines represent the average toilet sensor pattern, shaded areas the confidence intervals (figure 14).

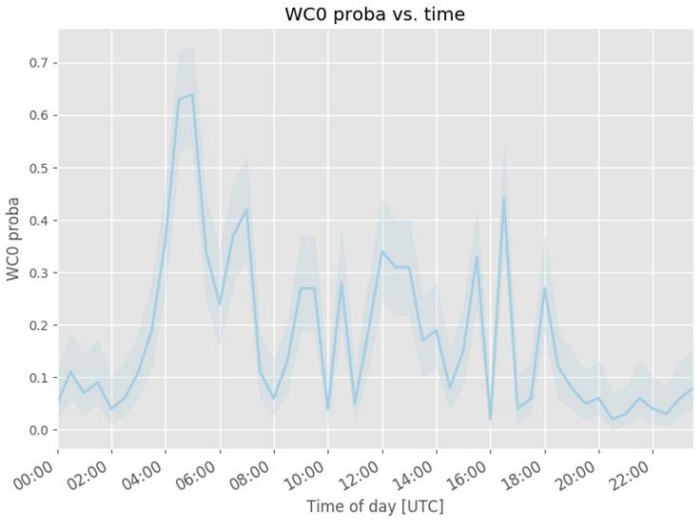

Figure 14 – Toilet use sensor data.

These curves are particularly interesting in order to detect changes in patterns over time: A comparative analysis can be made between different time periods, and statistical tests can be performed to spot significant changes. Two such examples are given below, for the bed and chair sensors, respectively. Red curves represent the initial reference period (first 20 days), whereas blue

lines represent patterns from more recent period (last 20 days). The changes are significant around noon, and such changes (increasing bed presence, decreasing chair presence) are in line with the results presented above on historic trends (Figure 15).

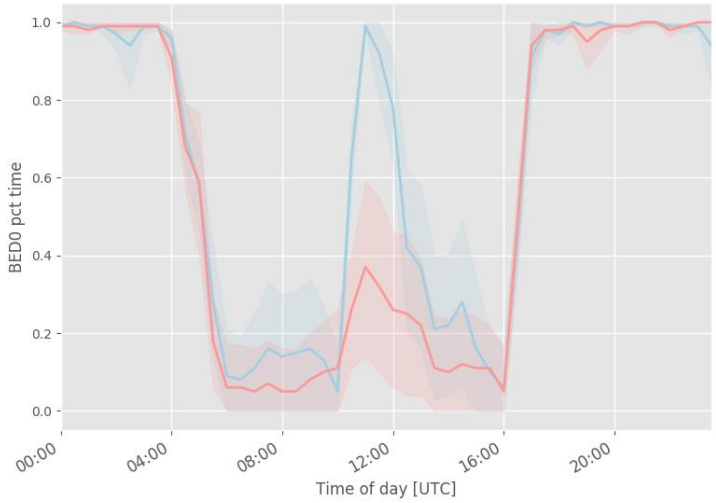

Figure 15 – Plot of bed and chair usage data.

2) *User experience*

Impact assessment

The pilot running impacted the elderly's and the caregivers' routine in a different way. The elderly experienced a very poor interaction with the devices, mostly because of their reduced self-sufficiency level of using the technology. Hence the focus on nurses as primary users.

Nevertheless, only one of them suffered some kind of discomfort (and finally decided to withdraw from the pilot, protesting that he was afraid of electromagnetic interferences); for all other participants the presence of devices and technological tools in the living environment was substantially neutral or non-relevant. This may be interpreted as an encouraging feedback in the perspective of a large-scale adoption of ENSAFE technology in intensive caregiving units.

On the contrary, the caregiver professionals positively interacted with the devices, without protesting any discomfort. They regularly attended at the requested tasks, cooperating with the engineers and the pilot coordinators.

The organisation of the assistance never suffered any fail due to the functioning of the devices, and the Cuviva triage system appeared to be easy and friendly. The caregiving managers accepted to test the devices in their facilities or service, and actively cooperated to the pilot conduction. The general sentiment towards the ENSAFE tools was positive and curious.

The only negative remark is a general lack of awareness of the potential benefits that this technological layout could ensure. This could be due to a cultural bias (lack of trust in technological help), but also to the absence of a ready-to- use interface.

Learning curve

The available devices are mainly operated: a) by the caregivers (reflecting the elderly's point of view) or b) under the caregiver's supervision.

The interaction with the devices has been described as simple, clear and not intrusive, with low impact on the caregiving setting. No major difficulty or error has been registered.

The caregivers did not experienced any learning curve in using technologies.

3) *Pilot organisation and evaluation*

Recruitment process

Iteration 1 had mainly been a technological stage, aimed at testing the general functioning of the system. No interaction between the system and the end user (or the caregiver) was necessary at that stage, and the only request was not to interfere with the devices performance.

Iteration 2 has therefore been intended as the first qualitative stage: the first opportunity to test the *end user's role*.

For those reasons, iteration 2 is expected to give clear feedbacks and indications about soft factors and subjective user's experience. In particular, the introduction of Cuviva displays changed the pilot structure, directly involving the elderly and the caregiver into the technology usage.

It should be noted that, due to ENSAFE 3 and 4 peculiar characteristics, in most cases the real end-user is the formal caregiver (and not the elderly), and that specific evaluation criteria should be considered to assess the caregiver's contribution to the interface design.

The end users involved in the pilots have been recruited within Proges' facility system, such as: homecare services, nurse-homes, assisted apartments, etc. The inclusion criteria were technological and environmental (i.e. presence of a fast internet connection), user related (i.e. people living alone, without major mobility issues and using toilet), and political/administrative (people paying out of pocket for being assisted, or people assisted in a service held by an active-cooperating and open-minded Public Administration).

Probe (interviews summary)

The first step of the user's experience assessment has been a qualitative interview with 4 caregiver and caregiver managers. During the conversations, the interviewee was let free to give any feedback about his/her impressions about the devices and the data input. The interviews generally showed good perceptions and confidence in terms of organisational impact. No interviewee experienced any particular discomfort or interference due to the presence of the ENSAFE devices, and no one of them referred to the technology as a potential disturbing factor within the caregiving interactions. Nevertheless, no one of them seemed to have clear ideas about the ENSAFE system's potential.

Focus group

Final evaluation of the user's experience at *Iteration 2 stage* will be made by a focus group discussion (comprising elderly, caregivers and managers), aimed at pointing out the user's impressions, the effectiveness of the devices, the impact factors, the expectations about future developments of the interface, and any other suggestion or critical remark about the pilot. The caregiving managers' point of view will be taken into account to devise the organizational utility of the system, even into a business perspective.

A focus group (comprising 4 people representing the caregivers and the managers) discussed the pilot experience in a stand-alone meeting that took place on June 5th. The discussion touched on different aspects of the pilot organization.

Users' experience

Technological devices have been daily used during the whole pilot period by the caregivers without major discomforts. The interface has been considered as 'interesting', 'friendly' and 'simple'. No need of a day-by-day supervision has been claimed by the caregivers.

Impact factors and impact assessment

No particular concern has been showed about the impact of ENSAFE technologies on everyday life and working routine. The focus group is confident in future benefits arising from the large-scale adoption of technological devices.

Expectations about future developments of technological layouts

The expectations about future versions of the interface mainly concern reduction of complexity (i.e. font size, colors, buttons position). General recommendations were arisen about data protection, privacy and respect of the primary user's dignity.

Critical issues

Despite the clear disclaimers provided by the engineers, the elderly and the caregivers still tend to rely on ENSAFE as a sort of real-time alert and warning system.

Final remarks

The outcomes of the final evaluation stage are strongly positive, expecially with regard to: 1. low impact on the job routine, 2. Clear and objective trends and needs detection, 3. improvement of the service quality.

4.4 The ENSAFE pilot of level 3/4 in Sweden

Evaluation period: April 2017 to March 2018

Total number of users: 9

Responsible coordinator: Paul Martin, SICS/HIQ

For iteration 1, in Sweden, the installation of 3 ENSAFE sensor kits in the homes of single-living users was completed during early April 2017, with 3 Cuviva displays added to the systems during late May. In addition, 2 Go Live phones were acquired and used by additional users not using the rest of the ENSAFE system.

Later, for iteration 2, in November and December 2017, meetings were held with one of Norrköping's local municipal home care service providers (*Hemtjänst Gamla Lasarettet*) to mobilise users and care givers for the second test iteration of the ENSAFE system. We quickly established that the formal care giving organization was interested in participating in tests, and that 4 end users could be recruited to take part in testing during Q1 2018

1) Technology

Preparation

Iteration 1:

Users were recruited through the existing test bed environment in Norrköping, Sweden. After an initial session during which potential users were informed of ENSAFE's overall objectives, they were invited to a second session to learn more about the test phase itself, and to hear further details of what their participation in the evaluation of the ENSAFE technology would entail.

Seven users expressed interest in learning more about testing the system, and attended the second session. Two of these decided not to participate due to limitations imposed by their living conditions. In one case this was due to living with a spouse suffering from dementia. The other case was due to travel plans which would mean a lengthy absence during the test period.

In the end we had 3 users interested in testing the ENSAFE sensor network & Cuviva displays, and 2 users interested in testing the Go-Live Phone including Go-Live Wear.

Installation

Iteration 1:

Installation of the sensor kits was straight forward thanks to the clearly written manual provided by UniPr. There were however some installation problems encountered, mainly due to the reliability or speed of the internet connections in some users' apartments.

Likewise, installation of the Go-Live app on the Samsung A3 smartphones was a trouble-free process that worked well straight away thanks to quick response to questions from Gociety Solutions.

Iteration 2:
In mid-January 2018, ENSAFE sensor kits were installed in the homes of two single-living wheelchair-bound users. Cuviva displays were added to the installations during February.

In the second test iteration no Go Live phones were used. Installation of the sensor kits was again straightforward thanks to previous experience and the clearly written manual provided by UniPr. There were no installation problems encountered, as a prerequisite for participation in testing was the existence of a stable internet connection in the user's home.

Operation (errors/bugs/connection etc.)

Iteration 1:
Of the three ENSAFE sensor networks installed in Sweden, only one proved to function fully as intended and without errors. The other installations encountered issues with lost or un-transmitted data, again mainly due to limitations imposed by the internet bandwidth in the users' apartments.

In our experience, the ENSAFE sensor network requires a stable, relatively high-speed (> 2MB/Sec) connection to function properly. In practise this means that a mobile 4G router is unsuitable for ENSAFE, a fixed cable is necessary.

In the Swedish tests only one user lived in an apartment where the internet connection exceeded 2 MB/Sec. One of the other users had a fixed 0.5 MB/Sec connection, and the third relied on a 4G mobile modem.

The installation of the 4G router in the third apartment was straightforward in itself, but proved unreliable in practice due to the modem's inability to transmit user data via the internet in a timely and reliable fashion. The reason for this failure we suspect is due to the (unwanted) execution of Windows Updates by the Cuviva hardware. These updates quickly consume the data volumes on the prepaid 4G subscription, leaving no room for the ENSAFE data within the user's data subscription of 1 GB/month.

Our conclusion is therefore that such connection problems can only be overcome through stable and reliable internet connectivity.

In practical use we had some issues with the alarm sounding unexpectedly on the GoLive Phone, sometimes late at night. We are still unclear as to why the alarm should go off when the phone is seemingly idle and unused. One user believes that it may be related to charging, and that the alarm sounds as a warning of low battery level. This should be discussed with Gociety Solutions.

On the Cuviva interface we have had some issues with weight scale and blood pressure data not appearing on screen within a reasonable timeframe. Lengthy delays of up to 24 hours or more have sometimes been experienced. Also, the scheduling of the "How are you today" screen hasn't worked as intended. The initial intention was that the screen should appear according to a daily schedule,

instead the screen appears at random during the day. These issues should be investigated and fixed by Gaia.

Iteration 2:
The ENSAFE sensor networks installed in Sweden functioned fully as intended and without major errors, thanks in part to lessons learned from Iteration I, when we had problems with lost or un-transmitted data due to limitations imposed by the internet bandwidth in the users' apartments.

The Cuviva interface has again had issues with weight scale and blood pressure data not appearing on screen within a reasonable timeframe. This is probably due to misconfiguration in the ENSAFE back-end system and will be investigated.

Text messages indicating the users' daily moods ("How are you today" status) were received by home care personnel and users received prompt replies to these.

2) User experience

Results questionnaire

End users expressed a positive view of the ENSAFE system. They felt more connected to their care providers through the Cuviva platform and they appreciated the interaction it provided. The ENSAFE devices are perceived as unobtrusive and unproblematic, and they have no impact on the user's living environment.

The lack of feedback from the sensor system unfortunately means the users perceive little direct value in the short term. They expressed an interest in seeing their ENSAFE sensor data, particularly sleep patterns, so some form of visualisation would most likely provide greater value to end users.

There was no perception of behavioural change during the 8-week test period. Nor was there any great willingness to pay for ENSAFE in its current form. However, if sensor data and a more functionally developed communications interface were to be developed (e.g. free text entry via Cuviva), a price level similar to a local mobile phone subscription was thought to be acceptable. One user thought she might have a greater willingness to pay if she was in a lesser state of health.

Home care providers were also positive to the use of ENSAFE and the perceived impact of the system on end users. They experienced greater peace of mind through the text messages received via Cuviva, and saw a positive change in users' mood as a result of the direct text communication. They also felt Cuviva brought them closer to the end users.

Again, a lack of insight into the ENSAFE sensor data meant there was no perception of any great value added to the current level of care provided. This could be rectified by simple measures such as displaying blood pressure measurements, something which today's Swedish legislation unfortunately only allows within the confines of a private data network, rather than through open internet protocols.

Home care providers were unwilling to express any view on their employer's willingness to pay for ENSAFE, but they did feel that a number of end users' relatives would be interested in a system that provides insight into their elderly mother or father's wellbeing, either through an app or a text message service.

Learning curve

Iteration 1:
For the GoLive Phone, users felt they became more engaged and involved once they were given access to their usage data via GoLive Assist. They expressed that seeing their activity history and progress gave them a feeling that life became more interesting and motivated them to stay active. They also expressed that seeing other users' data would most likely spur some users to become more active if their competitive spirit was stimulated.

The GoLive Phone's geolocation function was not activated, but users expected it could be very useful if used.

Users found the ENSAFE sensor system unobtrusive in day to day life. There were no feelings of being watched or monitored, nor did they express feelings of increased security or independence. Users expressed an interest in gaining access to a visualization of their ENSAFE user data, saying this would give them a greater insight into their behavior and an understanding of how they may be able to change behavior to maintain their health and independence.

As for the Cuviva display, users appreciated having access to a visual interface, and expressed great satisfaction at having access to an interactive device (note: these users had previously only ENSAFE sensors, no GLP). Users expressed benefits and joy at being able to communicate via text messages to relatives (informal care givers) via the display. Being active digital users, the group felt the preprogrammed messages to be somewhat limiting. They would like to be able to communicate more freely, preferably via a Voice interface. All users felt that it would be nice if messaging could also be initiated by their relatives, rather than the system simply allowing relatives to respond to the users' status messages. Communication with formal care givers is something users would like to see in future version of Cuviva.

Iteration 2:
Users did not experience any learning curve for the ENSAFE sensor system which they found more or less unnoticeable and unobtrusive in day to day life. One user was unable to take her own blood pressure due to frailty, and relied instead upon help from formal care givers.

As for the Cuviva display, users found the interface almost too simple, expressing an interest in increased text-input functionality. This is probably due to an above average digital literacy among users who are already experienced in the use of mobile smart phones and tables as tools of digital communication.

Care givers experienced no learning curve to respond to users' text messages.

Focus group

Iteration 1:
The users' experiences and views on their 3 month evaluation of the various components in the ENSAFE system can be summarized as follows:

- All users feel a sense of contribution
- Being involved makes them feel useful. As one user said with a smile: "Being a tester cheers me up, it keeps me busy and stops me thinking about stuff like dying…"
- They feel a sense of responsibility and are concerned when things don't work as expected
- They want to contribute to the project and help improve the experience so it can benefit other people
- The users are interested in knowing how the data contributes to the project. They are also interested in the bigger picture, about how the system can contribute to the improvement of our health care systems
- They are all very interested in knowing more about their own health
- They are genuinely glad to have been part the project
- Users become frustrated, and concerned by system errors. They worry that they are not helping the project.
- Users are however still somewhat unclear about how the sensor system contributes to their independence – they would like more visualization and insight into the data produced and how it is used.
- Despite an overwhelmingly positive response to the system, they are still concerned that ICT solutions might one day replace human contact and the personal side of health care.

Iteration 2:
The users' experiences and views on their 8 week evaluation of the various components in the ENSAFE system can be summarized as follows:

- All users expressed a greater sense of social connection.
- ENSAFE is perceived as unobtrusive and does not negatively impact on daily life.
- Users are still somewhat unclear about how the sensor system contributes to their independence – they would like more visualization and insight into the data produced and how it is used.
- In its current state ENSAFE is not thought by users to be worth paying for. This attitude could change if users were given more insight into their ENSAFE data, and/or if a more advanced communications interface were available in Cuviva.
- Despite an overwhelmingly positive response to the system, there is still some concern among both users and care providers that ICT solutions might one day replace human contact and the personal side of health care.

3) Evaluation method and pilot organisation

Recruitment process

Iteration 1:

Users were recruited through the existing test bed environment in Norrköping, Sweden. After an initial session during which potential users were informed of ENSAFE's overall objectives, they were invited to a second session to learn more about the test phase itself, and to hear further details of what their participation in the evaluation of the ENSAFE technology would entail.

Seven users expressed interest in learning more about testing the system, and attended the second session. Two of these decided not to participate due to limitations imposed by their living conditions. In one case this was due to living with a spouse suffering from dementia. The other case was due to travel plans which would mean a lengthy absence during the test period.

In the end we had 3 users interested in testing the ENSAFE sensor network & Cuviva displays, and 2 users interested in testing the Go-Live Phone including Go-Live Wear.

Strictly speaking, the Swedish test group is composed of users from ENSAFE categories 1 and 2. This is a conscious decision for the first test iteration in order to receive constructive feedback from the users themselves, rather than from informal or formal care givers most likely connected to users in ENSAFE category 3 and most definitely connected to those in category 4.

All users are female, all are aged 85+, and all are living alone at home, with little or no formal care (from zero to twice a week). 4 of 5 have above average digital literacy, using iPads daily for things like email, browsing, video chat, social media and internet banking.

Iteration 2:

Formal care givers in the form of 4 carers employed by the local municipal home care service provider were recruited as users in Iteration II. The Cuviva platform was set up so that the end users' answers to the "How are you today?" screen generated text messages which were sent to the 24-hour standby mobile phone used by the home care team.

Four end users cared for by the home care service provider were invited to participate in testing.

Only three users turned up for the initial information session during which users were informed of ENSAFE's overall objectives, given information about the test phase itself, and provided with details of what their participation in the evaluation of the ENSAFE technology would entail.

After this session one user expressed concerns related to privacy and data-sharing. In combination with travel plans which would mean a lengthy absence during the test period, the user decided not to participate in ENSAFE testing.

Three new candidates were recruited by the home care team and invited to a similar information session. Two turned up and expressed an interest in being part of the testing. Unfortunately, just as the ENSAFE sensors and Cuviva display were due to be installed one candidate expressed

reservations and asked to withdraw from testing. The second candidate also withdrew from testing due to illness.

In the end we only had 2 end users involved in testing the ENSAFE sensor network & Cuviva displays during an 8-week test period.

The end users are in ENSAFE category 3, and have daily visits from formal care givers. Both end users are female, aged 90+, and living alone at home, with daily formal care. They have above average digitally literacy for their age, using a tablet or computer for things like email, web browsing, internet banking, and on-line shopping.

Discussion and conclusion

Iteration 1:

-We can be even clearer in communicating that we are in a test phase, and underline the expected presence of bugs/errors.

-Users express a desire for clearer instruction on what to do when errors occur (log it? call support? etc.)

-Current group of test users in Swedn are all ENSAFE category 1 and 2 – future tests should involve users who are not already active.

-We need to get relatives onboard early and involve them correctly next time.

Iteration 2:

The ENSAFE sensor system was found to be more or less unnoticeable and unobtrusive in day to day life. There were no feelings of being watched or monitored, and nor were there any feelings of increased security or independence. This would most likely change if users were given access to sensor data via a visual dashboard providing them with insight into their behavior and an understanding of how they may be able to change behavior to maintain their health and independence.

The Cuviva display is appreciated for its intuitive visual interface, and the fact that it is an interactive device. Users expressed benefits and joy at being able to communicate via text messages to formal care givers via the display. However, as active digitally literate users, they felt the pre-programmed messages to be somewhat limiting. They would like to be able to communicate more freely and in longer text messages.

4) Pilot synthesis

In this section we will seek to synthesise the pilot results described (mainly in a qualitative way) above, to find shared insights and common findings to steer the development of health care-oriented technology for older adults further.

1) ENSAFE level 1 and 2

The pilots conducted in the Netherlands and the United Kingdom, in total 80 participants, revealed the experience of users with technology designed for ENSAFE I and II. This technology mainly consisted of smartphone technology, extended applications, clinical sensors as peripherals and later on the newly designed application Ommetje.

In general, there was a high appreciation for learning new smartphone technology, and many people were very willing to start learning the technology. One reason was to keep up with technology, others aimed to prepare for the later stages in life.

The smartphone technology used, the GolivePhone, had a specific interface designed for older adults. And this was received with mixed feelings. It seemed new users did appreciate it in both the UK and NL pilots, however, for people with smartphone experience it meant learning something new, additionally, it was difficult for friends, family and peers to provide support. Our conclusion is to not design specific OS interfaces for older adults, but teach them the common standard.

Specific applications that were introduced, also needed to be explained to the older adults. Successful applications were the train application (in the Netherlands), and WhatsApp (for social contact). For these applications it is important that there is a strong motivation within the user to learn them, as experience in the pilot shows they are willing to learn. What helps is keeping these apps as easy to use as possible, which was later used in the ENSAFE and Ommetje applications designed as part of the ENSAFE system development. Providing clear contrasts, information on screen, and flat menu structures is recommended.

In particular WhatsApp was highly valued by the participants in the Netherlands, all users used this to a high degree, and they mentioned how their social connection with their friends and family improved. The UK participants also mentioned their social connection improved. However, sometimes errors were made in contacting people by accident, both in WhatsApp and the GoLivePhone alarm feature.

The more health-oriented features were highly valued and appreciated by the users, however we saw less dedication and willingness to learn how to use these features. Additionally, and specifically during the ENSAFE II pilot in both NL and UK, the scale and blood pressure systems presented difficulties. The systems were difficult to connect to the phones and caused technical errors. While the systems did help the participants to reflect on their health behavior, technical malfunctioning needs to be avoided at all time with such a user group. It causes the users to disregard the systems, and revoke their willingness to use it. However, for those that did not experience technical challenges, the clinical sensors were really appreciated and used consistently. The users could

imagine this to be a standard in the future, where their visits to the doctor could be reduced and attain one of the goals of ENSAFE.

In the development and evaluation of the walking application 'Ommetje' we used some of our findings above to develop a new type of health-oriented application. Rather than putting health at the forefront, social and personal motivators were used to increase healthy behaviour, just like participants showed in using WhatsApp. Ommetje was based on a dominant hobby among the user group: hiking, and the users that were into this really appreciated the design. While they preferred to record and share special hikes, the willingness to use the application was high. However, this application needed to be learned, and this took a couple of sessions. For sustainable behaviour change from this new type of health care intervention, the first explorative results are available, but more rigorous data is needed before we can generalize this.

2) ENSAFE level 3 and 4

In the study of the ENSAFE levels 3 and 4, the users mainly interacted with the home monitoring sensors provided by IT partners, and the Cuviva display, developed and provided by SE partners. The synthesis of this study resulted in the following insights.

Concerning the home monitoring sensors, users generally did not feel they were intrusive or that they intervened in their daily life, they were comfortable having them around in the house. *"The ENSAFE devices are perceived as unobtrusive and unproblematic, and they have no impact on the user's living environment." (participant Swedish pilot).* Both in the instances where they interacted with the technology and the display (SE), and in the instances where only the sensors were active (IT).

Participants in Sweden in particular expressed an interest in viewing their sensor data on the screen. However, the sensor system did not provide a clear insight as to the added value this would achieve for the care already provided.

The professional caregivers that interacted with the system mentioned something similar, it was unclear for them as to what the technological benefits of the system could be. However, the professional caregivers commented that the usability of the Cuviva and sensor system did not present any issues and it appeared easy and friendly to the nurses that used the it. The caregivers were highly appreciative of the system as it enabled them to feel closer to the patients and afforded them greater peace of mind.

In the Swedish pilot the participants interacted more actively with the display and the system. They appreciated the features it provided and felt more connected to their care providers. However, they felt that the interface was too simple, and more features could potentially be added, for example, allowing users to type their messages.

5) Discussion and Conclusion

In this document we summarize the pilot evaluation activities that took place as part of the ENSAFE project, to develop and evaluate the ENSAFE system to provide health care and behaviour change services to older adults. In this document we structured the field study setup in four levels, and covered qualitative results over two iterations, and synthesized them to inform the ENSAFE system user appreciation and usability, but also the design of applications and projects for this target in general.

The pilot evaluation, and related synthesis of the results, shows how important it is to involve the users throughout the development of new technologies and systems. Especially in the health care context, where systems are connected, multiple different stakeholders are involved and multiple perspectives need to be considered, developers and designers need to weigh their decisions and their practical implications through field studies. The results of this report provide insight in how to do that, but also provides concrete pointers how to design for older adults when aiming for health improvements and behavior change. There is a need for proper and easy to use, fail safe, design of the technology we put into place to improve health. This project provides a first and concrete step towards that goal.

Also involving the users in a coherent and pleasant way is important, their values and day-to-day life needs to be respected. Throughout the report you will find our technology and methods where perceived as non-intrusive, which is a great contribution of our pilot evaluation strategy. Often users where disappointed that they could not continue the user studies, even if they were critical about the technology at hand.

Finally, we found that learning is key aspect of technology design, especially when designing systems for an older target group. Often the design of a system is considered as is, and the way the technology should be introduced is not a part of the concept. This will result in family members or formal caregivers to interpret usefulness and usability of a system, creating a great liability in system adoption. With this work we illustrate that easy introduction of new technological concepts can increase the adoption greatly, and increases the appreciation by the users.

The concrete implications for the design are taken into account in the WP2 final service delivery and the WP4 business proposal.

6) References

Almirall, E., Lee, M., & Wareham, J. (2012). Mapping Living Labs in the Landscape of Innovation Methodologies. *Technology Innovation Management Review*, (September), 12–18.

Koskinen, I., Zimmerman, J., Binder, T., Redström, J., & Wensveen, S. (2011). *Design Research Through Practice From the Lab, Field, and Showroom*. Waltham, MA: Morgan Kaufmann.

Brankaert, R., den Ouden, E., & Brombacher, A. (2015). Innovate dementia: the development of a living lab protocol to evaluate interventions in context. *Info*, *17*(4), 40–52.

Hummels, C., & Frens, J. (2011). Designing disruptive innovative systems, products and services: RTD process. In D. A. Coelho (Ed.), *Industrial Design-New Frontiers.* (pp. 147–172).

Barnard, Y., Bradley, M. D., Hodgson, F., & Lloyd, A. D. (2013). Learning to use new technologies by older adults: Perceived difficulties, experimentation behaviour and usability. *Computers in Human Behavior*. https://doi.org/10.1016/j.chb.2013.02.006

Appendices

Appendix A - Informed consent.

Informed Consent for participation in an innovation project

Project Title: ENSAFE pilot participation

Statement of Consent

I have received oral and written information and know enough about the purpose and method to say yes to participating.

I give my consent to participating in the innovation project and have received written information about the project for my own use.

I give my consent ENSAFE project can use observations and recordings in an anonymised form in connection with the evaluation of the prototypes.

Execution of and information from the test will be handled confidentially and with respect for me as a participant.

I know that it is voluntary to participate and that I can withdraw my consent at any point.

Name: _____

[BLOCK LETTERS]

Date: _____ Signature: _____

Appendix B – two week questionnaire - subjective input

Evaluation survey: ENSAFE project

This questionnaire is intended for a two-weekly evaluation of the ENSAFE products.

What is your current opinion of the ENSAFE Technology?

☐ Very Negative ☐ Negative ☐ Indifferent ☐ Positive ☐ Very Positive

I would give it the following mark (1 – 10): _____

Motivate your answer: _____

_____

How often do you use the ENSAFE Technology on a daily basis? (This includes smart phone, scales, blood pressure etc.)

☐ Not at all ☐ 1 or 2 times ☐ 3 to 5 times ☐ 6 to 10 times ☐ More than 10 times

What do you use the Cuviva for and how frequently?

Please choose the appropriate response for each item:

	Not at all	Once a month	Once a week	Couple times a week	Daily
Taking phone calls	☐	☐	☐	☐	☐
Text messaging	☐	☐	☐	☐	☐
Video calls	☐	☐	☐	☐	☐
How are you? feature	☐	☐	☐	☐	☐
Activity tracking	☐	☐	☐	☐	☐
Fall prevention	☐	☐	☐	☐	☐
Guide Me home feature	☐	☐	☐	☐	☐
Emergency Calls	☐	☐	☐	☐	☐
Carer Contact	☐	☐	☐	☐	☐

Medication Reminder	☐	☐	☐	☐	☐
Puffell.com application	☐	☐	☐	☐	☐
Internet	☐	☐	☐	☐	☐
Whatsapp	☐	☐	☐	☐	☐
Take Photo/Video	☐	☐	☐	☐	☐
Games	☐	☐	☐	☐	☐
Voice Activated Commands	☐	☐	☐	☐	☐
Other (1) _____	☐	☐	☐	☐	☐
Other (2) _____	☐	☐	☐	☐	☐

In general, how easy do you find the ENSAFE Technology to use?

☐ Extremely Difficult ☐ Difficult ☐ So So ☐ Easy ☐ Extremely Easy

`

Make a comment on your choice here:

Are the health and data applications on the ENSAFE devices useful to you as an individual?

☐ Not At All ☐ A little ☐ Not Sure ☐ Quite Useful ☐ Extremely Useful

Make a comment on your choice here:

Does the Cuviva help you get better support?

☐ Not At All ☐ A little ☐ Not Sure ☐ Quite Useful ☐ Extremely Useful

Make a comment on your choice here:

Thank you for participating!

Appendix C – Discussion guide – final evaluation session

General introduction of the day

1. Cuviva evaluation (system, learning how to use it and setup)
    A. *Group round*: to ask how the overall experience with the GLP system and support track went (weekly support groups).
    B. *Super user structure*: How did the superuser structure work for you? Repeat it again?
    C. *GLP specific services*: Did the "how are you?", Bring me home and Help button work?
    D. *Service provision by Frank (Gociety)*: Did you get sufficient technical support?
    E. *Social impact and GoLiveAssist*: How did others around you respond to the smartphone? Did they benefit from you having the device?
    F. *Any other concerns*: Open discussion.
    G. Collect email addresses for data collection.
2. Research evaluation
    A. *Questionnaires*: Both introduction and bi-weekly questionnaires. Where they easy to understand/fulfil?
    B. *Probe 1:* Hobbies and leisure activities.
    C. *Probe 2:* Places around Leende and in the Netherlands
    D. *Probe 3:* Tips for the future self
    E. *Probe 4:* Social network
    F. Group round: which one did you prefer? And why?
    G. Sending probes vs group meetings vs one –on-one sessions?
3. Other aspects
4. Improvements to the system, potential new apps or changes in software.
5. ENSAFE future plans, open discussion
6. Closure (Gifts)