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ACTIVAGE PROJECT

ACTivating InnoVative IoT smart living environments for AGEing well

D9.6 Final results report & sustainability plan (I to IX)

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Abstract

We have reached the end of a challenging and rewarding journey, after 45 months of ACTIVAGE, this is the last report that aims at providing a taste of the huge work done by the teams at the local sites. This is a testimony of the more than 45 partners that have participated in this WP.

We started with 9 DS in 7 countries and we finish with 12 DS in 9 countries, having incorporated three new DS through the open call, and expanding ACTIVAGE vision and ecosystem to Portugal and Bulgaria.

We have been able to reach the target of deploying AHA-IoT solutions for more than 7.200 users, we hit the mark of 7.776 and almost 97% of the expected deployments.

All DS have been able to perform the evaluation, at local and global level, generating the evidence that ACTIVAGE vision is pertinent, relevant, and effective. Details are provided in the individual results and in D6.5.

By the end of the project, still 80% of participants continue operation, and almost all DS have in place sustainability plans to continue providing ACTIVAGE services in one way or another. Even in the cases where no clear plans have been possible, there are opportunities for exploiting the services and the knowledge gained in the project.

Statement of originality

This deliverable contains original unpublished work except where clearly indicated otherwise. Acknowledgement of previously published material and of the work of others has been made through appropriate citation, quotation or both.

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1 About This Document

This document is the final deliverable of WP9, reporting on the DS final results of the local experiments as well as the strategies defined at local level to ensure the continuity of the deployed solutions.

The goal of the document is to provide the reader with an overview of the performance of the DS in the different activities that implies a large scale pilot: from user recruitment, to deployment, operation of the solutions and local evaluation.

1.1 Deliverable context

Project item	Relationship
Objectives	(Main) Use cases, Services and Business Cases built, demonstrated, expanded, and grown is presented across all DS of 7 EU countries and also in respect to the 3 new DSs.
Exploitable results	This document contributes to the following exploitable results: - DS applications & services, as it provides evidence of the results of the DS applications and services deployed and the sustainability plans for its exploitation - Knowledge assets, as it provides results of the local evaluations carried out in each of the DS
Work plan	The deliverable is linked to all tasks in WP9 as it provides a complete view of the work performed in all of them It is also very relevant for WP6, as it contributes to the evidence generation of ACTIVAGE and also to WP8, with the sustainability plans of the DS:
Milestones	MS5 - Sustainability
Deliverables	Content of this deliverable has already been used as input for D6.5 White Book, as wel as D8.8 Innovation impact, D8.9 Socio-economic impact and D8.10 Exploitation report
Risks	

1.2 The rationale behind the structure

The deliverable dedicates chapter from 3 to 14 to the individual input of each of the 9 original DS plus the 3 new DS integrated from the second open call.

Chapter 2 provides a consolidated view at the level of LSP, aggregating, analysing, and highlighting the most relevant aspects of the overall content.

2 LSP overview of results

This chapter aims at providing kind of an executive summary of the huge amount of work performed by the local teams at the DS and reflected in the individual chapters. It is a challenge to consolidate the work and results achieved in a manageable size, so the indicators, highlights and conclusions here provided will not be exhaustive. For further details, please refer to the individual chapters.

2.1 Pilot deployment and operation

This section will address the indicators achieved in relation with the activities of pilot deployment and execution, making references to user recruitment, installations performed, devices installed, support and incidence management.

The following table and chart summarise the status of user recruitment per DS, compare with the targets defined in the DoA, it is worth mentioning that in some cases DS have set target only for older people (marked with * in the table), while in other cases the target included also informal and formal carers. During the DS experiment definition phase, some DSs have revised and updated their targets, while in other cases updates have been needed due to difficulties found at deployment time. When needed, concrete explanations are provided after the table.

Table 1: Number of users involved in the pilots

Pilots	Users recruited on 30/06/20	Targeted[1] (end project)	Progress[2] (%)
DS1 GAL	2518	700*	360%
DS2 VLC	1620	750*	216%
DS3 MAD	1029	1000	103%
DS4 RER	142	650[3] (150)	22% (95%)
DS5 GRC	1221	1000	205%
DS6 ISE	141	175*	81%
DS7 WOQ	179	150*	139%
DS8 LEE	457	1000	46%
DS9 FIN Turku	152	100*	159%
DS10 LIS	120	283	42%
DS11 SOF	117	50*	234%
DS12 BCN	50	100	50%
TOTAL	**7746**		

[1] According to DoA description, in some cases DS have set target only for elderly users, while in other cases the target included also informal and formal carers.

[2] Progress is calculated over the targeted number of users established in the DoA

[3] Due to the difficulties found in the identification and recruitment of patients, this target was already downsized to 150 users at the time of the first review meeting.

Concerning DS ISE, the panel involving KORIAN facilities was experiencing delays caused by the restrictions to deploy technology in a healthcare facility and the integration with the legacy systems. Despite the efforts, it has remained unsolved and it has decreased the user count.

Regarding DS LEE, the target set in the DoA was referred to both elderly citizens and formal and informal caregivers, however, difficulties have been found when trying to recruit informal carers. The planned number of elderly people, 350, has been reached but the number of relatives involved has been sensibly lower than expected, mainly due to cultural and liability concerns.

Finally, the new DS incorporated as result of the second Open Call, has started their implementation and were progressing according to the plans, but they were heavily impacted by COVID19 in terms of completing user recruitment and deployment, as it is reflected in the individual reports..

The target goal of users for ACTIVAGE was 7.200 users, and that goal has been accomplished, as we have reached a total of **7.746 users** that have been in operation in the different DS.

Overall, the number of users involved per DS in ACTIVAGE pilots is depicted in the following figure.

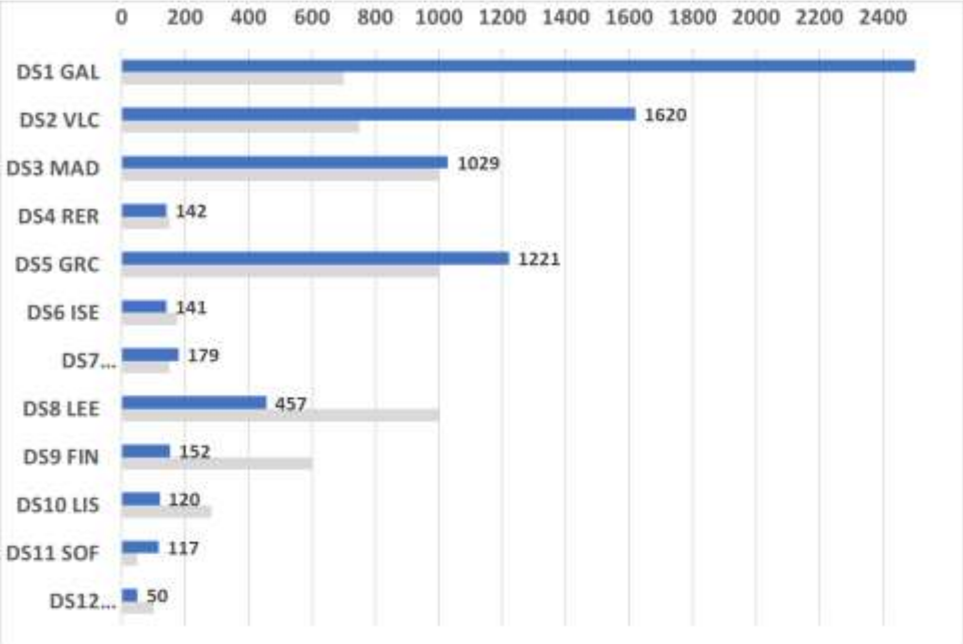


Figure 1: Number of users involved per DS in the ACTIVAGE pilots

Looking at the distribution between the categories of stakeholders that have participated in the project, we have the following

Table 2: Number of users involved in the pilots per user category

Pilots	Elderly	Informal carer	Formal carer	Other stakeholders
DS1 GAL	708	1121	218	471
DS2 VLC	547	1071	0	0
DS3 MAD	891	100	38	0
DS4 RER	55	55	31	1
DS5 GRC	946	275	0	0

Pilots	Elderly	Informal carer	Formal carer	Other stakeholders
DS6 ISE	77	0	51	13
DS7 WOQ	161	7	10	1
DS8 LEE	357	95		5
DS9 FIN Turku	140	0	10	2
DS10 LIS	30	30	60	0
DS11 SOF	71	15	12	19
DS12 BCN	34	6	6	4
TOTAL	**4017**	**2728**	**486**	**516**

We can also analyse the level of participation per RUC and DS. In the figure we can see which have been the final deployment of RUCs in the DS:

Table 3: Mapping of RUCs with DS

	DS 1	DS 2	DS 3	DS 4	DS 5	DS 6	DS 7	DS 8	DS 9	DS 10	DS 11	DS 12
RUC01 Daily activity monitoring	■	■	■	■	■	■	■	■		■	■	■
RUC02 Integrated care	■			■	■	■				■		■
RUC03 Health parameter monitoring	■									■	■	■
RUC04 Emergency trigger	■					■	■	■			■	
RUC05 Exercise promotion			■	■		■			■			
RUC06 Cognitive rehabilitation			■									
RUC07 Prevention social isolation	■		■	■		■		■				
RUC08 Safety and comfort at home						■						
RUC09 Mobility monitoring & active mobility									■			
RUC10 Notification of abnormal situation		■				■				■		
RUC11 Support for caregivers										■		

Although in some cases DS had to change the plans to deploy a RUC, all of them have been covered.

In the picture, we can see the volume of users per RUC, keeping in mind that the same person can use different solutions that address different RUCs.

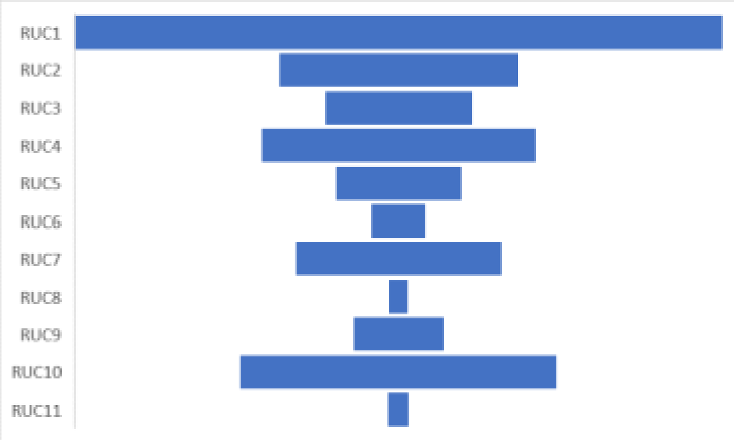


Figure 2: Quantity of users involved per RUC

As it was expected, daily monitoring is the most used, while the less experimented is safety and comfort at home.

For each DS a number of distinct installations is anticipated; an installation may include a single private home or other type of building facilities as well as personal environments. The table below provides an overview of the relevant progress made per DS.

Table 4: Number of current and targeted installations per DS

Pilots	Completed on 30/06/20	Targeted (end project)	Progress (%)
DS1 GAL	708	700	101%
DS2 VLC	547	525	104%
DS3 MAD	354	350	101%
DS4 RER	27	30	90%
DS5 GRC	430	452	95%
DS6 ISE	63	85	74%
DS7 WOQ	179	150	137%
DS8 LEE	357	350	102%
DS9 FIN Turku	10	5	200%
DS10 LIS	30	30	100%
DS11 SOF	36	50	72%
DS12 BCN	29	100	29%
TOTAL	**2735**		

The current distribution between the different types of spaces of the installations done is reflected in the following graph.

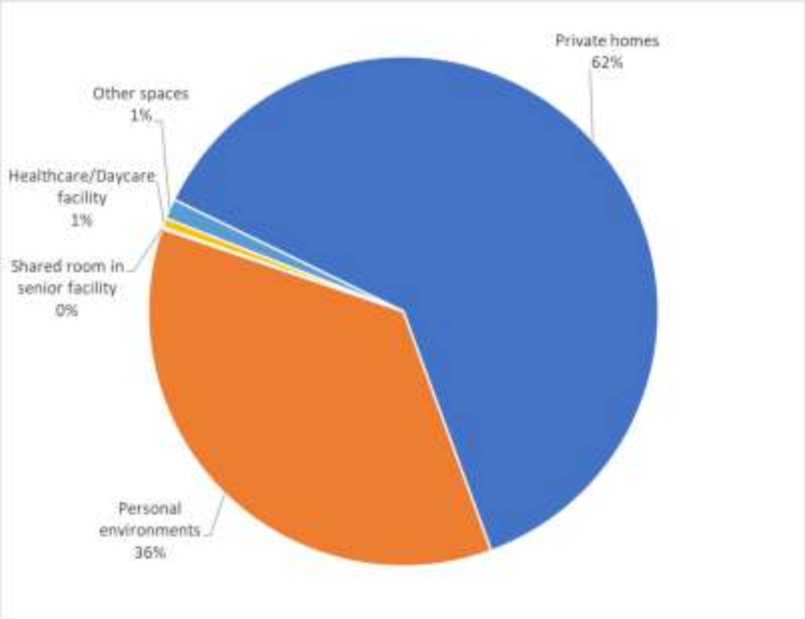


Figure 3: Distribution of environments in ACTIVAGE installations

Considering the overall project level, regarding **expected installations** to achieve by the end of the project, we have **reached the 99%.** The remaining installations correspond to DS that have experienced delays and problems and that had to redefine their original targets.

Looking at the IoT ecosystem deployed, we have registered overall **19.770 devices,** whose distribution is shown in the table below.

Table 5: summary of devices installed per category

DS	Gateways	Environment sensors	Wearables	Health / Alarm devices	Communication devices	User interface devices
DS1 GAL	708	1911	50	767	0	2
DS2 VLC	547	2735	124	0	0	1286
DS3 MAD	297	238	60	0	0	379
DS4 RER	0	101	0	15	27	0
DS5 GRC	319	1466	0	315	0	0
DS6 ISE	61	871	51	37	58	68
DS7 WOQ	233	3842	0	178	55	0
DS8 LEE	284	1340	357	0	0	359
DS9 FIN Turku	10	10	0	0	0	30
DS10 LIS	0	0	30	30	0	30

DS11 SOF	34	130	55	90	40	75
DS12 BCN	6	24	3	0	6	26
TOTAL	**2499**	**12668**	**730**	**1432**	**186**	**2255**

Finally, it must be pointed out the effort done to counteract the restrictions posed by the COVID19 pandemic and the lock-downs adopted in all participating countries that has limited the access to the elderly population, and in some cases shut down specific services that were provided in day care centres or elderly care settings. Despite the situation, by the end of the project we have most of DS in operation with some limitations. Details are provided in the following table.

Table 6: Number of users in operation by end of project

Pilots	Elderly	Informal carer	Formal carer	Other stakeholders
DS1 GAL	596	207	1,010	0
DS2 VLC	448	907	0	0
DS3 MAD	260	100	38	0
DS4 RER	44	44	0	0
DS5 GRC	562	0	5	10
DS6 ISE	0	0	0	0
DS7 WOQ	161	7	10	1
DS8 LEE	242	0	48	5
DS9 FIN Turku	0	0	0	0
DS10 LIS	15	15	60	0
DS11 SOF	37	10	9	17
DS12 BCN	29	6	6	5
TOTAL	**2394**	**1296**	**2482**	**38**

A total of **6.210 users** are still enjoying ACTIVAGE solutions, that means that almost an **80% of the participants** are continuing after the end of the project.

2.2 Guidelines for ACTIVAGE's replication and scaling-up

IoT-AHA Service sustainability, replication and scaling-up poses massive challenges due to several factors that can hinder market take-up. These main factors are mainly linked to the following main reasons:

- No willingness from public authorities to support the IoT-AHA service implementation and wider scalability,
- High costs to develop a running service,
- No users' confidentiality toward the new service,
- Infrastructural barriers (legal and technological)

In ACTIVAGE, the DSs have get around these obstacles by basing the future services sustainability plans **on a strong EVIDENCE** of the impact of the deployed solutions (ref. deliverable D6.5).

Additionally, since the project beginning DSs have strongly favoured and maintained a strong dialogue with local public authorities and local stakeholders, trying to solicit their interest by letting them steadily informed through a strong local dissemination activity. On top of this, advertising campaigns aimed at raising awareness among users have been constantly deployed in order to make them as much as possible confident with the new service regardless users' gender or age.

On top of this, Ethical and legal issues may be risky obstacles toward the service's replication and scaling-up. In ACTIVAGE, as it is provisioned for each research that concerns humans, project ethics' management was incorporated both in a. official documentations b. as well as actions as response to annual evaluation of ethical risks' management by the consortium.

During the whole course of the project, taking into account that compliance with GDPR is a constant process; two parallel activities have been conducted:

1. Continuity of the monitoring and re-assessment of the 'old' DSs and
2. Review of the legal and ethical process in respect to the new data usage and the prerequisites for data subjects' rights protection.

There was a long course starting from the letter of law interpretation, leading to the effective countermeasures use and fall-back plans development to mitigate potential threats/attacks in an IoT system and regular update of regulatory activities due to the diverse needs of different stages of the project.

The main three countermeasures used systematically before the crisis were the following:

- Strong and systematic collaboration of DSs Data Controllers and Data Processors with the ACTIVAGE Ethical Manager, to accelerate pending legal issues.
- Final elaboration of the ACTIVAGE data protection strategy (D3.9 Security and Privacy Report [M30] aligned with T1.4 results (Ethical and privacy protection), D1.10: D1.6.2: Ethical and Legal Report [M24], D1.11: Ethical and legal report [M36], D1.12:1.6.4 [M42], D1.13 [M45].

However, the unexpected outbreak of coronavirus on March 2020 brought additional considerations and needs to all DSs. In front of the lock down challenges, the maturity level acquired in ethics and legal issues handling according data management and governance along with the strategic methods of the project have been proven effective tools for the successful confrontation of this unexpected crisis.

In the following paragraph guidelines for IoT-AHA services replication and scaling-up are provided according to ACTIVAGE's experiences.

2.2.1 Deployment strategy – roadmap

IoT-AHA services replicability and scaling-up has to be planned since the service's designing phase. On top of this general consideration, there are some key actions that have to be implemented. According to the ACTIVAGE's DSs, below are reported the main steps to be undertaken:

1) **To engage stakeholders and decision makers since the service designing phase**; this is resulted in a key activity in order to understand their interest and needs thus driving the service development to address such needs. This has to be considered as an iterative process that continuously is going to drive the service evolution.

In ACTIVAGE, the strong stakeholders' engagement has been the base for services' replicability and scalability. Especially in those scenarios in which during the piloting phase needs have been really addressed, this has produced the replication of the ACTIVAGE's service in neighbouring municipalities and the scalability in terms of users' enrolment and services deployed; e.g. DS Galicia, DS Leeds, DS Valencia just for citing some of them (ref. D9.6)

2) **To adequately select UCs and objectives**; this process is strictly intertwined with the previous one and has to be driven by the identified stakeholders' needs. This process constitutes a further step for properly develop the service.
3) **To adequately deploy the service according to local determinants**; to deploy an innovative service is a critical moment that is affected by high costs. In order to avoid budget constraints, since the initial project phases, the ACTIVAGE DSs have considered specific activities aimed at reducing additional deployment costs. In particular, these activities mainly have been: **a) training activities** to DS's personnel and users in order to reduce waste of resources also during the installation phase, users' disaffection and consequential high drop-out rate. **b) Legal and ethical compliance** in order to smooth the overall deployment process, avoid legal constraints and barriers in later service deployment stages thus avoiding additional unexpected costs.
4) **To implement a solid service evaluation and impact analysis**; innovative services they can be unknown in terms of results and user acceptance thus preventing the service's market take-up. This issue can be avoided through the design and implementation of a specific evaluation framework (personalised according to the local ecosystem) able to provide decision makers and stakeholders with knowledge concerning the impact the innovative service can generate in terms of QoL, costs saving capacity and users' acceptance. To provide **EVIDENCE** towards the service's generated impact is one of the fundamental brick for driving decision making process toward service replicability and scalability.

In the ACTIVAGE's case, all the deployments phases have been monitored (ref. D9.6) in order to favouring as much as possible services sustainability in the medium-long run.

The implementation of the aforementioned steps have been translated into some specific successful stories in terms of IoT-AHA services replicability and scalability as reported below.

2.2.2 IoT-AHA replicability and scalability key successful ACTIVAGE's stories

Within ACTIVAGE three main replicability and scalability strategy have been recognised by the DSs (for major info refer to D9.6).

1) **Engagement with local decision makers in order to replicate the service in neighbour municipalities**: this is the case, among the others, of the Leeds DS in which the Shropshire municipality have been approached to roll out ACTIVAGE's assistive technology in Shropshire in the expand and grow phase of the project. At the time of writing ACTIVAGE for Shropshire has 234 users, 116 elderlies and 118 informal carers.
2) **Engagement with foreign stakeholders in order to replicate the service in different EU countries**: this is the case of the Galicia DS in which Televés reached an agreement with the Bavarian Red Cross to replicate and scale-up the DS-GAL daily activity monitoring UC in the German market. For the development of the pilot, 20 homes will be equipped with sensors that allow for the monitoring of people's daily activity, analysing their habits and routines to establish parameters that allow for the definition of potential risk situations, which will automatically activate the assistance resources, thus complementing the traditional emergency button.

3) **Service scaling-up in terms of users enrolled and refinement of the proposed service according to users' feedbacks**: this is the case of the DS-VLC in which the strategy for scaling-up is based on reaching new users and also new services. As for deploying new services, the pilot has allowed to identify improvements and new functionalities necessary to fulfil users' needs.

These are just insights of key success stories but all the ACTIVAGE DSs have worked to replicate and scale-up their own local deployed services in order to make the service and the ecosystem sustainable in the medium-long run.

3 DS 1 GAL final report

3.1 DS Experiment report

3.1.1 User engagement report

The DS-GAL has been piloted in **700 homes** and **2,314 users** (709 older adults, 1,605 caregivers and 266 professionals) and from installing 4,116 IoT devices, has led to the creation of a socio-health ecosystem in the community. The first one in Galicia (Spain).

The DS-GAL has been evaluating the impact of the new model incorporated in ACTIVAGE, for the provision of social and health services. One of the most important tasks that has been carried out is the coordination between the different services and the interdisciplinary actors that work together. Focus on older adults and their integral care.

In this period of the project, the DS-GAL pilot has evaluated the impact of a new model of social and health services provision, focusing on users over 60 years old, in some cases with chronic diseases, favouring the improvement of their quality of life and their permanence in their usual environment. To this end, the project has advanced in the integration of both health service platforms (home care, telemedicine, monitoring, etc.) and social services, and in turning the home into a point of care.

With the DS-GAL, ACTIVAGE has managed to put technology at the service of people, but without interfering in their daily lives. To this end, by means of wireless detectors, behavioral data and bio-measures are collected which allow risk situations to be detected (falls, decompensations, sleep problems, etc.) and also help with small tasks (medication reminders, memory exercises...). All the data collected is completely confidential and is used only for personalized decision making for each user.

Figure 4: DS GAL Ecosystem

3.1.1.1 DS-GAL users

Older adults living independently in the community were recruited into this study by word of mouth, the Ministry of Social Policy, training associations for older adults, the Spanish Red Cross and the doctors and nurses of the health centres.

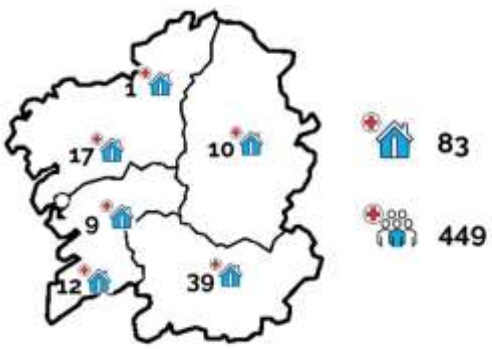
Participants were included if they were over 65 years of age. For AUC1.1 and AUC2 older adults would have to suffer from anticoagulated atrial fibrillation (ACAF). All eligible participants signed an informed consent form.

Figure 5: DS GAL users portrait

The health centres that have participated in ACTIVAGE have been 83 and 449 medical or nursing professionals.

By health areas the data are:

- 1 Health Centre in the area of La Coruña
- 10 Health Centres in the area of Lugo, A Mariña and Monforte
- 39 Health Centers in the area of Orense, Verin and Barco
- 9 Health Centres in the area of Pontevedra and Salnés
- 17 Health Centers in the area of Barbanza
- 12 Health Centres in the area of Vigo



3.1.1.2 Recruitment

Initially, many people were recruited. In order to reach 100% older adults in DS-GAL, we had to recruit 56% more older adults. To reach the target of 700 older adults, many recruitment tasks have been carried out to reach the target, which has led to an over-cost in recruitment.

The target of older adults to pilot ACTIVAGE on the DS-GAL was 700. To reach the goal, it was necessary to recruit 56% more older adults, that is, 397 additional older adults.

In total, 1,105 older adults have been recruited into the DS-GAL.

There have been several reasons for the older adults to participate in ACTIVAGE.

We could highlight two main reasons. The first one was to recruit the older adults and for them to spend several weeks before installing the solution in their homes. The second was that several older adults confirmed their participation to their nurse or doctor, but later changed their mind about participating.

In a smaller percentage, older adults who had signed the informed consent could not participate due to coverage problems in their homes, distrust of having devices installed in their homes, or changes of opinion because they considered that they were too young to need the telecare (all older adults were over 65).

The figures per RUC are as follows:

Table 7: DS GAL – Users recruited vs final user participation

		Older adults	Older adults who were recruited and have not participated	Total Older adult
RUC_01	Daily activity monitoring	106	8	114
RUC_02	Integrated care	154	202	356
RUC_03	Health parameter monitoring	138	163	301
RUC_04	Emergency trigger	260	18	278
RUC_07	Prevention of social isolation	50	6	56
		708	**397**	**1.105**

Table 8: DS GAL Total users recruited per category :

RUC	Elderly	Informal caregiver	Formal caregiver	Other stakeholder
RUC_01	114	7	222	22
RUC_02	356	104	282	449
RUC_03	301	89		449
RUC_04	278	17	567	22
RUC_07	56	1	50	22
TOTAL	**1,105**	**218**	**1,121**	**471**

3.1.1.3 Users

A total of **2,518 users** have participated in the DS-GAL.

The number of older adults who have piloted the ACTIVAGE solution in the DS-GAL is 708. And the number of formal and informal caregivers who have officially participated is 1810.

Although we know that there are many other caregivers who have been monitoring and caring for older adults through the ACTIVAGE solution.

The figures of users who have finally participated by RUC are as follows:

Table 9: DS GAL User participation per category :

		Older adults	Formal Caregivers	Informal Caregivers	Professionals
RUC_01	Daily activity monitoring	106	7	222	22
RUC_02	Integrated care	154	104	282	449
RUC_03	Health parameter monitoring	138	89		449
RUC_04	Emergency trigger	260	17	567	22
RUC_07	Prevention of social isolation	50	1	50	
		708	**218**	**1.121**	**471**

Table 10: DS GAL Total number of facilities confirmed

RUC	Private homes	Personal environments	Shared room in senior facility	Healthcare/Daycare facility	Other spaces
RUC_01	106				
RUC_02	154				
RUC_03	138				
RUC_04	260				
RUC_07	50				
TOTAL	**708**				

To these figures must be added 40 informal caregivers who have signed the informed consent to participate in ACTIVAGE, but finally, due to coverage problems, it has not been possible to carry out the installation in the home.

3.1.1.4 Socio-demographic profile

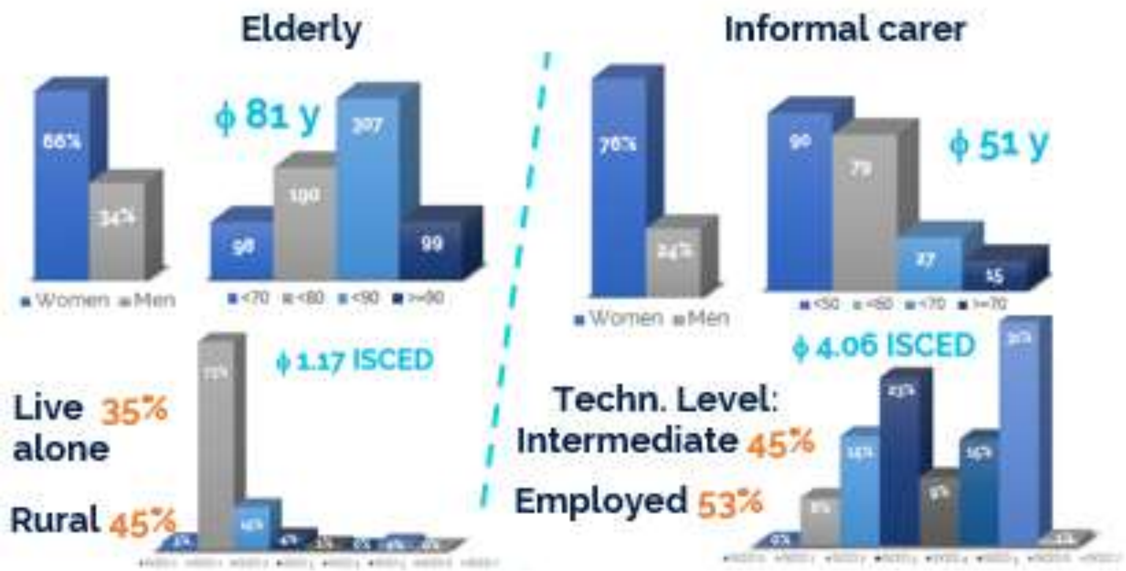


Figure 6: DS GAL socio-demographic profile

More than 12 carers are over 90 years old.

3.1.1.5 Legal & Ethical

The DS-GAL worked on the ethical and legal aspects. It complies with the GDPR. All older adults signed informed consents.

The health study has been approved by the Clinical Research Ethics Committee of Galicia (CEIC).

The CEIC approves RUC3-Clinical monitoring at home in January 2018 and RUC2-Integrated care for people with chronic diseases in March 2018.

Registration of the Spanish Red Cross personal data file with the Spanish Data Protection Agency has taken place.

3.1.1.6 Support of government authorities

Televés Corporación sitúa a Galicia en vanguardia de la teleasistencia en Europa

Setecientos hogares con mayores de 60 años participarán en el piloto de Activage, casi el 10 % del total en 7 países de la UE

POR LA IZQUIERDA Sebastián Pantoja, director de I+D de Televés, y Santiago Rey, director general de la corporación empresarial; los conselleiros Vázquez Almuíña y Rey Varela, la directora de la Amtega, Mar Pereira, y la edil Concepción Fernández. - FOTO: F. Blanco

Televés colabora nun sistema aberto de IoT para mellorar a calidade de vida dos maiores

Televés acolleu o arranque da fase piloto de Activage Galicia, proxecto TIC a prol do envellecemento activo

xoves, 16 de novembro do 2017 | Fernando Sarasketa

As instalacións da Corporación Televés, en Compostela, acolleron onte a posta en marcha da primeira proba piloto dun ambicioso proxecto europeo de I+D+i destinado a crear solucións concretas a prol da saúde na terceira idade e o envellecemento activo. Estamos a falar do proxecto Activage, no que participan Televés, Cruz Vermella, a Fundación Vodafone España, a Universitat Politècnica de Valencia e mailo Servizo Galego de Saúde (SERGAS), contándose coa colaboración da Axencia para Modernización Tecnolóxica de Galicia (AMTEGA) e a Fundación Tecsos. O

Figure 7: Government support exhibit

3.1.2 IoT infrastructure deployment

3.1.2.1 ACTIVAGE Solution

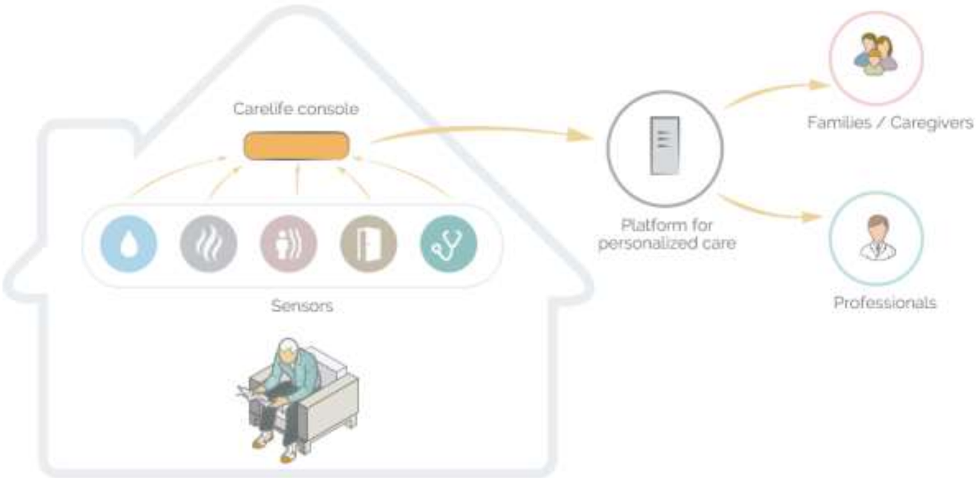


Figure 8: DS GAL ACTIVAGE solution concept

ACTIVAGE is a complete care system with tailored solutions to each need. It provides a complete personal vision: Medical, Social and Technical. It consists of a telecare platform for professionals and families/caregivers where an ecosystem of IoT devices can be connected according to the user needs.

Figure 9: DS GAL IoT Ecosystem

The IoT system installed in each participant's home, consisted of commercially available devices that transmit the data to a gateway, which connects directly to health systems (EHR) and social systems.

The older adults have been monitored with this IoT solution since their incorporation into the program. The older adult who has been in the program the longest has been 21 weeks, and the one who has been in the program the shortest has been 4 weeks.

Through an intelligent system based on telemonitoring, the health and well-being of a person was analysed autonomously, generating reports and automatic alerts when anomalous situations were detected.

The sensors installed in the user's environment allow the system to monitor and analyse the daily routine of a person, generating basic information for their care. Additionally, the solution incorporates a panic button, which allows for comfortable hands-free communication with the older adult.

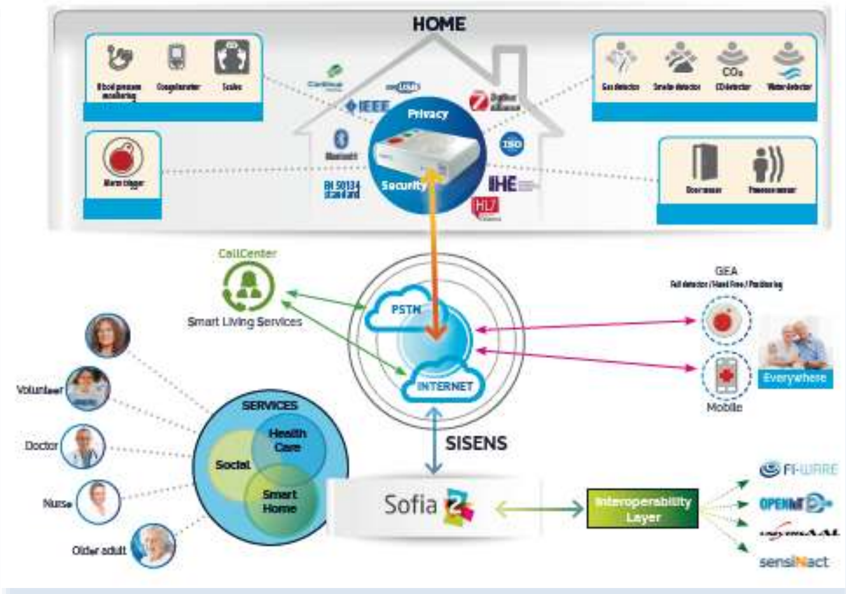


Figure 10: DS GAL ACTIVAGE solution architecture

The system collected data from:

- Motion sensor and door opening sensor. Data on changes in mobility, lack of movement, sleep disturbances, eating disorders, unusual use of the bathroom are collected through wireless sensors that were placed in different rooms of the home and at the main entrance to the house and the refrigerator door.
- Medical devices: Medical information such as blood pressure, body mass index is collected by collecting weight and height, and blood clotting level (INR).
- Emergency button, which not only alerts you to times of emergency, but also covers another need that has been detected, which is the need for some people to talk to someone, thus avoiding social isolation. By pressing the button, the user connects directly with the specialised staff of the Spanish Red Cross call centre.
- Technical alarms for CO, smoke, gas (natural or propane) detection, which generate an alert to the Spanish Red Cross call centre.

All DS-GAL installations have been carried out in private homes.

3.1.2.2 Pre-Pilot

The first installation took place on January 12, 2018.

We carried out an exploratory observational study over a 21 weeks period. At baseline, participants completed a lifestyle questionnaire to document information on demographics, socioeconomic status, and lifestyle behaviours. Validated questionnaires were also completed to document information on health related quality of life (EQ_5D_3L) or the impact of providing informal care on carers (CarerQoL 7D).

- Living Lab: UC2 virtual user installed in Televés ShowRoom
- Technical testing: 35 installations running during 21 weeks
- Aiming at technical performance assessment. ~1,446 hours

3.1.2.3 Pilot

The installations carried out are as follows (700 installations, 2.518 users & 4.274 devices):

- 138 older adults in AUC1.1 - Clinical home monitoring (target: 110)
- 106 older adults in AUC1.2 - Monitoring of daily activity (target: 100)
- 154 older adults in AUC2 - Integrated care for chronically ill people (target: 140)
- 260 older adults in AUC4 - Emergency button with technical alarms (target: 250)
- 50 older adults in AUC7 - Prevention of social isolation (target: 50)

Figure 11: DS GAL Distribution of installations

The end date of the pilot was 31/12/2019.

The DS-GAL pilot has been maintained to the date of this document while the sustainability of the solution is being studied with the service providers.

As of the date of this document 596 older adults are still active today.

Most drop-offs were due to death or because the older adults were admitted to residential care homes.

Table 11: DS GAL distribution of installation per type of environment

RUC	Private homes	Personal environments	Shared room in senior facility	Healthcare/Daycare facility	Other spaces
RUC_01	106				
RUC_02	154				
RUC_03	138				

RUC_04	260				
RUC_07	50				
TOTAL	**708**				

Installation time

The time for deployment of the motion and door opening sensors per household was 90 ± 30 minutes. The time for deployment of the medical devices (1 x tension meter, 1 x scale and 1 x coagulometer) was 15 ± 5 minutes. The time for deployment of the technical alarm sensors per household was 40 ± 10 minutes.

Pairing devices (motion sensor, door opening sensor, technical alarm sensors, panic button, medical devices) with the gateway, element and server logging, software updates) prior to the installation visits reduced installation time by -35 ± 10 minutes.

Installation AUC1 & AUC2	Installation AUC4	Installation AUC7
Average time 90 min. Average nº of devices per installation: 12 + gateway. Total nº of installations: 398.	Average time 40 min. Average nº of devices per installation: 5 + gateway. Total nº of installations: 260.	Average time 40 min. Average nº of devices per installation: 2 + gateway. Total nº of installations: 50.

Before deployment, the devices were preconfigured to minimize the deployment time per session. This involved the configuration of:

- Gateway
- SIMCard
- Storage server for information
- Spanish Red Cross Alarm Receiving Centre
- Devices
- Registration of medical devices on the IoT SOFIA2 platform

An installation guide was prepared that included the configuration for each AUC.

When accessing from the Galician Health Service (SERGAS) to the CareLife monitoring application (to which all non-medical devices report), there was an access problem due to the security policy of SERGAS servers.

To solve this problem, a domain was enabled with a secure certificate that allowed access to the application from all the Health Centers.

Main characteristics of installed devices and examples of real installations are provided below.

Table 12: DS GAL Gateway devices and their main characteristics

Name	Description	Supplier (brand) + Model	Number of Units Per user home	Device Type(s)
Carelife	This Aggregation point allows the data gathering from devices using different protocols. The aggregated data is sent to Internet through – The Router /modem (Gateway connect the AP via Ethernet) – 3G/4G connection	Televes Gateway "Carelife"	1 x home	Aggregation Point
ADSL Gateways	The aggregated data is sent to Internet through this Router/modem Gateway	Telecom Provider	1 x home	Gateway

Table 13 DS GAL Devices main characteristics

Name	Description	Supplier (brand) + Model	Number of Units	Device Type(s)
Presence sensor	Indicates the presence of people	Televes.	4 per home	Sensor Node
Door opening	Indicates the Door state (open/close)	Televes	2 per home	Sensor Node
Weighing scale	Indicates people weight.	A&D UC-352BLE	1 per home	Healthcare device
Tensiometer	Indicates the blood pressure	A&D Medical UA-651BLE	1 per home	Healthcare device
Coagulometer	Indicates levels of clotting factors in the blood.	Roche CoaguChek	1 per home	Healthcare device
Emergency push button	Indicates emergency call	Televes	1 per home	Sensor node
Smoke detector	Indicates presence of smoke	Televes	1 per home	Sensor node
CO Detector	Indicates presence of CO	Televes	1 per home	Sensor node

Table 14: DS GAL distribution of devices per RUC

UC	Nº of sensors	Wireless sensor	Sensor Placement	Measurements
RUC3	1	Blood Pressure Meter	Close to gateway	Blood Pressure (Systolic, Diastolic, MAP) (decimal)
RUC3	1	Scale	Close to gateway	Weight (decimal)
RUC3	1	Coagulometer	Close to gateway	Blood clotting level (INR) (decimal)
RUC1	4	Motion sensor	1 x bedroom 1 x living room 1 x kitchen 1 x bathroom	PIR (binary)
RUC1	2	Door opening sensor	1 x front door 1 x fridge door	Open/close (binary)
RUC1	1	Emergency button	In body person	Call (binary)
RUC2, RUC4	1	Blood Pressure Meter	Close to gateway	Blood Pressure (Systolic, Diastolic, MAP) (decimal)
RUC2, RUC4	1	Scale	Close to gateway	Weight (decimal)
RUC2, RUC4	1	Coagulometer	Close to gateway	Blood clotting level (INR) (decimal)
RUC2, RUC4	4/5	Motion sensor	1 x bedroom 1 x living room 1 x kitchen 1 x bathroom	PIR (binary)
RUC2, RUC4	2/3	Door opening sensor	1 x front door 1 x fridge door	Open/close (binary)
RUC2, RUC4	1	Emergency button	In body person	Call (binary)
RUC4	1	Smoke sensor	In the living room	Alert (binary)
RUC4	1	Natural/Propane gas sensor	In the kitchen	Alert (binary)
RUC4	1	CO sensor	In the bedroom	Alert (binary)
RUC4	1/2	Emergency button	In body person	Call (binary)
RUC7	1	Emergency button	In body person	Call (binary)
RUC7	1	Smartphone	In body person	Call (binary)

The average number of presence sensors installed in a home is 5. We have found many homes in rural areas with two floors. In these cases, it was necessary to install more presence sensors to cover all the rooms of the home. The same case has occurred with the door opening sensors. In many rural homes, they have another door that leads to the vegetable garden, or to the exit to the garden. In these cases, more door sensors have had to be installed.

Another factor that has had to use more door opening sensors, was because the refrigerators that have many older adults, are old. These coolers do not hold the glue well enough to attach the two parts of the door opening sensor. In these cases, the maintenance service has had to go and fit another sensor in a different way.

Devices installed

The following table shows the devices installed in the DS-GAL:

Gateway	700
Blood Pressure Meter	255
Scale	257
Coagulometer	255
Door opening sensor	322
Presence sensor	631
Smoke detector	343
CO detector	339
Gas detector	276
Emergency button	495
SmartPhone	50
Others	213

Total: 4. 274 Devices

Figure 12: DS GAL summary of devices installed

Table 15: DS GAL devices installed per category

RUC	Gateways	Environment sensors	Wearables	Health / Alarm devices	Communication devices	User interface devices
RUC_01	106	636				2
RUC_02	146	584		401		2
RUC_03	138					2
RUC_04	260	691		366		2
RUC_07	50		50			2
TOTAL	**708**	**1,911**	**50**	**767**		**2**

3.1.3 Experiment running report

3.1.3.1 User participation

Older adult ACTIVAGE inclusion criteria

Since The first installation took place on January 12, 2018 a total of 733 older adults have been added to the DS-GAL.

The criteria for an older adult to be considered an ACTIVAGE older adult are as follows:

- Meet the inclusion criteria described by each AUC
- Sign the informed consents and other informative documents about the installation.
- Installation of the ACTIVAGE solution in the home
- Stay at least 3 months using the solution.

Of the 733 older adults who have met these requirements, 25 of them have not been on the project for 3 months.

The reasons for dropping have been:

- Communication problems (1)
- Death (7)
- Decision of the professional (6)
- Income in residential care home (4)
- No conformity with the devices (3)
- Patient's decision (2)
- The city council has granted him the basic teleAssistance service of the regional government of Galicia (2)

Training

The DS-GAL trained 708 older adults and more than 1,121 informal carers and more than 484 formal carers have been trained.

Training has been carried out as follows:

- Face-to-face training for health and social professionals. The training was carried out in a cascade fashion. From the leaders of the DS-GAL, the directors of SERGAS and CRE were trained. And they trained the following. Thus, training has been provided to all social and health professionals.
- Classroom training for older adults in planned training sessions.
- Training has been carried out in the home, and by telephone to many caregivers.

The benefit of a personalized intervention:

Figure 13: DS GAL user training exhibit

Older adults in ACTIVAGE

The drop-offs of the older adults who enter the project are mainly due to death or institutionalization in residential care homes.

The older adults and the caregivers have demonstrated their interest in continuing with the solution after the pilot, as it is shown in the below table with the number of users still using the solution.

Table 16: DS GAL number of users in operation by 30th of June.

RUC	Elderly	Informal caregiver	Formal caregiver	Other stakeholder
RUC_01	93	7	209	
RUC_02	118	96	241	
RUC_03	100	87		
RUC_04	235	17	510	

RUC_07	50		50	
TOTAL	**596**	**207**	**1,010**	

Drop-off

The drop-offs recorded as of the date of this document amount to 112. Most of the older adults have left ACTIVAGE, due to a change in clinical pathology (decision of the clinical professional), due to death or have had to leave their home to go to a Residential Care Home because their health had deteriorated.

The reasons for dropping off have been by 30th of June:

Reasons for drop-offs	Number of drop-offs
Change of address (they've gone to live with a son)	10
Death	43
Decision of the professional	20
Income in Residential Care Home	11
No conformity with the devices	6
Older adult's decision	18
The city council has granted him the basic teleAssistance service of the regional government of Galicia	8

Distribution per stakeholder and RUC

The final involvement of stakeholders in DS GAL is shown in the following tables:

Table 17: DS GAL stakeholders participation per category

Authorities	Overarching authority	9
Assistance Providers	Healthcare providers	449
	Social providers	22
Technology providers	Deployers	11
	IT providers	16
	monitoring devices providers	10
	Application providers	15
Developers	Research institutions	5
End Users	Assisted persons	708
	Caregivers - formal	218
	Caregivers - informal	1.121
		2.584

Table 18: DS GAL distribution per RUC

		Older adults	Formal Caregivers	Informal Caregivers	Professionals
RUC_01	Daily activity monitoring	106	7	222	22
RUC_02	Integrated care	154	104	282	449
RUC_03	Health parameter monitoring	138	89		449
RUC_04	Emergency trigger	260	17	567	22
RUC_07	Prevention of social isolation	50	1	50	22

Average usage level of the solution per RUC

The use of ACTIVAGE by older adults is 24 hours a day, 7 days a week.

The only exception is older adults associated with RUC_03 Health parameter monitoring. These older adults collect their clinical variables on average once a month according to medical prescription. Some older adults collect them more frequently, according to their self-care condition or medical prescription.

Table 19: DS GAL average usage of ACTIVAGE solution

		Older adults	Formal Caregivers	Informal Caregivers	Professionals
RUC_01	Daily activity monitoring	7x24	7x24	7x24	7x24
RUC_02	Integrated care	7x24	7x24	7x24	7x24
RUC_03	Health parameter monitoring	30 min/month	30 min/month		30 min/month
RUC_04	Emergency trigger	7x24	7x24	7x24	7x24
RUC_07	Prevention of social isolation	7x24	7x24	7x24	7x24

3.1.3.2 Operational effectiveness

The solution is a mature one and this has been demonstrated by the number of issues reported by the DS-GAL service providers, the Galician Health Service and the Spanish Red Cross.

With the piloting of the solution the number of issues has been decreasing and the solution for older adults and caregivers has stabilized.

Below is the number of issues received by the technical department. The average response time to requests/consultations from end users has been less than 12 hours.

Table 20: DS GAL technical incidences received

		Jun.18 - Dec.18		Jan.19 - Jun.19		Jun.19 - Dec.19		Jan.20 - Jun.20	
		Older adults	Issues	Older adults	Issues	Older adults	Issues	Older adults	Issues
RUC_01	Daily activity monitoring	73	21	106	6	106		106	
RUC_02	Integrated care	1		119	23	148	4	148	
RUC_03	Health parameter monitoring	116	24	136	15	136	3	136	
RUC_04	Emergency trigger	182	42	253		260		260	
RUC_07	Prevention of social isolation	--		2		50		50	

The percentage of resolution of the issues has been 100%.

In all cases, less than 24 hours have passed from the time a problem is reported to the time ACTIVAGE successfully addresses it (a workaround is provided).

Jun.18 - Dec.18	0,23 issues per older adult
Jan.19 - Jun.19	0,07 issues per older adult
Jun.19 - Dec.19	0,01 issues per older adult
Jan.20 - Jun.20	0 issues per older adult

3.1.3.3 Services & Apps in use


:

Figure 14 DS GAL App for Spanish Red Cross Service

Figure 15: DS GAL App for informal / formal care giver

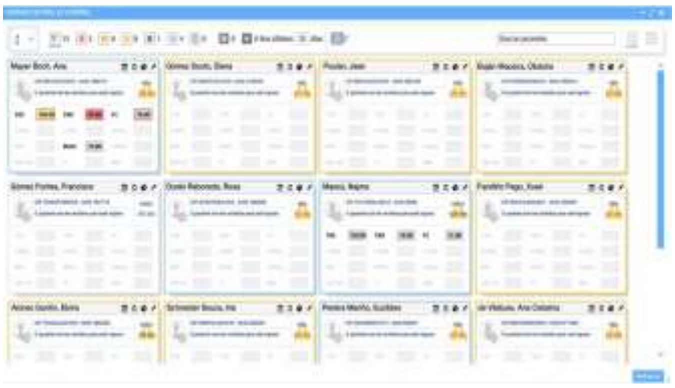


Figure 16: Home telecare platform integrated with EHR

3.1.3.4 Releases

Since the pilot started in 2018, 3 releases had to be released that affected the sending of information to service providers.

Version 01.02.012 was deployed in October 2018 and addressed the following improvements:

- Improvements in linking health devices:
- Improved internal battery management

Version 01.02.013 was deployed in February 2019 which addressed the following improvements:

- Update of the SOFIA2 certificate of the SERGAS in the gateways.

Version 01.02.014 was deployed in June 2019 which addressed the following improvements:

- Improvements in sending measurements to the SOFIA2 IoT platform

At the same time, different versions of the platform have been released for the care of older adults, professionals and caregivers/relatives, to improve the usability of the application and addressing various features requested by service providers and users in general.

3.1.3.5 Use case exchange report

DS-GAL import subservice DSGRC_SBSRV_E_1: Vital parameters monitoring of Blood Pressure and glucose from DS-GRC service A from DS-GRG.

- Description: Measurement of vital parameters such as BP and glucose. All the data are collected in a transparent way by the IoT infrastructure deployed in the home. Then the information is analysed in the background and a set of results is produced. These results can be seen by the health professional.
- Service related: DSGRC_SRV_E.
- RUCs: RUC_02, RUC_03, RUC_11.
- Data collected: Blood pressure and glucose sensors.
- Assisted persons inclusion/exclusion criteria: Users must have blood pressure and glucose sensors at home and internet.
- Main beneficiaries: Formal and Informal caregiver.
- Devices: FORA D40b blood pressure/blood glucose device, Raspberry Pi 3 Model B+, Power supply for Raspberry Pi, Plastic case for Raspberry Pi, Memory card microSD. Bluetooth adapter.

DS-GAL export subservice DSGAL_SBSRV_C_6: Biometric alarm out of range. Management of biomeasures within the permitted ranges to DS-GRG.

- Description: Management of biomeasures within the permitted ranges.
- Service related: DSGAL_SRV_C
- RUCs: RUC_02, RUC_10, RUC_11
- Data collected: Biometric alarm out of range
- Assisted persons inclusion/exclusion criteria: Users must have an advanced clinical and social telemonitoring system.
- Main beneficiaries: Older adults and informal/formal caregiver and healthcare professionals

- Devices: Blood Pressure Meter, Scale and Coagulometer.

The UC exchange has been carried out with fictitious older adults, exchanging the information collected by the IoT devices from the DS-GAL to the DS-GRC and vice versa.

Specific data:

- Types of apps imported: DS Greece has a universAAL native application that provides the heart rate assessment service. This service is imported to DS Galicia.
- Advantages of these apps vs current apps (summary) - The health monitoring application in DS GAL only monitors the heart rate values of a user, the heart rate assessment is a service that complements this monitoring providing assessment about risky or abnormal rates.
- Platform A SOFIA2 (DS Galicia)
- Platform B universAAL (DS Greece)

3.2 Local evaluation report

3.2.1 Evaluation

The evaluation has been a continuous, dynamic and systematic process, focused on the collected aspects of the quality of life of the older adult, and it has served to verify the achievements in terms of the proposed objectives. We have not worked on an exact measurement, but a value judgment that takes place thanks to a quantitative and/or qualitative measurement.

Televés has standardized the information collected by CRE and SERGAS on a monthly basis.

Carrying out the tasks of analysis, review and sharing with WP6 and WP9.

The information collected from the different questionnaires, or qualitative information from meetings and contacts with older adults, was reported monthly to WP6 and WP9, as well as uploaded to the ACTIVAGE information collection tool developed by the UPM (DS evaluation LSP dashboard).

3.2.1.1 Data collection

The data collection process in DS-GAL is as follows:

When an older adult joins ACTIVAGE, CRE & SERGAS make a phone call to the older adult where the following data is collected:

- Demographic data
- Caregiver (formal or informal)
- Global KPIs
- Quality of Life Questionnaire (EQ-5D-3L)
- UCLA (if the older adult participates in UC6 or UC7)

After that, a telephone call is made to the caregiver:

- Demographic data caregiver

- Quality of life questionnaire (CarerQoL-7D)

When the adult Older has been in ACTIVAGE for 6 months, they are called by telephone to complete the following questionnaires:

- Global KPIs
- Questionnaire of service acceptance and user's satisfaction (UT-UAT)

One year after participating in the project, the final evaluation is carried out:

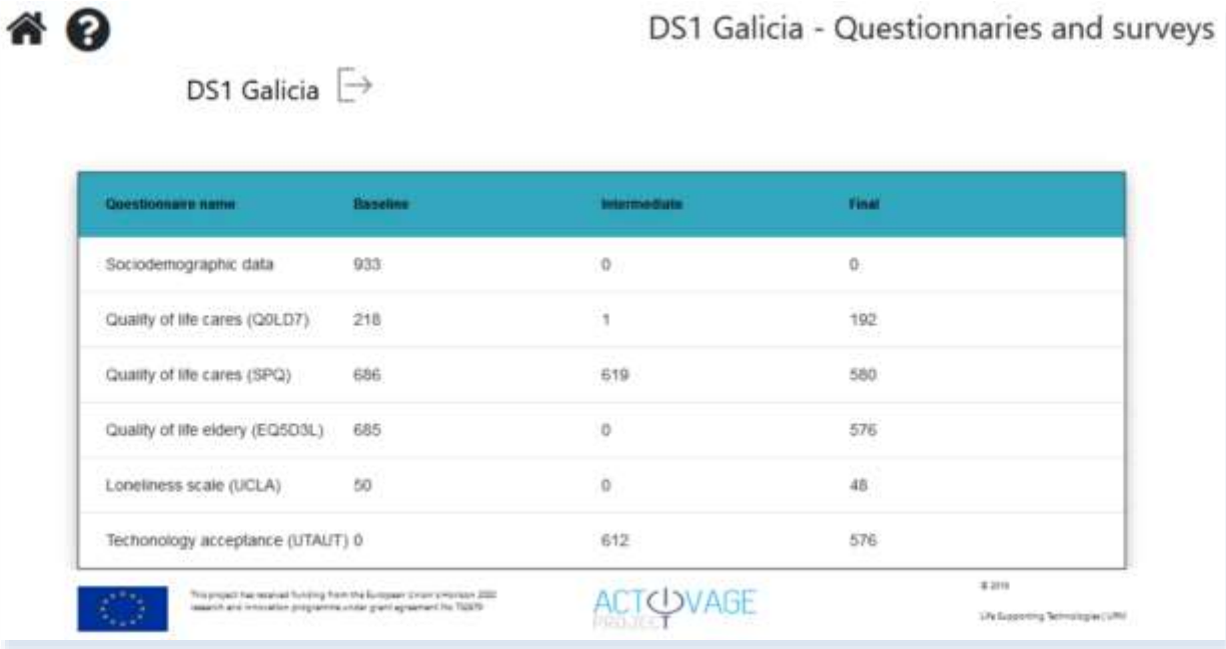
- Global KPIs
- Quality of Life Questionnaire (EQ-5D-3L)
- Quality of life questionnaire (CarerQoL-7D) (through a call to caregivers)
- UCLA (if the older adult participates in UC6 or UC7)
- Questionnaire of service acceptance and user's satisfaction (UT-UAT)

Feedback questionnaires were completed by the participants to document information relating to the user acceptability.

In data:

- 933 sociodemographic data have been collected from older adults and caregivers.
- 411 caregiver load questionnaires (CarerQoL7D) have been completed for caregivers
- 1,885 Quality of Life questionnaires have been carried out through the global questionnaire defined in ACTIVAGE (ACTIVAGE Global Questionnaire) to older adults
- A total of 1,261 Quality of Life (QOL) questionnaires (EQ-5D-3L) were administered to older adults.
- 98 evaluation questionnaires of the Loneliness Scale (UCLA) have been made to older adults
- 1,188 Acceptance and Use of Technology (UTAUT) questionnaires have been administered to older adults

A total of 5,776 questionnaires have been completed in the DS-GAL for older adults and caregivers.



Questionnaire name	Baseline	Intermediate	Final
Sociodemographic data	933	0	0
Quality of life cares (QOLD7)	218	1	192
Quality of life cares (SPQ)	686	619	580
Quality of life eldery (EQ5D3L)	685	0	576
Loneliness scale (UCLA)	50	0	48
Techonology acceptance (UTAUT)	0	612	576

Figure 17: DS GAL LSP Dashboard

With regard to IoT data collected, this is a summary of the events collected through the IoT platform.

18,787	4.315.600	113.080	132.400	307	136
Clinical data collected	Presence detection	Door opening detection	Door close detection	Emergency button calls	Alarms (CO/ smoke/ gas)

Below are the events collected during the DS-GAL pilot:

- 28,337,306 events collected
- 271.06 events/month/housing
- 1.8 MB person/month data

3.2.1.2 Local KPIs

ACTIVAGE provides personalized intelligent services to users. The information collected from existing sensors, profiles, ontologies specific to the standard application domain, which will produce rich key performance indicators (KPIs) to provide a contextual and personalized view to evaluate the perception questions and support professionals in the real understanding of the process.

To do this, it is necessary to provide a new KPI framework that provides richer and more understandable indicators. To this end, DS_GAL has defined the following key performance indicators (KPIs). KPIs aim at creating process-based indicators by providing human readable and contextualized key performance indicators.

In order to achieve this overall objective, the following specific objectives have been identified:

- **Impact on QoL**
  - Improve the quality of life of the users (Initial and final)
  - Reduce the workload for the caregiver
  - Achieve a high value of user satisfaction (Daily activity monitoring): installation, monitoring, personal attention ... (monthly)
  - Increase the level of users with the intention of remaining high
  - Increase the level of caregivers with intent to remain high
  - Increase global average satisfaction
  - Improve socio-health care through monitoring
  - Quality of life
  - Impact of the IoT solution on your Quality of life
- **Innovation**
  - Decrease social isolation
  - Satisfaction of the IoT solution
  - Daily usage of the IoT solution
- **Sustainability**
  - Maintain a low level of voluntary desertion decisions due to dissatisfaction with service/total desertion decisions.
  - Reduction of number of access to the Hospital emergency services.
  - Reduction of number of access to the PAC (Point of continuous attention) emergency services.
  - Reduce the number of visits to primary care physicians.
  - Reduce the number of visits to primary care nursing visits.
  - Reduce the number of home visits in primary care.
  - Reduce the number of hospital admissions and the number of days in hospital.
  - Average time (in seconds) of response of operator to a call, once it has entered the ARC.
  - Average time (in minutes) from a call to the ARC to the mobilization of the specialized resource (firefighters, security forces, ambulances, health services, etc.).
  - Average time (in minutes) from a call to the ARC to the mobilization of other resources (family, friends, neighbours, etc.).
  - Improve various cognitive areas (orientation, memory, clock drawing, and verbal fluency).
  - Maintain the level of INR stability of the group of patients in intervention.
  - To reduce the time of dedication of the sanitary professionals by diminishing the consultations of follow-up of the patients who participate in ACTIVAGE.
  - Reduce the number of visits to health centers for patients with active caregivers.

3.2.1.3 Local evaluation protocol

For the elaboration of this set of KPIs, both good practices at regional, national and international level have been taken into account, as well as the necessary flexibility for their direct application, or their adaptation to the objectives, criteria and procedures of their potential users.

The methodological proposal of the DS-GAL protocols is based on the following elements

- It has a systemic and integrating character, valid for the different modalities and that uses the same principles and criteria in the different stages of the evaluation process (ex-ante, during, and ex-post).
- The system of forms, which support this process and summarize essential information for decision-making, is also consistent.
- It makes it possible to ascertain that the objectives of the DS-GAL are being met consistently, because it allows evaluations in these three instances (Impact on QoL, Innovation and Sustainability) to be carried out on the same basis.
- It seeks to make the most advanced evaluation and innovation systems compatible with the needs and expectations of the SD-GAL, which will favour, in the long term, their insertion in international science and technology networks.
- It uses a participatory approach in determining the current state of the process, as well as the "vision" of the desired state of the process. The diversity of opinions gathered through the different forms has made it possible to obtain the indicators of the general principles and objectives.

The evaluation starts with the definition of the KPIs, planning, execution and analysis of the results.

In the DS-GAL the implementation of the local KPIs has been planned every 6 months.

The information has been collected using the following procedures:

- Perception of older adults and caregivers: Conducting questionnaires at the beginning, middle and end of the project.
  - Although most of the users are still in the project at the moment of the realization of this document, the following milestones of information collection have been established:
  - Initial: One month after joining ACTIVAGE (so that they would know the solution and be able to compare at the end of the pilot)
  - Intermediate: Between 6 and 12 months.
  - Final: When the older adult drops out, or after a year and a half of being in the project.
- Collection of information on the sustainability of social and health services.
  - The data of the SAME older adults have been compared one year before piloting ACTIVAGE and one year after being in ACTIVAGE.
  - This information has been provided every 6 months by the Galician Health Service, obtaining the information from the own clinical history of each participating older adult.

3.2.1.4 Analysis of results

The evaluation of the KPIs in the DS-GAL demonstrates the benefits of intelligent living at home with IoT technology, in terms of satisfaction, safety, quality of life and independence among others, in particular the local KPIs have been adapted to investigate the promotion of "long independent and safe living" in the DS-GAL.

The results of the DS-GAL KPIs have shown that ACTIVAGE has improved the quality of life and autonomy of older adults by 2 points after almost two years of ACTIVAGE use.

Taking into account that the quality of life of our older adults, due to their age (the average in the DS-GAL of older adults is 81 years), each year, in principle, the quality of life would be maintained or would worsen, with ACTIVAGE it has been possible to improve it.

This is also demonstrated by the positive impact that older adults have observed in how the IoT solution piloted in the DS-GAL has influenced their personal feeling of quality of life and autonomy.

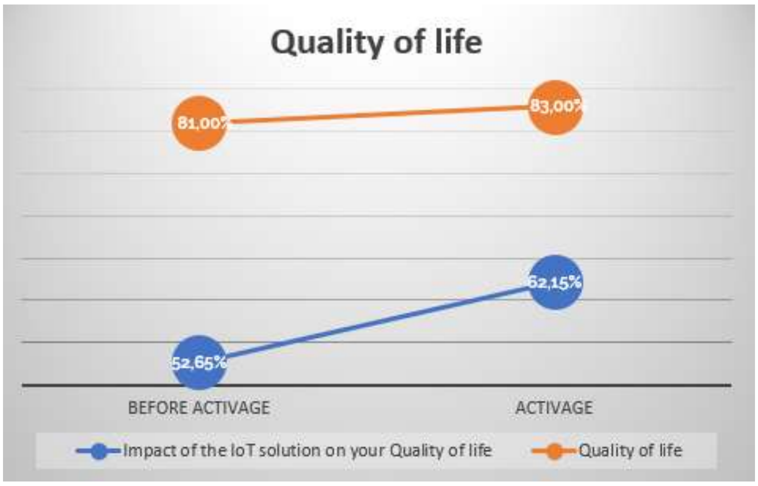


Figure 18: DS GAL average QoL before-after results

In order to make a good evaluation of the use and satisfaction of the IoT solution for the older adult, the DS-GAL has decided to carry out the questionnaires after one month in which the older adult had the solution at home, an intermediate evaluation and another one at the end of the pilot one and a half years later.

This has allowed us to have quality information regarding the older adult's perception of the IoT solution piloted in their home.

The results in the DS-GAL have been better than expected. Concluding that the older adults, value positively the IoT solution and transfer how it affects the promotion of their independent life, the mitigation of their fragility and the preservation of their quality of life and autonomy.

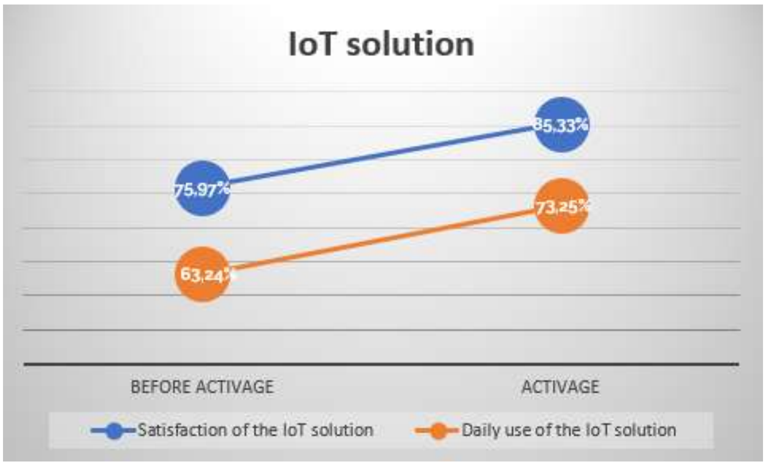


Figure 19: DS GAL Correlation between satisfaction and daily use of IoT solution

The DS-GAL has also focused on reducing social isolation and increasing empowerment.

Technology has been used to help older adults leave their homes, feeling safe through technology.

In the DS-GAL, the level of social isolation has decreased by two points because older adults have felt safer leaving their homes with the ACTIVAGE technology.

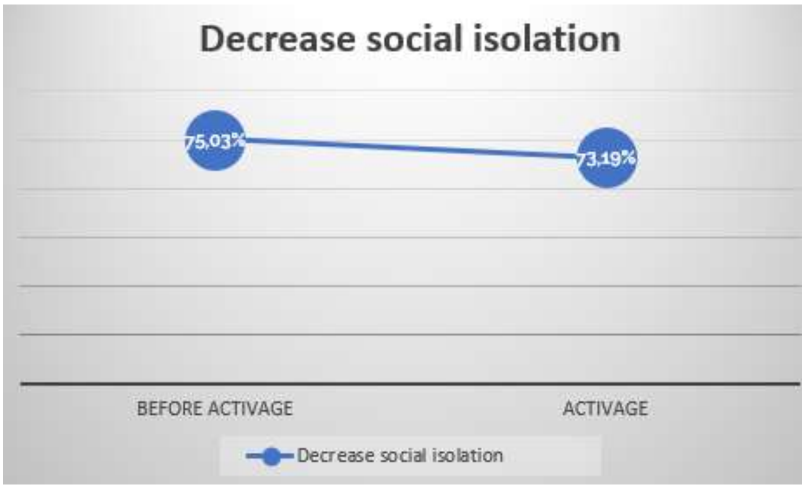


Figure 20: DS GAL decrease in social isolation

In the DS-GAL we liked taking care of the caregivers, and this has been demonstrated by the data obtained in the questionnaires.

The average age of the DS-GAL carers is 51, and more than 12 carers are over 90.

The ACTIVAGE technology has helped the carers a lot. Many carers have been able to tell us in work forums, presentations, etc. that thanks to ACTIVAGE, they have better mental health, improving their own quality of life, and feel that they can continue to care for their older adult as well or better.

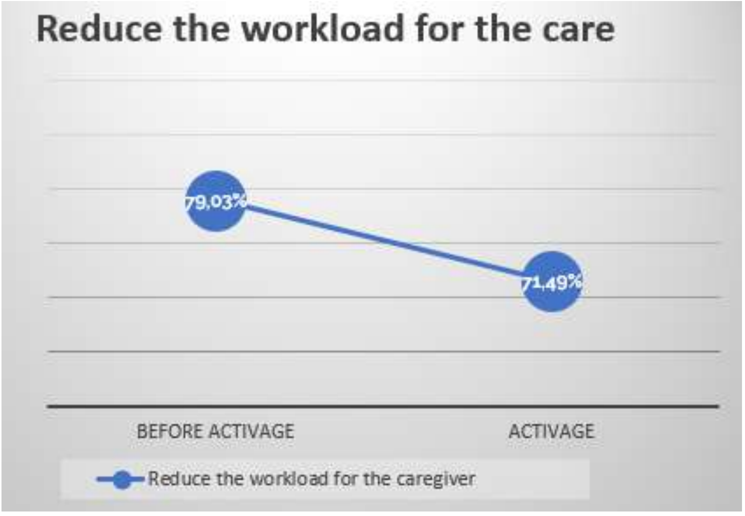


Figure 21: DS GAL reduction in caregiver workload

The DS-GAL focuses on the older adult, how it feels. The clinical symptoms or survival rates are no longer sufficient, and particularly when older adults are treated for chronic or life-threatening conditions. Therefore, ACTIVAGE tries to achieve a life worth living from a social and psychological point of view as well as a physical one.

In this search for the complete quality of life of the older adult, the DS-GAL has analysed and followed other indicators related to the quality of life of older adults with respect to access to different health services such as access to Health Centres, Continuous Care Points (PAC), Emergency Services and Hospital admissions.

This evaluation related to the sustainability of health and social services, has compared the data access to health services, of the SAME older adults one year before piloting ACTIVAGE and one year after being in ACTIVAGE.

This information has been provided by the Galician Health Service, obtaining the information from the own clinical history of each participating older adult.

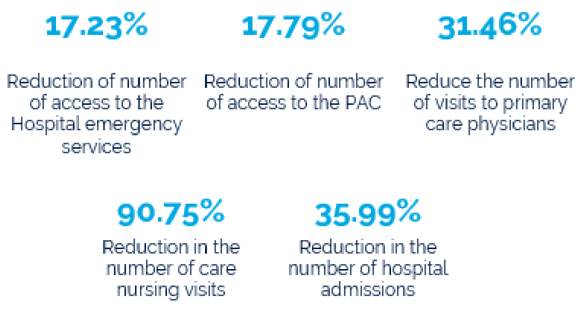


Figure 22: DS GAL sustainability of health and social care services results

ACTIVAGE equates the face-to-face consultation to the non-presential one.

KPIs show that 98% of monitored patients obtain the same level of health control in their homes as in Health Centers.

3.2.1.5 Conclusions

The evaluation of the DS-GAL KPIs has demonstrated the benefits of intelligent living by incorporating IoT into their homes and lives.

Satisfaction, safety, quality of life and independence indexes, among others, have shown that thanks to ACTIVAGE, the prolongation of independent and safe living of our older adults.

Older adults have commented on the improvement in their perception of their physical, emotional and social well-being in various areas of their lives.

The impact of the IoT solution in their lives has meant a 10% improvement in their quality of life, concluding with a considerable improvement of 2 points in their quality of life in a year and a half.

The satisfaction and consequently the use of the IoT solution has grown as the pilot has progressed, reaching a 10% increase in satisfaction and use in a year and a half.

ACTIVAGE has improved the social isolation of the older adult, measuring this measure in 2 points of improvement. Although the best results have been obtained by the comments of the older adults that thanks to the feeling of security inside and outside their home, they go out more.

ACTIVAGE takes care of the caregivers. Through the information collected in the questionnaires, it was found that with ACTIVAGE the caregivers' workload has been considerably reduced (by almost 8 points), while their peace of mind and mental health have improved.

Completing the perspective of improving the quality of life with respect to active and healthy aging, other data are incorporated that treasure the results of this pilot.

There was a reduction of 17.23% in access to hospital emergency rooms, 17.79% in access to Continuous Care Points, 31.46% in visits to family doctors at health centres, 90.75% in the number of visits to nurses at health centres and up to 35.99% in the number of hospitalisations. These data have been reported by the Galician Health Service, comparing the data of the same older adults one year before ACTIVAGE and with ACTIVAGE. This concludes that the data are even better.

Finally, other benefits have been identified and are detailed below:

- Improved quality of life for older adults
- Social isolation decreases
- Assistance to the adult older without the need to press a button
- Detects anomalies and risk situations
- Prevents accidents (gas, smoke, CO detector)
- Family/caregiver alerts
- Improves continuity of care
- Facilitates socio-health monitoring
- It favours the conciliation of family and work life of the older adult and their relatives and carers
- Saves money for the older adult and the environment
- Increases the safety of older adults in your home
- Prevents complications
- Improves the care of primary care professionals
- Improves the control of older adults by the health service
- Avoids trips to the health center
- Expedites primary care consultations
- Guaranteed data security and privacy

Concluding that ACTIVAGE has demonstrated the benefits of intelligent living by incorporating IoT into their homes and lives, as demonstrated by the various indicators collected before and after the pilot in the DS-GAL.

3.2.2 Testimonials

Below are some of the testimonies collected by older adults in presentations or working groups.

"Since I have Activage at home, my daughters are more relaxed, because they live far away and know that the system will warn them if something out of my routine happens. Anyway, they call me every night".

"It gives me a lot of peace of mind. It's a 'person' who is always there with me".

"Thanks to ACTIVAGE, I can continue to live alone in my house with peace of mind".

"I'm delighted with the system: it works very well. The other day, a girl from the Red Cross called me on the phone because they detected that there was smoke in my house. She had left a pan on the stove and was watching TV in the living room".

"I don't feel it's there. Only that if something happens to me, ACTIVAGE will warn my son. I feel taken care of".

"I'm older now, and sometimes I slip out of my chair. Thanks to ACTIVAGE, when that happens to me and the girl is not there, my neighbour comes to pick me up. Thank you for taking care of me".

"ACTIVAGE warned my son John, that I could not get up because I was dizzy. The system makes me feel safe in my house. Because I want to stay in my little house, even if I'm alone".

"My life has improved because I feel safer. I feel protected. And even though it seems like a strange thing, I feel accompanied. At home I have installed motion sensors, but I forget that they are there".

"Thanks to ACTIVAGE, my daughter Anna came to pick me up when I fell in the kitchen a few weeks ago".

3.3 Local sustainability plan

3.3.1 Product/Service Definition

CareLife is an advanced telecare system, to ensure the care and quality of life of people in the home, where the home becomes a point of reference for care, not only in the health field, but also in the social field.

It is an intelligent system aimed at older people that analyses their habits and routines to establish patterns that facilitate monitoring and it is possible to alert possible emergency situations when the user is not able to alert, thus completing the traditional emergency button.

This is achieved through sensors installed throughout the home. The solution is based on devices that analyse the behaviour (presence devices and opening doors), also enriched with devices that alert situations of danger in the home (smoke, gas, flood, CO).

Carelife® guaranties strict compliance with specific regulations typically associated in the processing of personal data.

Its benefits are:_

- Proactive vs. reactive care
- Detection of fragility in functional and physical decline
- Preservation of quality of life and autonomy
- Promotion of active and healthy aging to encourage independent living

- Provision of personalized social and health care
- Increasing safety in the home
- Reconciliation of the caregiver's family and work life and their environment
- Energy poverty indicators

3.3.2 Market Analysis

3.3.2.1 PESTEL analysis

Table 21: DS GAL PESTEL analysis

Element	Factor	Business Impact
Political	To achieve sustainable systems within a changing social and health context, not only is a greater application of ICT required, but also bold decisions need to be made to advance system reform that will ultimately lead to greater efficiency and quality of services for older adults. In recent years Spain has lost some ground to the countries that lead this transformation, partly because the initial momentum of the Administration has been weakened that the investment effort required for the adoption of these technologies has decreased.	It is therefore up to all the actors who make up the social and health sector to lead this transformation by meeting the needs of the population and offering a modern health care, always being well aware that the penetration of ICTs, new connected lifestyles and demographic change will eventually exercise the necessary pressure that will sooner or later lead to the transformation of the system in the same way as has happened in other sectors. ACTIVAGE is aligned with the definition of a government led digital health, social services and equality strategy. This political leadership, with the will to undertake the digital transformation of the socio-health sector, must apply a greater effort in communication to the different actors involved. The agents need direction and vision about where the social and health sector is headed and how it is intended to be transformed by taking advantage of the benefits of Digital Health, through the voice of government policies.
Economic	From the digital economy perspective, IoT systems and solutions are one of the main generators of data through communications between machines, and this information will be needed to release the potential of large data and predictive modelling in sectors such as smart cities, smart buildings, e-government or smart industry, among others. All figures, such as those indicated in the following study (https://www.statista.com/statistics/666864/iot-spending-by-vertical-worldwide/) support the growth expectations of the IoT solutions	Therefore, the potential of this market is outstanding and the possible benefits for solutions in this field are really attractive for investment. Within the IoT market, ACTIVAGE's vision is to be the world reference to provide the evidence that standard-insurance-intraoperative IoT ecosystems enable new business models and cost-effective solutions for active and healthy ageing, contributing to the sustainability of social and health systems, the competitiveness of European industry through innovation and the improvement of the quality of life and autonomy of older adults in independent living. The 2018 Ageing Report, published in May 2018, shows that fiscal costs related to

	market, reaching more than $400 billion by 2020 and maintaining an accumulated TCCA of around 40% over the next five years.	pensions, health and long-term care are expected to increase in the coming decades as Europe's population ages. Europe's population is ageing as a result of falling birth rates and increasing life expectancy, which will pose a number of challenges but also represents a significant economic opportunity for European businesses. Older citizens are increasingly shaping economies, constituting a large and growing segment in many areas of consumption, and the expansion of this demography is expected to boost demand in many sectors. The so-called Silver Economy is a concept that has attracted the attention of policymakers and economic operators alike, and this promise of higher growth and employment is a powerful response to the most typical anxieties about worsening dependency rates. The Silver Economy is a balancing act, which will be profitable for business and related to a positive and socially inclusive identity for Europe's older adults.
Sociological	A recent report[4] of Technopolis and Oxford Economics on the Silver Economy provides market figures and projections for the European Union. According to this document the EU Silver Economy in 2015 is estimated at €3.7 trillion. Just over 10% of this total figure relates to public expenditure for the benefit of older people. Taking into account population projections, the study estimates that the EU Silver Economy will increase by approximately 5% per year and will amount to €5.7 trillion in 2025. The report shows that there are many areas of the Silver Economy where markets are only just developing (e.g. domestic robotics) or otherwise do not work particularly efficiently (e.g. assisted living). Projects such as ACTIVAGE will rewrite the rules about markets drivers in existing sectors as well as create new business models that will need new standards and policy mixes to facilitate their growth. ACTIVAGE works in five of the ten areas defined: • connected health	The ageing of society must be seen as a sign of social and economic progress. One that, because of increased longevity, provides more opportunities for economic, social, and cultural development. It opens up new areas for economic growth and employment as technological innovation enters the marketplace. Demographic change also poses a major challenge to the current "ways of doing business" in the European economy. A strategic vision is essential to fully mitigate risks and exploit opportunities.

4 The Silver Economy https://publications.europa.eu/en/publication-detail/-/publication/2dca9276-3ec5-11e8-b5fe-01aa75ed71a1

	• integrated care • built environment and smart home solutions • tools/apps for data analytics for active and healthy ageing • Interactive platform to fast-track product and service development The ten case studies developed in the report have been selected on their potencial for growth of the market sector and ideas obtained through extensive stakeholder consultation, covering a broad spectrum of opportunities. The Figure 3 presents a schematic illustrating the idea that all of these new or emerging Silver Economy opportunities will need to contend with several major challenges before they can hope to progress from niche to mainstream. The specific needs of Europe's older people will lead to increased public and consumer spending. This will have a significant pull effect on many existing or emerging markets, benefiting the ageing population and the economy in general. The Silver Economy has attracted the attention of both policy makers and economic operators: the ageing population promises more economic growth and more jobs.	
Technological	The market for IoT solutions is continuously growing and is expected to skyrocket over the next few years, thanks to the expansion of the hyperconnected world and cyberphysical systems. Regarding the AHA market, as part of the European Innovation Partnership on Active and Healthy Aging, a new Market Innovation Plan (MIP) is being developed. This plan has identified several barriers that "hinder the deployment of large-scale digital solutions for health and healthcare: a problem of communication between supply and demand, a highly fragmented market, lack of harmonisation and funding needs". It also stresses that these barriers are particularly	ACTIVAGE solutions combine social and business technology aspects, developed through user-centred design to provide effective services to older people. The AAL Market and Investment Report, published in May 2018, outlines five enabling technologies that are part of the system providing AAL solutions: 1. Sensor technology: provides electronic data for a wide range of AAL solutions. These technologies are included in a wide range of ACTIVA solutions, have become more readily available and affordable, which facilitates their integration into smart homes. 2. Reasoning technology: aggregates, processes and analyses (sensors) data ACTIVAGE solutions use reasoning technology to aggregate, process and analyse data applied to remote assistance solutions and decision support systems

	evident in this sector, where chronic diseases, social and cultural conditions and living environments are serious elements affecting citizens.	3. Actuation technology: execute actions or operate system components. ACTIVAGE solutions are ready to integrate intelligent actuators or partner robots. 4. Interaction technology: facilitates human-machine interactions. ACTIVAGE facilitates the accessibility and usefulness of the solution to the end users. 5. Communication technology: allows the different components of a system to exchange information.
Environmental	The Market Observatory Study in the field of Ambient Assisted Living is in line with the above statements. The AAL market is growing beyond its traditional boundaries and this is attracting increasing interest from potential investors, the ICT industry and all service and care providers: "The dual factors of demand attraction (due to the rapid growth of the elderly population) and technology push (development of new ICT solutions and services) are combining to profoundly change the market landscape itself".	The Observatory concludes that the most interesting drivers of new solutions in the AAL market are the following: • New generation sensors • The convergence between mobile health, telehealth and social technologies • Geo-location services based on user location • Intelligent environments based on IoT technologies characterized by autonomous procurement, management and monitoring. Solutions provided by ACTIVAGE, from the definition, validation and implementation of a global architecture of the AAL ecosystem, which can be applied to other countries, accelerating the adoption of ICT solutions for active ageing and AAL across the EU ACTIVAGE strengthens the value chain and contributes to an EU-wide market.

Legal	The provision of integrated social and health services on a regular basis would require a new legal framework, as integrated services for regular provision have not been defined at regional level.	ACTIVAGE incorporates legal and ethical aspects from the design:
		
		Security by design:
		• IoT secured devices and gateways
		• Secured Platform with controlled access:
		  ○ Using EIDAs certificates for professionals.
		  ○ Using login/password and one use pin code for users/patients and carers
		• Complete access and error logs
		
		Privacy by design:
		• Informed consent for users and carers
		• Use of minimum amount of personal data.
		• Subcontractors and staff individually signed privacy declaration.

		All documents related to data protection have been adapted to European regulations (GDPR).

3.3.3 Competition/sector Analysis

3.3.3.1 Competition profile analysis

The current market for social solutions is in the hands of a few manufacturers with large market shares, and these manufacturers are capable of developing solutions similar to ACTIVAGE. Below are details of these entities:

- Tunstall (in Spain Tunstall Televida). Tunstall Group was founded in England in 1957 and is considered the world leader in the manufacture and distribution of telecare equipment, with 50 years of experience, surpassing any other manufacturer. Tunstall designs, manufactures, supplies and installs tailor-made solutions. It currently has subsidiaries in 30 countries around the world.
- Neat Group. A Spanish company that was founded in 1988 with a clear vocation for customer service and defines itself as a service company that offers technological solutions in the different business areas in which it works. In 2011 it bought the Australian company TelMedcare, which culminated its process of technological convergence within the healthcare sector. It also managed to increase its international presence and sales force in the countries where the company is represented.
- Bosch. The German company began its journey in this market in 2006 with the purchase of the Swiss company Telealarm. Telealarm was the leader in Northern Europe in the supply of social alarm systems and health care. With this acquisition, Bosch completes its security line that includes fire prevention systems, video surveillance, access control and communication systems.
- Caretech. Swedish company with little presence in Spain. Small in size, its Kalix headquarters employs some 20 people, dedicated to the entire cycle from development to sales. In Sweden, Europe and around the world, a network of agents and partners provides a strong international sales organisation. It currently also has offices in Finland, the Netherlands, Germany, Great Britain and Australia.

In addition to these examples, there are numerous companies with partial tele-care solutions for both home and mobile environments, such as Apello UK, TytoCare, Healthcom US and Tynetec, among others. Even large multinationals such as Philips are carrying out developments for personal emergency systems (PERS), which demonstrates the activity and interest in this type of solution.

3.3.3.2 Porter's 5 forces analysis

Table 22: DS GAL Porter's 5 forces analysis

Force	Analysis of potential factor
Competitive rivalry	However, all these solutions face older adults in an isolated way, without considering a joint analysis using artificial intelligence techniques or data analysis. ACTIVAGE is based on the generation of data patterns that allow a predictive analysis that provides a remarkable improvement of social health services.

	On the other hand, the solutions present in the market do not solve in a clear way the problem of active and healthy ubiquitous ageing, as it is faced by ACTIVAGE.
Threat of new entrants	The most important barriers to placing ACTIVAGE with a good market share are • **Economy of scale:** In ACTIVAGE MALL indirect network effect is crucial to grow. ACTIVAGE must leverage on the sustainability plans of 12 DSs: with an initial customer base (consumers) of almost 8.000 persons, and all profiles of technology and services supply, this is an initial advantage point from which to create and boost the network effect. This action will mostly relay on activity within the NETWORK unit. • **Product differentiation:** The solutions that make up socio-sanitary ecosystems are disruptive, so ACTIVAGE's differentiation from the rest of the suppliers that address these solutions is clear. • **Access to distribution channels so that the customer can consume the final product.** Through ACTIVAGE.ORG • **Legal barriers such as all kinds of regulations marked as mandatory which vary in each country.** Such as certifications of social and health products, which are different in some EU countries. • **Experience gained** One of the most relevant knowledge assets that ACTIVAGE has is its own capacity to implement knowledge transfer as part of a sustainable business. • **Movements of already seated organizations.** ACTIVAGE.org promotes and acts for new organisations to become involved in the ecosystem, including innovative start-ups, SMEs, the IoT industry, service providers, venture capital and key stakeholders, in order to create sustainable conditions for the continued growth of demand and supply of IoT based services from/to larger populations of senior people.
Threat of substitutes	Substitute products and/or services pose a threat because they often set a limit on the price that can be charged for a product. We must always be aware of developments in our industry and the influence that these developments can have on our organization. The production, maintenance and evolution of technology are for the moment well protected in ACTIVAGE. ACTIVAGE.org will

	focus on attracting new innovative companies and SMEs to produce more and better solutions and applications once the robustness and stability of the platform and the AIOTs can be guaranteed from now on. Service providers and demand are geographically limited to local environments. This is also reflected in our consortium with more small and medium-sized companies than large players. Here we have a lot of room to grow and facilitate the connection (i.e. transactions) between technologies.
Bargaining power of suppliers	When suppliers have a lot of organization within their sector, relevant resources and conditions on prices and order sizes that is when they make a market more attractive. Some of the strategies to follow in order not to depend on only one supplier or to find better options are • Increase our supplier portfolio. • Establish long-term partnerships with them. • To move on to manufacture our own devices and gateways, as Televés does.
Bargaining power of customers	The more customers organise themselves, the more demands and conditions they impose on the price, quality or service relationship, so the company will have less margin and the market will then be less attractive. Furthermore, the customer has the power to choose any other service or product from the competition. This situation becomes more visible if there are several potential suppliers. Faced with this threat, ACTIVAGE.org provides the following strategies: • Increase investment in marketing and advertising. • Improve sales channels. • Providing new added value.

3.3.3.3 SWOT analysis

Table 23: DS GAL SWOT analysis

STRENGTHS	WEAKNESSES
ACTIVAGE strong perception and understanding of the magnitude of Global Ageing ACTIVAGE Technology Enabler Assets ACTIVAGE AHA solutions Assets ACTIVAGE Knowledge Assets	Value proposition still lack of performative Power. Market exposition to 2 categories of competitors: • Legacy players • Digital transformation giants

Experience of platformization in ageing well (DS, open calls ...).	Financing of ACTIVAGE.ORG. Governance of ACTIVAGE.ORG. Process of definition and financing strategies by public/private services of solutions for active and healthy ageing. Deep-seated structural reforms are needed to ensure the sustainability of health and social welfare systems, while ensuring access to services for all citizens.
OPPORTUNITIES	**TREATHS**
Ecosystem mobilization through strong entities (DS, Members ...). Platformization (product & services innovation). Market Fragmentation as a key lever. Convergence of social and technology value chains. ACTIVAGE allows the development of solutions and new service provision models that are a European reference, thanks to the exchange of experiences between the different countries.	Pauperization of the elderly due to demographic dynamic affecting growth. Understanding and anticipation of "getting old" within an older population living independently, across different cultural environments.

3.3.4 Value proposition and Targeted Customers

Lean Canvas

Problem	Solution	Unique Value Proposition	Unfair Advantage	Customer Segments
Efficient exploitation and collection of data on the future sustainability of the health system (doing more with less). People want to live at home for as long as possible and safely. Efficient use of public money (health - care). Integration with the Smart City. Metrics to support promised improvements > not demonstrated at "labelled solutions" scale.	Integrate tele-care and tele-health services on an open platform. Interoperable platform with security and privacy by design. Incremental approach: "labelled solutions" to support also B2C. Interoperability with other services in the city.	Interoperable solution, considering privacy and security by design demonstrated on a large scale around Europe. Solution that improves the way of life of the elderly.	The solution demonstrates a large-scale all-over Europe.	Senior citizen and their families to involved in the creation and demand of new AHA services that makes their life autonomous and safer and improve their Quality of Life. Institutional environment (nursing homes and expertise centres). Health and Social care policy/service providers makers to invest public and private money in scaling up AHA services. Technology industry to innovate on IoT, support standards for interoperability, to ignite a global wellbeing market growth. SMEs to create innovative solutions and technologies in a growing demanding market.

Existing Alternatives	Key Metrics	High-Level Concept	Channels	Early Adopters
Limited. Fragmented approach based on presential services. In many occasions, without communication between them. Low penetration of telecare and telehealth services.	Savings on service provision. Improved quality of services Service Reliability Change of care model service Data Interoperability	ACTIVAGE = Solution for the delivery of AHA services.	Demonstrations – Conferences. Exhibitions. Papers – Publications. Televés network with operators, IoT services providers, etc. In Europe, USA and Middle East. B2B for Security for Homes Product line.	Government prescription. IoT technology providers to provide a market advantage for their clients.

Cost Structure	Revenue Structure
Development, consulting, engineering and sales staff costs. Facilities and other overheads. Infrastructure for cloud-based services. Marketing services. Acquisition of the cost of the inventory. Cost Service User IoT equipment. Installation. Maintenance/ Incidence. Training. Follow up.	Sale of services Sale of technological solution (gateway, security devices, monitoring devices, medical devices, etc.). Recurring services: maintenance and support.

Value Proposition Canvas

Value map

Gain creators

Monitoring and detection of risk situations

- Advanced Teleassistance. An intelligent system aimed at older people that analyses their habits and routines to establish patterns that facilitate monitoring. Thanks to the information obtained, it will be possible to identify parameters that describe hidden patterns that allow the generation of proactive alerts. This will help define new prevention algorithms.

Shared Assistance

- Digitalization of care.
- Personalized care protocols.
- Integration with Clinical History in the Health Service.

New Services

- It helps people to continue living in their homes, having all the attention and care they need.
- Improves adherence by scheduling reminders to take medication and to collect vital signs.

Product & Services

- Support daily activities
- Chronic health needs
- Health monitoring and support
- Emergency trigger
- Exercise promotion
- Cognitive stimulation
- Prevention of social isolation
- Safety and security at home
- Mobility support
- Abnormal situation notification
- Caregivers support

To provide solutions based on intelligent applications (IoT) to provide socio-health services. This capacity is also scalable to support future services.

Through the use of Machine Learning and Data Analytics techniques applied to Big Data: Early identification of risk situations and changes in habits that allow professionals to adapt and customize the services provided to the needs of users.

FIT

Customer profile

Gains

IoT Service Provider

- Transparent to the service
- Be perceived as a privacy-friendly

IoT device manufacturer

- Complete control of the solution
- Enhanced security perceived by its client

Telecare service provider

- Care of people (older adults, caregivers, relatives)
- Increased security and peace of mind as perceived by users
- To be perceived as a company that improves people's quality of life

Older adult

- Improved quality of life for older adults
- Social isolation decreases
- Assistance to the adult older without the need to press a button
- Detects anomalies and risk situations
- Prevents accidents (gas, smoke, CO detector)
- Improves continuity of care

Customer Job(s)

IoT Service Provider

- To provide service with high quality perceived by the customer
- Ensuring user privacy and security
- Complying with GDPR

IoT device manufacturer

- Hire more service providers
- Support the work of the IoT service providers and maintenance

Telecare service provider

- Encourage self-care of older adults by monitoring their health (stress, weight...) and following their daily routines (time in the bedroom, in the bathroom, outdoors...) proactively detecting dangerous situations that may occur at home to promote physical, mental and emotional well-being.
- Attending to users' emergencies.
- Ensuring the privacy and safety of older adults and caregivers.
- Complying with GDPR.

Older Adult

- Active and healthy aging
- Feeling safe and cared for through IoT solutions
- Normal activity (cooking, cleaning, etc.) in possible fragile conditions.

• Personalised care plans, with a social and health vision and of an eminently preventive nature.			• Facilitates socio-health monitoring • It favours the conciliation of family and work life of the older adult and their relatives and carers. • Saves money for the older adult and the environment. • Increases the safety of older adults in your home. • Prevents complications. • Avoids trips to the health center • Expedites primary care consultations. • Guaranteed data security and privacy. **Caregiver** • Family/caregiver alerts • Remote care of the older adult • Improves the care of primary care professionals • Improves the control of older adults by the health service	**Carer** • Caring for the older adult directly or indirectly • Monitoring the vital signs of older adults, and changes in routines that may be relevant. • Be careful of the relative comfort.

Pain relievers			Pains	
Alerts/Control Panel • Platform for data collection, analysis and obtaining indicators to assess specific trends and patterns. • Generator of social and clinical alerts to the professional and/or caregiver, according to personalized configuration of thresholds, identifying when alerts should be generated by classifying them as moderate or severe. The alerts can be received in the application, SMS or email. **Third Party Integration** • The proposed system includes devices, with an integration architecture and innovative decision support systems: using large amounts of data, developing expert algorithms and systems, making use of machine learning and big data technologies, exploiting sophisticated cloud technologies, as well as IoT technologies			**IoT Service Provider** • The user's discomfort with the solution • Additional cost • Effort in the adoption of new platforms **IoT device manufacturer** • Additional cost • Effort in integration • Complexity in manufacturing **Older adult** • Risks of an unattended emergency • Lack of emergency contact • Fear of losing privacy **Caregiver** • Time spent explaining the caregiver and interacting • The lack of transparency • The relative's reluctance to use this system	

3.3.5 Strategy for local sustainability

3.3.5.1 Open Data strategy

No data set will be made available to the project from the DS-GAL.

3.3.5.2 Continuation strategy

In the DS-GAL, the ACTIVAGE solution has been piloted in more than 700 homes. During this period, intense work has been done so that the solution piloted in ACTIVAGE for the care and improvement of the quality of life of the elderly and dependent people contributes to the sustainability of social and health systems, to the competitiveness of European industry through innovation and to the improvement of the quality of life and autonomy of the elderly.

The experience of piloting 700 homes and 2,518 users (708 elderly people and 1,810 carers) and 4,168 installed IO devices, has led to the creation of a socio-health ecosystem in the community. The first one in Galicia (Spain).

The DS-GAL has been evaluating the impact of the new model incorporated in ACTIVAGE, for the provision of social and health services.

In this period of the project, the DS-GAL pilot has evaluated the impact of a new model of social and health services provision, focused on users over 60 years old, in some cases with chronic diseases, favouring the improvement of their quality of life and their permanence in their usual environment. To this end, the project has made progress in integrating health service platforms (home care, telemedicine, monitoring, etc.) and social services, as well as converting the home into a point of care.

With the DS-GAL, ACTIVAGE has managed to put technology at the service of people, but without interfering in their daily lives. To this end, by means of wireless detectors, behavioural data and biomedical measurements are collected that allow risk situations to be detected (falls, decompensations, sleep problems, etc.) and also help with small tasks (medication reminders, memory exercises...). All the data collected is completely confidential and is only used for personalised decision making for each user.

The DS-GAL social service provider, the Spanish Red Cross, has carried out a sustainability assessment by asking 76 older adults about the continuity of the pilot, also asking the cost they would be willing to pay for the service.

Of the older adults consulted, 58 said they wanted to continue with the solution at home, which represents 76.32% of those surveyed.

The Spanish Red Cross is launching a new commercial service based on the ACTIVAGE solution for monitoring people at home.

The commercial programme called Cuidate+ is available through its website: https://www.cruzroja.es/principal/web/teleasistencia/cuidate

Currently there are more than 500 older adults enjoying this service and more than 1,000 more are expected before the end of 2020.

On the part of the Galician Health Service, continuity depends on the health service itself, as the service is public.

SERGAS has confirmed its intention to integrate the ACTIVAGE solution as a new model of remote assistance within the care provided to citizens.

Televés is working with SERGAS on the continuity model for active older adults and the new incorporations of older adults.

3.3.5.3 Replication strategy

The use case of daily activity monitoring developed in the DS-GAL has been piloted by the Spanish Red Cross as a service provider.

Thanks to this, we have worked with the Bavarian Red Cross (Germany) to create a business strategy with which we can make the most of everything we have at our disposal in order to obtain the greatest benefit in return or a lower cost.

From the knowledge and know-how obtained in ACTIVAGE, we have found management synergies, taking advantage of the skills and knowledge of a team that have been applied to new situations or markets.

This situation allowed the scaling up of the daily activity monitoring solution piloted in the DS-GAL to be replicated in the German market, with the Bavarian Red Cross service provider.

Televés reached an agreement with the Bavarian Red Cross to launch a pilot project to develop a care model for elderly or dependent people in the German market Carelife™. This important step towards internationalization comes after having reliably validated, within the framework of the European ACTIVAGE project, the reliability and robustness of this advanced telehealth solution.

For the development of the pilot, 20 homes will be equipped with sensors that allow for the monitoring of people's daily activity, analyzing their habits and routines to establish parameters that allow for the definition of potential risk situations, which will automatically activate the assistance resources, thus complementing the traditional emergency button.

"We are very pleased to initiate this collaboration with Bayerisches Rotes Kreuz. Because of their resources, experience and their proven commitment to service, we could not have a better partner to develop Carelife™ in such a demanding market, which is also full of opportunities, as Germany is," said Matthias Dienst, Managing Director of Televés Germany.

For his part, Gabriel Pollak of the Bavarian Red Cross pointed out that "Televés' solution has been solidly tested in Spain and, in terms of technology, it represents a very important step forward compared to the traditional concept of remote assistance. We are convinced that the pilot will be a success and that it will lay the foundations for the implementation of Carelife™, to the benefit of our users".

https://www.marcasrenombradas.com/actualidad-marcas/televes-pone-en-marcha-un-piloto-con-cruz-roja-baviera/

The following describes the actions that have been carried out in order to replicate the ACTIVAGE solution piloted in the DS-GAL in Bavaria.

- Value Network.
- Selected UC & BC.
- Definition of objectives.
- Developments for the adaptation of the solution to the German market (language, protocols, etc.), as well as the process of certifying the solution as a socio-sanitary solution in the German market.
- Experiment deployment.
- Training.
- Legal & Ethical.
- Certifications and documentation.

- Installations.

3.3.5.4 Scaling-up strategy

Cost reduction is one of the main concerns in the business world. The great maxim in every company is to achieve the maximum profit with the least possible expense. In this sense, one of the main objectives is to maximize this benefit by saving costs.

The DS-GAL has improved the lives of older adults, increasing their security and allowing them to continue in their own living environment and improve their social relations. The results demonstrate this.

The barriers we have found in continuing the DS-GAL have been the cost.

The percentage of the population aged 65 or over in 2017 was 24.56 in Galicia (IGE) and 18.7 in Spain (INE). The projections of the National Institute of Statistics (INE) for the year 2030 place these percentages at 30.7 and 24.9 respectively.

Currently 35% of people over 80 years of age have two or more chronic diseases.

The investment to be made by the Galician Health System (SERGAS) in providing for the chronically ill is high, which makes it necessary to carry out an exhaustive study of the stratification of chronic illnesses and to draw up a model for an individualized plan of comprehensive care. This model has to promote innovation aimed at improving older adult care based on information technology, using the solution piloted in the DS-GAL.

For this reason, Televés worked hard to study the measures needed to reduce costs in the implementation of the DS-GAL solution. The study concluded that one possible option to reduce costs is to produce a multi-user product.

In this stage of scaling up to other business models, the domestic solution has been adapted to a multi-user environment. Adapting the solution to shared housing.

An exhaustive analysis was made to know in detail the fundamental variables to carry out the monitoring in a multi-user solution.

The role played by each process was studied in depth, as well as the interaction between them.

A very useful analysis and work method was acquired in the development of how to scale the DS-GAL solution to a multi-user solution.

The solution developed the ability to discriminate, in the performance of monitoring information collection, between relevant and non-relevant information, and to adequately evaluate contradictory data.

The actions taken to scale up the ACTIVAGE solution piloted in the DS-GAL in shared homes are described below.

- Value Network.
- Selected UC & BC.
- Definition of objectives.
- Developments for the adaptation of the solution for the older adult at home, to a multi-user solution.
- Experiment deployment.
- Training.
- Legal & Ethical.

- Documentation.
- Installations.

4 DS 2 VLC final report

4.1 DS Experiment report

4.1.1 User engagement report

The DS VLC has been piloted in 545 homes and 1818 users (545 older adults, 1,273 caregivers) and it has been in operation for 18 months.

User engagement has been done by the members of local team that provides social care services to the elderly population, complemented by a successful local recruitment campaign that has allowed us to reach the targets defined.

In order to reach 100% older adults in DS VLC, a process of screening of the service providers databases was done, identifying and contacting more than 7000 users (both elderly and relatives) to inform about the project and if interested to evaluate compliance with inclusion criteria.

Table 24: DS VLC Total users recruited per category

RUC	Elderly	Informal caregiver	Formal caregiver	Other stakeholder
RUC_01 indoor	545	1071	0	0
RUC_01 outdoor	121	224	0	
TOTAL	**545**	**1071**	**0**	**0**

Table 25: DS VLC Total number of facilities confirmed

RUC	Private homes	Personal environments	Shared room in senior facility	Healthcare/Daycare facility	Other spaces
RUC_01 indoor	545	-	-	-	-
RUC_01 outdoor		121	-	-	-
TOTAL	545				

4.1.2 IoT infrastructure deployment

The IoT Infrastructure of DS VLC has evolved with the integration of AIOTES and the deployment of the imported use case and the open call. Figure 8 represents the architecture specified in the different layers of IoT and showing the different elements that have been deployed and how they interact between each other and with the different users.

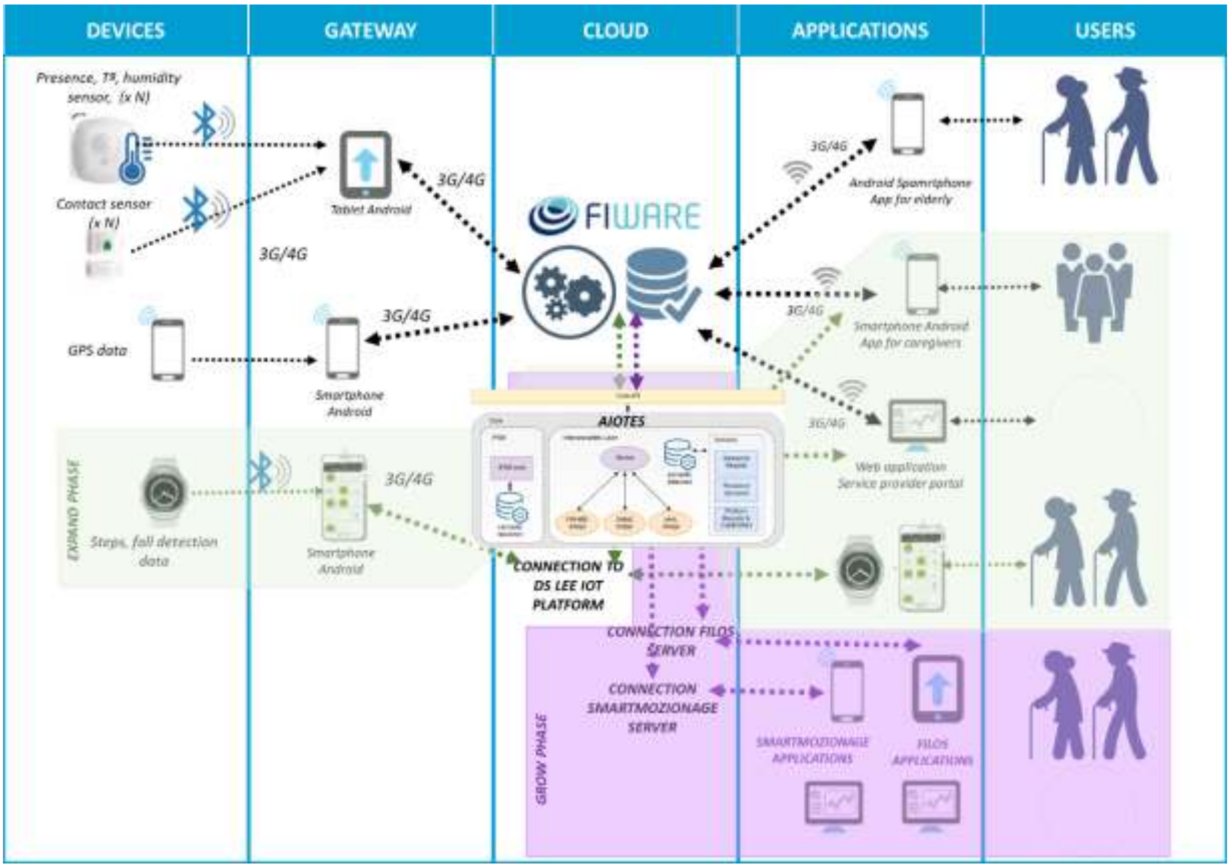


Figure 23. DS VLC architecture

The core of the IoT infrastructure is the DS VLC FIWARE which includes all the backend services required for the services to work. This middleware is connected to the deployed instance of AIOTES.

Table 26. DS VLC solutions

Solution	Description	Deployment in Architecture	Related RUC
LOCS family app	Provides real-time information about the daily patterns of the elderly, allows the configuration of alerts for abnormal situations.	iOS and Android app	RUC1
LOCS dashboard for service providers	Provides real-time information about the daily patterns of the elderlies, allows the configuration of alerts for abnormal situations. Provides user and installation management and supervision.	Web application	RUC1
LOCS home monitoring	Collect information from set of sensors deployed in the elderly home, registering location events and transmitting to IoT platform	Sensors + gateway	RUC01 indoor

LOCS outdoor	Monitor position of elderly outdoor and collect information about location in safe areas and points of interest	Android app	RUC01 outdoor

Table 27: DS VLC distribution of installation per type of environment

RUC	Private homes	Personal environments	Shared room in senior facility	Healthcare/Daycare facility	Other spaces
RUC_01 indoor	547		-	-	-
RUC_01 outdoor		121	-	-	-
TOTAL	**547**	**121**			

LOCs solution includes 4 presence sensors, 1 door sensor and 1 tablet acting as a gateway for each user. The relatives use their own mobile phones as user interface devices. To provide the outdoor service, smartphones have been provided to the elderly, being considered as wearables.

Table 28: DS VLC devices installed per category

RUC	Gateways	Environment sensors	Wearables	Health / Alarm devices	Communication devices	User interface devices
RUC_01 indoor	545	3200				1071
RUC_01 outdoor			109			224
TOTAL	**545**	**2725**	**109**			**1295**

The time for deployment of the motion and door opening sensors per household was 45 ± 15 minutes. Pairing devices (motion sensor, door opening sensor) with the gateway, prior to the installation visits was key to reduce the initial installation time (originally 75 ± 15)

Percentage of installations completed over total targeted is **104%** (545/ 525) for indoor solution.

4.1.3 Experiment running report

4.1.3.1 Users participation

The final number of users in operation for RUC 01 indoor has been 545 older adults + 1093 informal caregivers= total of 1638 end users, that is 312% of target

In RUC 01 outdoor we reached a total of 121 older adults + 224 informal caregivers= total of 345 end users, that is 153% of target

In all cases the users of RUC 01 outdoor are also users of RUC 01 indoor-

Number of drop-offs by 30th of June: measured by number of older people

Reasons for drop-offs	Number of drop-offs
Move with relatives	23
Move to nursing home	14
Death	34
Formal caregiver	3
Dissatisfaction with solution/ project	12
TOTAL	86 (facilities or older people)

Table 29: DS VLC number of users in operation by 30th of June.

RUC	Elderly	Informal caregiver	Formal caregiver	Other stakeholder
RUC_01 indoor	448	907	0	0
RUC_01 outdoor	55	128	0	0
TOTAL	**448**	**907**		

With regard to the usage level, in the following table we provide the thresholds for the different levels of usage defined for the solutions. Due to technical constraint, usage information has been collected related to RUC01 indoor.

Table 30: DS VLC usage levels.

Solution	Rule applied for regular use	Number of regular users	Related RUC
LOCS home monitoring	Does not need user interaction (passive use). Usage is 24x7	545	RUC1 indoor
LOCS family app	4 times per week on average or higher	65% of relatives in average	RUC1 indoor

4.1.3.2 Operational effectiveness

Table 31: DS VLC main technical incidences received

RUC	Description of main issues experienced
RUC_01 indoor	1.- The mobile phone operator's service cut off all installations (July 2018). Once the service was restored, a large number of tablets did not automatically recover their Internet connection and required home assistance to restart them

	2.- In the first months of operation of the new version of the platform (2nd term 2019) there were various incidents that required optimizations in the software of the Tablet. 3.- Start of battery changes in the motion sensors. 4.- Dropped sensors. 5.- Tablets: The most common incidents have been due to tablet changes (tablet lock, operating system error, etc.) or revision of signal levels that require tablet repositioning to correctly receive from all sensors.
RUC_01 outdoor	1.- Setting of security areas: smartphones were configured with recommended security zones too large and generated incidents. 2.- An update of android operative system caused that a new version of the app did not work in all kind of smartphones, just in some brands (April 2019). This invalidated the use of part of the smartphones purchased by Las Naves for those participants who needed it to participate in outdoors use case.

In terms of number of incidences, the following figure shows the evolution of the incidences registered in the ticketing system per month and compared to the accumulated number of installations. As it can be seen, we have reached an status of technical maturity in the last year, where number of issues have been kept around the 30-40 per month, with a ratio of 0.07 incidences per installation.

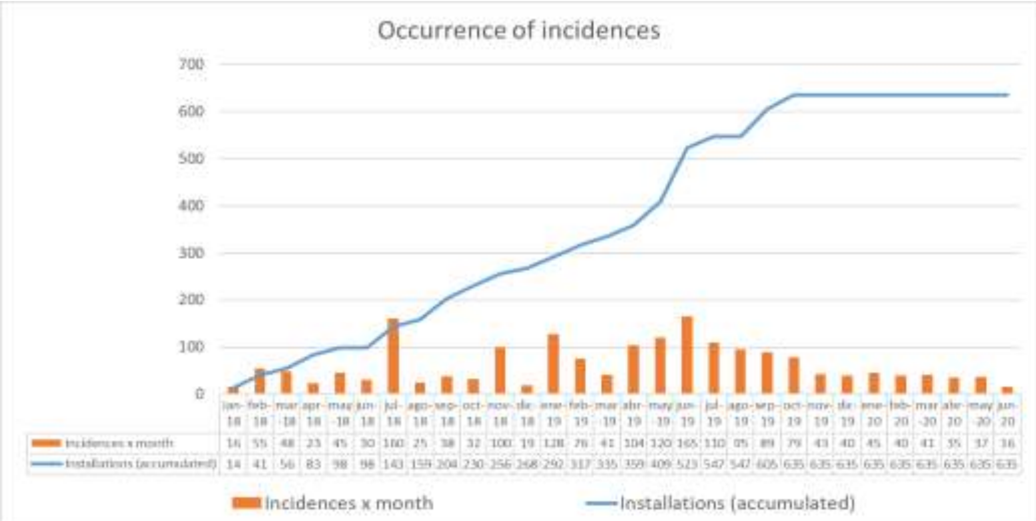


Figure 24: DS VLC number of incidences per month

The average response time to end-user requests/ inquiries has been 24 hours in average, while the average time to solve the incidences has improved until 48 hours during the last year of operation. The effectiveness in incidents management is 100%, we have been able to solve all issues raised to date.

4.1.3.3 Use case exchange report

DS_VLC imported the following UC from DS Leeds through the deployment of the following 2 services:

Table 32: DS VLC imported use case

Service ID	Title	RUCs	Main beneficiaries	Devices
DSLEE_ SRV_A	Detection of abnormal patterns in the home - alert to inactivity/deviation	RUC_01 RUC_07 RUC_11	Assisted person, caregivers - both formal & informal	Energenie/SmartThings: - home hub gateway, motion sensors, door sensors, electrical power outlet sensors.
DSLEE_ SRV_C	Detection & alert raising of falls	RUC_04	Assisted person, caregivers - both formal & informal	Samsung smart-phone and smart-watch.

But we adapted DSLEESRV_A devices for monitoring of electrical power consumption and detection of potential cases of energy poverty as well, thus deploying also RUC_08 Safety, comfort and safety at home. Thus, DS_VLC finally deployed 5 RUCs.

The following table gathers the number of devices deployed within these services, as well as the participants involved in this testing.

Table 33: DS VLCL imported use case participation

RUC	Number of devices deployed	Older people	Informal caregivers
RUC_04	22 (11 smartwatches+ 11 smartphones)	11	23
RUC_08	6 (electrical power outlet sensors)	1	1
TOTAL	28	11	23

DS_VLC exported AUC1 or RUC_01 to DS_Madrid.

Table 34: DS VLC exported use case

Service ID	Title	RUCs	Main beneficiaries	Devices
DSVLC_ SRV_A	Detection of abnormal patterns indoors (at home)	RUC_01 RUC_08 RUC_10 RUC_11	Assisted elderly person and informal caregiver	4 motion sensors, a pressure sensor, a tablet as gateway, smartphone for informal caregiver and app to consult the information

Service ID	Title	RUCs	Main beneficiaries	Devices
DSVLC_SRV_C	Detection of abnormal patterns indoors and outdoors	RUC_01 RUC_08 RUC_09 RUC_10 RUC_11	Assisted elderly person and informal caregiver	4 motion sensors, a pressure sensor, a tablet as gateway, for indoors, personal unit for tracking for the elderly person, smartphone for informal caregiver and app to consult the information; smartphone for the elderly person and app with information on municipal resources, agenda, public transport,...

4.2 Local evaluation report

4.2.1 Goal of local evaluation: primary and secondary endpoints

The ACTIVAGE project, developed in several cities in the European Union, aims to find technological solutions to face future problems arising from the ageing population and its subsequent need for care. The city of Valencia, under the leadership and coordination of Las Naves, has participated in this project through the execution of a pilot test through which the LOCS System has been developed and tested. This is an indoor monitoring system (through sensors) of the movements of the elderly in their own homes and another, outdoor system (for outdoors and through a mobile phone carried by the elderly) that provides information to their carers through a mobile application.

In addition to Las Naves, the technological company MYSPHERA (developer of the LOCS solution), the social services companies Atenzia, Gesmed and Iniciativa Social ISI Benestar and more than 1500 elderly people with their respective carers have participated in the experiment developed in Valencia.

With the aim of knowing the usefulness of this solution, a quasi-experimental evaluation has been proposed in which the changes produced in the users after the use of LOCS are studied. After several months of study and analysis of the data and information obtained through surveys, interviews and documentary analysis, the conclusions about the functioning and impact produced by this system are that, although there is no impact on the quality of life of the elderly, **it does seem that one of the most important objectives proposed by this initiative in relation to extending the life of the elderly in their own homes has been achieved.**

Likewise, this study concludes that the logical thing was not to have achieved an impact on some aspects related to the perception of the quality of life of the elderly, given that this is a passive element that is not aimed at improving any aspect of the physical or mental health of persons over 65 years of age. If we consider that the passage of time plays against it and that the age of 50% of the people who have taken part in the test is between 83 and 89, the data obtained are reasonable without, however, meaning that the usefulness and effectiveness of this technological solution has not been sufficiently proven.

In fact, **when observing the changes produced in the caregivers, we do detect that the intervention of the project has been decisive, in a percentage of the sample, in reducing the time spent on care, as well as in relation to the reduction of the costs derived from this task.**

On the other hand, the **capacity to generate local employment** in case the project is scaled up is very remarkable due to the fact that the production of the sensors is local and as a consequence of the implementation of a "new social service" that will require certain installation, maintenance and monitoring tasks.

It has also been observed that **this trial period, of more than one year,** has allowed for the adjustment of the technology's operation, the detection and resolution of the failures and errors that prevented its being placed on the market, and the development of an effective incident management system that provides confidence to the caregivers.

This study also made a series of recommendations aimed at finding a marketing solution that would avoid the public administration having to assume the costs of the LOCS system and all its components, but taking into account that this could be detrimental to smaller service providers. In addition, it is recommended to ensure that the people to whom the outdoor system is installed are well aware of the implications it entails, and it is also recommended to avoid this system of monitoring the elderly outside their homes by means of their mobile phones.

Finally, among the recommendations included in this study is that of applying Las Naves' own Transfer Methodology in order to inform all other agents in the city with interests, concerns or responsibilities about the consequences of the ageing of the population and their need for care now and in the future, of this technological solution.

4.2.2 Local KPI collected

The global KPIs used for the impact on QoL, sustainability and innovation and growth were the following listed:

- QoL
- Social isolation
- Physical Activity
- Profitability
- Hospital admission
- Daily IoT/Technology usage per patient
- Service acceptance
- New IoT based / AHA Services
- IoT Business Market
- IoT Performance

4.2.3 Local evaluation protocol

OBJECTIVES

In this case, **the evaluation aims to find out to what extent elderly people who need (minor) care could maintain an independent life at home thanks to the technological solution developed** by MySphera based on the study of the impacts that have been generated throughout the months in which it has been in operation, as a pilot test, in 525 homes in the city of Valencia.

In this sense, **the main evaluation questions** are the following ones:

- Would the use of the LOCS solution extend the life of the elderly autonomously and in their homes?

- Is this solution effective in relieving caregivers of the responsibility and concern they feel while their elders remain in their homes?
- Would it improve the quality of life (as measured by parameters relating to the sense of tranquillity, reduced care costs and increased leisure time) of the carers?

On the other hand, we pose a series of **questions of second order** that will try to observe how the activities have been developed and what the outputs have been in order to make a study on the implementation of the program. In this case, the aim is to identify those barriers that have made it difficult to implement the programme, so that they can be considered if the City Council or any other public institution decides to replicate or scale up this project. For this purpose, the following questions are posed:

- What has been or could be the rate of installations per home and day? How many staff and with what professional profile is required to carry out this task?
- What have been the main problems encountered in the installation process?
- Would there be a sufficiently large potential number of users willing to make use of this type of solution? Have there been difficulties in reaching the expected number of people participating in the pilot test? Has the strategy for attracting users been effective?
- What is the percentage of serious and minor incidents in relation to the total number of incidents? What is the average time for resolving these incidents for both serious and minor cases? Is there a protocol for action? Is this protocol effective?
- Taking into account the incidents, is the solution ready to be put on the market and in a position to become a generalised public service?
- Would the price of the solution be an amortizable expense for families and for the State?

APPROACH

The public policy evaluation approach of Las Naves is based on a comprehensive approach to the interventions being evaluated. Through the analysis of the cycle of experience developed, evidence is provided on the successes obtained, as well as a series of recommendations for improvement.

In any case, **the main evaluation approach is oriented to the use of** results. In this sense, the results of this work are intended to go beyond the limits of this project by producing useful information for decision-makers and policy makers, and in general, for all those organizations that work to find solutions to improve the quality of life of older people and caregivers.

METHODOLOGY

For this purpose, an impact assessment is proposed based on the quasi-experimental method, which will use the before and after technique to compare the effects that the implemented test has generated on its beneficiaries. In addition, the evaluation will focus on the study of the impacts of the aforementioned pilot on older people and their informal carers. However, some indicators have been defined that allow us to observe which are the effects that this initiative generates in terms of business viability and job creation and, as mentioned above, the implementation process will be observed to see where the barriers are and what is the margin for improvement in case this solution would like to be scaled up or replicated by other public institutions.

There are multiple research techniques. The study has a mixed approach in the sense that it combines quantitative and qualitative research techniques. However, the weight of the conclusions of this study is based on the data obtained from the questionnaires carried out with both older people and caregivers.

The techniques used during this evaluation process have been the following:

1. Documentary Analysis

- Project formulation and description document of the Valencia pilot
- Quarterly monitoring reports
- User recruitment reports
- Incident report by My Sphera
- Document describing the functioning of the LOCS system developed by My Sphera
- Literature review of scientific publications on aging and care as cited in the references of this report
- Regulatory review and international agreements on active ageing and elderly care policies

2. Interviews with key players

- Elena Rocher (Las Naves). Coordinator of the Pilot Project Activage at local level in the city of Valencia
- Pilar Sala and Álvaro Martinez (MySphera). Developers of the LOCS System
- Mario Lecumberi (MySphera - Isi Benestar). Installer of the solution in the homes of the elderly and coordinator of the users assigned to Isi Benestar.
- Rachael Ann Dix (Atenzia). Coordinator of the users of Atenzia
- Michaela Monter and Mercedes Lagua (Gesmed). Coordinators of the users assigned to Gesmed

3. Quantitative Analysis

- Socio-demographic data of people participating in the programme (1186 surveys: 491 elderly people and 691 carers)
- Analysis of the LOCS system cancellation questionnaires at the request of users
- Questionnaires to measure the impact of the solution on the lives of older people before and after
- Questionnaires to measure the impact of the solution on the lives of the caregivers before and after

LIMITATIONS OF THE ASSESSMENT

During the process of project implementation, a number of circumstances have arisen that could influence the results of this evaluation. These shortcomings must be taken into account when interpreting the conclusions and recommendations of this report, and are as follows:

1. Differences in the periods of stay with the installed solution

Not all respondents and participants in this pilot project have had the solution installed and running for the same period of time. As explained in previous sections, the LOCS solution has been installed in the homes of the elderly gradually and for over a year. Therefore, there are people who have assessed the solution after more than a year of use while others have only used it a few months before being interviewed again to proceed with this assessment. These differences with respect to the periods of permanence must be taken into account since they could be influencing the results of this study either negatively or positively.

2. Number of surveys per user

Throughout the period of execution of this project, numerous surveys have been made to the people who have participated in it. Some, obviously, were aimed at developing this evaluation and others have been the result of a series of requirements in order to comply with the commitments made to the European Commission as the entity financing this initiative. In addition to the surveys that are part of this evaluation, standardized surveys have been carried out that allow for comparisons between populations from different countries and with different cultural appreciations, in relation to quality of life (EQ-5D and Carer QoL) and experience in the use of technology (UTAUT). On the other hand, every four months a small questionnaire was passed - via telephone - to receive inputs from the participants regarding their experience in the use of technology. Finally, a new questionnaire was also passed with the aim of studying whether there had been any change in the use of technology as a result of the health emergency produced by Covid-19, which led to the declaration of a state of alarm throughout the country and the need for isolation of most of the population of the State. All this volume of questions and calls to users may have influenced a certain loss of interest in providing answers that could be distorting, although to a small extent, the results of the questionnaires prepared as part of the evaluation process.

3. Health Emergency - COVID 19

The health emergency following the Covid - 19 which led to the declaration of the State of Alarm and the confinement of the entire population took place while the final surveys for this assessment were being conducted. More than 100 final surveys were conducted during the first 15 days of containment, so it is likely that the results of these surveys will be biased by this fact.

4.2.4 Analysis of results

In this section we present the analysis of all the information collected according to the main evaluation criteria (relevance, effectiveness, efficiency and impact). Although the evaluation seeks to focus on the impact that the LOCS solution has had on the lives of the people who have participated in the pilot, here we review the rest of the aspects of the chain that explain the underlying theory of change in order to contribute to a better interpretation of the achievements of this initiative.

4.2.4.1 Relevance (in relation to the problem to be solved)

As it is well established, **there is a real problem that the State will have to face, which has to do, on the one hand, with the ageing of the population and, on the other hand, with the need to relieve women, in particular, of these care tasks** that are mostly provided informally, thus generating a direct effect on their possibilities of improving their employability and on their physical and psychological well-being.

In this sense, the intervention is pertinent and, in case its functioning and the generation of positive impacts are demonstrated, it would be susceptible to be assimilated by the Public Administration to attend to the two groups on which it would act looking for improvements: the elderly people who want to maintain an independent life in their homes and (fundamentally) the women who attend or must attend to "their elderly".

4.2.4.2 Effectiveness (in relation to the results to be achieved)

Recruitment of users

The actions designed and executed that sought to attract users to participate in this pilot experience have had an effect. According to the data provided by the call attention records provided by Las Naves and observing the number of home installations of the LOCS system, **the achievement of this result is more than evident.**

This fact would further substantiate the pertinence of the objectives pursued by this solution, since the response of the citizens to participate in this initiative would confirm the existence of a real and felt need for a solution that could reinforce or relieve the care required by the elderly who remain at home.

It is also important to mention that it has been possible to attract users from all the districts of the city, including the districts. In any case, the differences between the volume of care achieved in the central area of the city (where the highest incomes are concentrated) and that achieved in the peripheral neighbourhoods should be highlighted. This could be due to the fact that those people living in the centre and with a higher income level can afford to access other formal care services (such as hiring a formal carer) to take care of these tasks, not needing to resort to finding other alternatives as in this case. On the other hand, this could also be due to the fact that people with higher incomes (mostly) tend to reach old age in better conditions as has been shown in numerous studies on the social determinants of health. To give just one example, in Catalonia, the difference in life expectancy in high-income cities such as Sant Cugat del Vallès was eight years more than in working class cities in the Barcelona beltway such as El Prat de Llobregat or Sant Adrià de Besòs. And within Barcelona, higher income neighbourhoods such as Pedralbes recorded a life expectancy of 11 years more than the working class neighbourhood of Torre Baró, which has the lowest life expectancy in Barcelona, during the period 2009-2013.

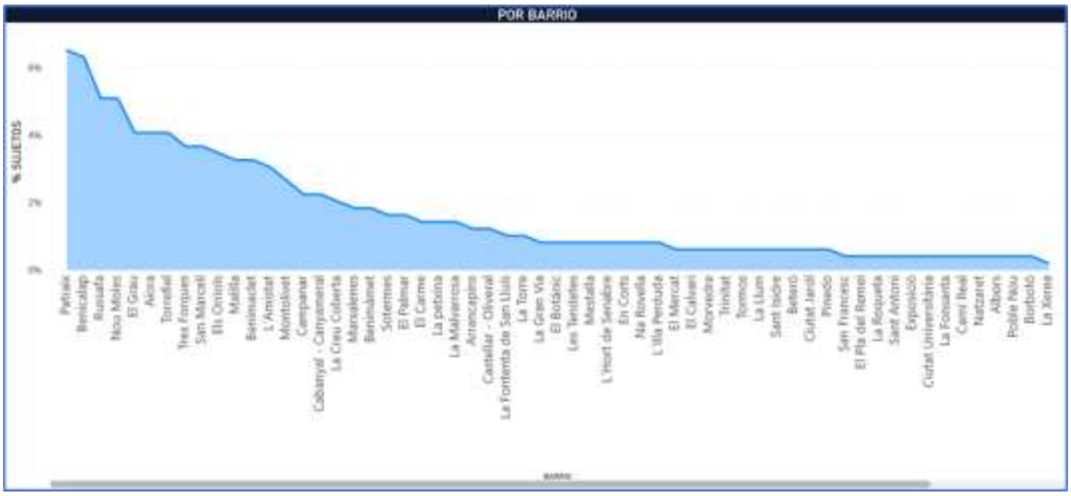


Figure 25: DS VLC distribution of participants per neighbourhood

Another significant aspect in relation to the profiles of the persons captured has to do with the distribution by sex. 88.39% are women and 11.6% are men. We understand that this fact is due, on the one hand, to the fact that women have a longer life expectancy and, on the other hand, to the fact that they are more independent and manage more autonomously at home. Older men, when left alone, tend to move to the homes of their relatives or are transferred to residences. In part, this fact alludes to a question of the gender roles assumed by this generation that have led men to occupy the work spaces of the public sphere with very few resources to assume the tasks of the home in an autonomous and independent manner.

Continuing with the observation of the profiles and social variables of the people who have participated in the pilot, they are between 69 and 101 years old, although 50% of the total are between 83 and 89 years old.

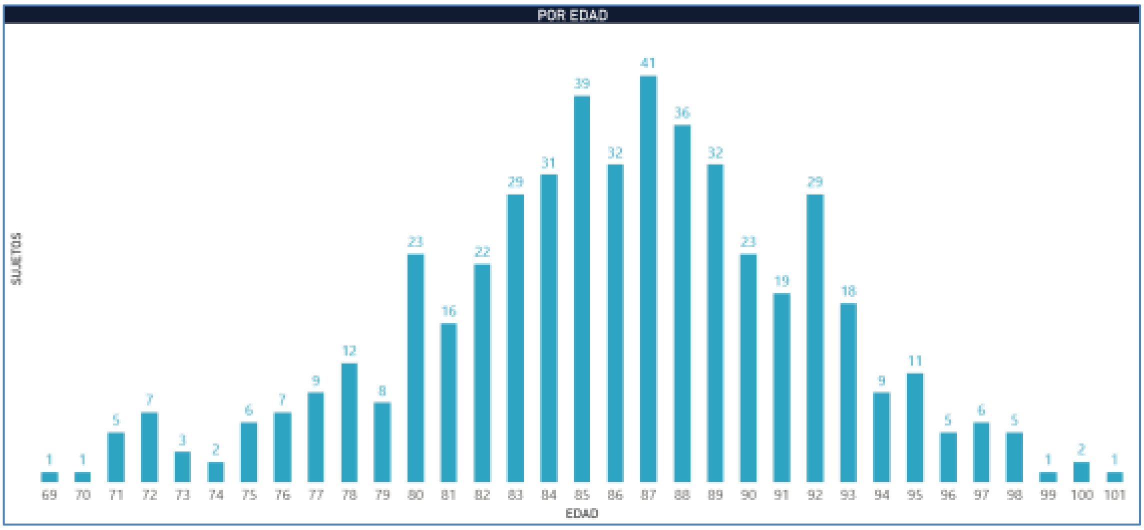


Figure 26; DS VLC distribution of participants per age

With regard to the level of education, we highlight that only 1.63% have higher education, while 49.9% have primary education and nearly 30% have no education at all. This low percentage in the level of studies is due to a generational issue in which there has been little access to the public education system at a time, moreover, when basic education was not yet compulsory as it is now.

Finally, it is very important to refer to the level of dependency (in this case the Clinical Fragility Scale has been used). Of the total number of people surveyed and participants in the pilot, 49.49% said that they managed well, which would indicate that those seeking this type of solution are still in reasonable health and have their capacities in a position to maintain an independent life.

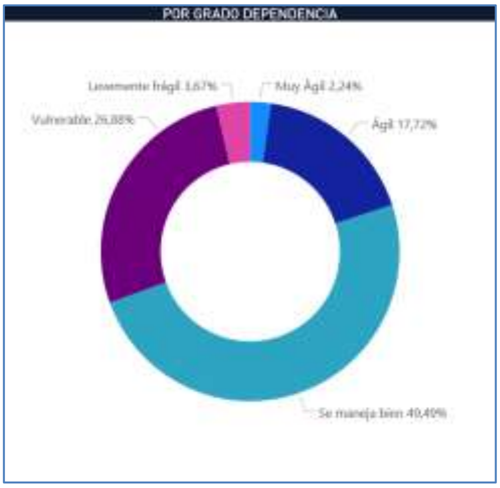


Figure 27; DS VLC distribution of participants per level of frailty

In order to establish the baseline of this project and to observe the socio-demographic variables of the caregivers, a total of 691 surveys have been carried out and the results are as follows

If we look at the caregivers according to their sex, we see that 42.36% are men while 57.64% are women. This data is striking, especially when there are studies carried out by official bodies that indicate that the tasks of care are not so balanced between men and women. In fact, this figure hides two things that should be taken into account. The first has to do with the fact that many of the men who appear here as being responsible for care are actually the children of the elderly who are in charge of the technological part and of observing the APP provided by this solution but who, in reality, delegate to their wives or sisters the effective tasks involved in caring for an elderly person (medical accompaniment, going to cook and attending to their most basic needs). Secondly, this high percentage of men is the result of the fact that, on many occasions, for each of the older people there are several family members who have been discharged from the facility (and who, therefore, have participated in the survey and appear in the records as carers). In these cases, the men are not the main carers, their sisters are, but they do attend to this application and appear as one more carer in this study. This is confirmed in the group interview carried out with the persons responsible for this initiative from the different social service companies that have participated.

By age, it stands out that 60% of the caregivers are between 51 and 62 years old and, the level of studies is very distributed among the different categories. In this case, only 9.46% have primary education, a significant difference with those who have claimed to have higher education, which amounts to 27.51%.

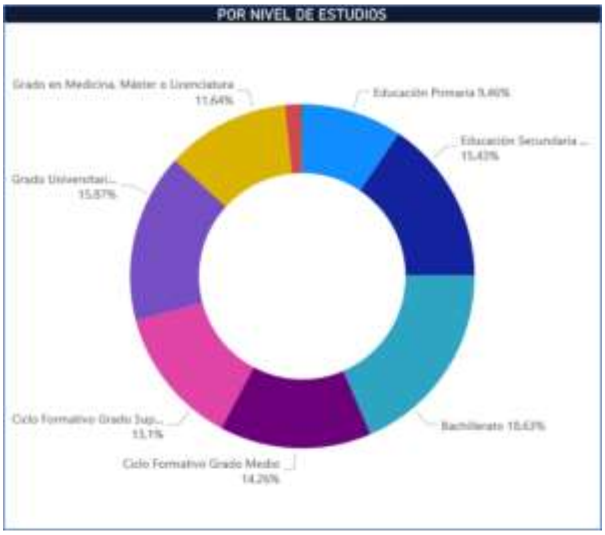


Figure 28; DS VLC distribution of informal carers by level of studies

Finally, it should be noted that if we consider the relationship of the caregivers with the greatest "cared" 82.53% are sons or daughters while 4.22% are nephews, 1.75% brothers or sisters and the rest have another type of relationship with them.

LOCS system (indoor and outdoor)

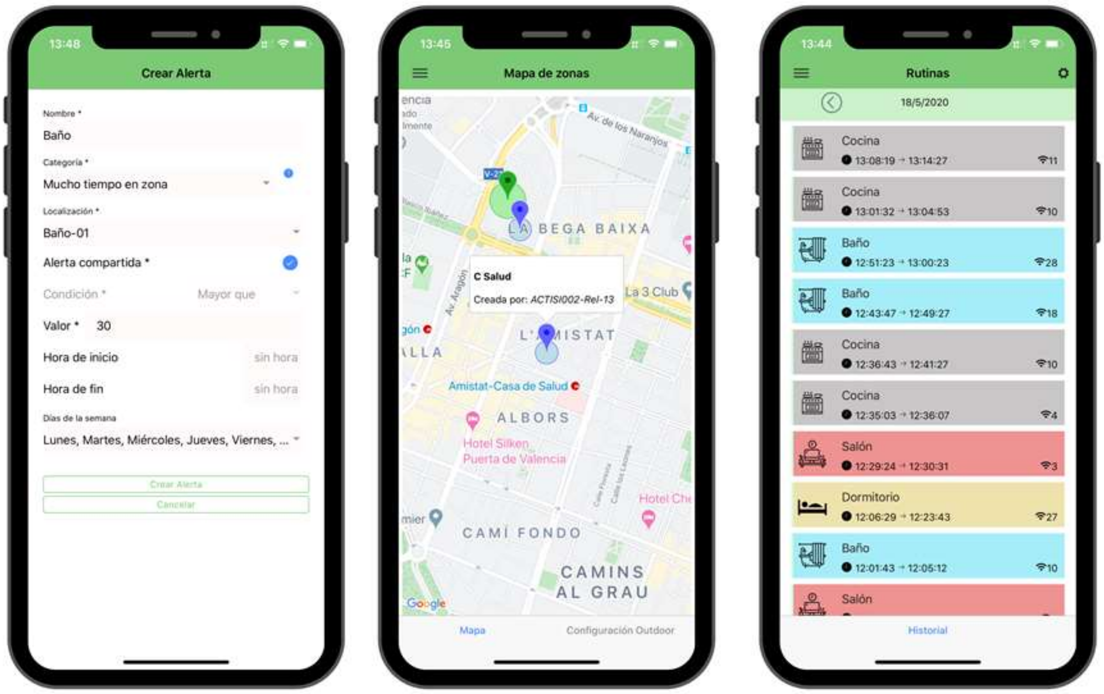
Both the documents describing the operation of the system and the fact that 545 home installations have been carried out show that the technological solution proposed by the company MYSPHERA has been developed almost entirely. Nevertheless, and although the period of execution of this pilot test has contributed to a great extent to the development of this technology, at the time of writing this report, it seems that all the technical problems that hindered the perfect functioning of the **indoor system have been solved, so everything indicates that it is now sufficiently mature to be launched on the market** and, therefore, to be recommended to the Public Administration for its inclusion in the social services portfolio.

Although the number of incidents has decreased considerably as the testing period has progressed and there was a limitation derived from the tablets that concentrate the information collected by the sensors in relation to the need for them to comply with a number of specific characteristics, the high level of wear and tear they suffer as a result of having to be in permanent operation and the dependence on software developed by an external company that may be subject to variations that are not controlled by MySphera, in recent discussions with this company it seems that this problem has been definitively solved.

The outdoor system that geolocates the elderly person when they are away from home, despite not having been the solution initially proposed in the project, is working. The problems that have been generated throughout the testing period are due to minor issues that have been detected and resolved as verified and collated through interviews with both the developers and other key players who have participated in this pilot experience. **In contrast, this system poses a problem in relation to the privacy** of the people being monitored whose movements are perfectly traced through this system and leave little option "to the freedom" of those who carry it.

APP of the family member or caregiver

The mobile application through which caregivers consult the information collected by the sensors installed in the homes of the elderly has been fully developed and is working.



In principle, **this application is working properly**. No evidence has been found that would suggest that major failures are occurring. In any case, the reported failures would have more to do with the operation of the sensor system itself and not with the operation of the application itself.

On the other hand, it is important to emphasize that the application has a very simple operation and is very visual, which allows its use by people who are not very familiar with the use of new technologies. In any case, there are several tutorials to which all the caregivers have access in which it is clearly explained how it works and which are the functionalities it offers.

The fact that the operation is simple is not a minor fact since there is still a large segment of the population that has little or no use of new information and communication technologies. In fact, among the caregivers who have participated in this project, 14% claim to have no or low knowledge about the use of these technologies.

4.2.4.3 Efficiency (in relation to resources required)

As reflected in the chain image of the underlying theory of change, the resources needed to implement a solution that will help older people to maintain an independent life in their own homes are, in addition to the indoor and outdoor monitoring system itself (created from 5 sensors and a Tablet plus a smartphone for the outdoor case), technical staff and specialists in the areas of technology, communication and social services.

In that sense, the solution presented does not require many resources to be implemented. However, it is now worth looking at the impact that both the resources invested, and the time required for its implementation have generated on the population it is aimed at.

The most noteworthy aspects with respect to this evaluation criterion have to do, on the one hand, with the costs derived from the LOCS system itself and those that could be derived from the installation work and its maintenance. On the other hand, all those related to the personnel necessary for the development that all the above implies.

Analysing the costs derived from the personnel is not the task of this evaluation and the volume of these costs has much to do with scale, that is, with the number of installations that would have to be made at any given time and that would therefore require subsequent maintenance. In any case, what we have seen through this experience is that for the development of this pilot test it has been necessary to have an installation technician who, in a full day would be able to successfully complete 5 home installations in different parts of the city. The CORE team dedicated to the development of the software and hardware would be composed of 8 people who must have computer knowledge. On the other hand, for the maintenance and follow-up with the families, depending on the types of incidence, it would be necessary to have technical personnel (the same ones that conform the Core for the most serious cases) and with not qualified personnel to solve the simplest incidences.

The kit that makes up the LOCS system (indoor) costs around 300 euros (Tablet included). The sensors are produced by the same entity that has developed this solution while, for now, the Tablet they use as an additional element to collect the information, comes from other companies that do not guarantee that the production is local.

A priori, and in view of all the elements set out above, it would seem that the costs involved in implementing this solution are more than reasonable, although the impacts that have been generated throughout this year of testing have yet to be analysed in order to determine whether or not the solution is effective. Be that as it may, it can be observed that, **if this solution were to be implemented in a generalised manner, it would contribute directly to the generation of local employment** with all the derived, always positive, benefits that this entails both for those who benefit from these new jobs and for the State and the Social Security system itself.

4.2.4.4 Impact (in relation to the changes produced)

It should be remembered that the conclusions and data collected in this section are the result of the surveys carried out both on older people and carers before and after their participation in this pilot.

As a consequence of the health crisis and also due to the deadlines set by the European Commission, it has been impossible to carry out the final survey on all participants. However, it has been possible to achieve a number of surveys that is a significant sample with respect to the total number of participants. Thus, in the case of older persons, we have 263 comparable before and after surveys, while in the case of caregivers, the number rises to 353.

IMPACT ON OLDER PEOPLE

Sense of Security

One of the changes expected as a result of the use of the LOCS system in the elderly, directly related to the quality of life, had to do with the sense of security felt by the elderly. The data from the surveys carried out show how this feeling of security not only does not increase, but has decreased. However, it is also true that the decrease is slight. The average sense of security after the project is 7.74[5] (on a scale of 0 to 10), which is a **decrease of 2.17% compared to the same perception in users before the project**. In any case, it is important to point out that this figure is an average that has not evolved in a similar way for all users. Just to give an example, we show an image of the evolution of the feeling of security according to districts:[6]

Figure 29: DS VLC Evaluation of the sense of security by neighbourhood

It could be concluded, from the data observed in this regard, that the LOCS **solution is not capable of improving users' sense of security**, which is not necessarily negative. It is logical to think that, with increasing age, the increase in the level of fragility and, above all in a situation such as that resulting from the COVID-19, the perception that an older individual has of this will worsen. And although there are no previous studies regarding the increase or decrease in the sense of security and the age or level of fragility of an older person with which to compare these results, it **could be possible that the LOCS system, although it has not managed to improve this milestone, has managed to contain the decrease in the value of this figure**. In other words, it is very likely that the score that the people who have participated have given to their sense of security would have been lower if they had not been using this solution.

Social Life vs. Sense of Loneliness

The term Solitude has a number of implicit negative connotations, especially among older people. It is for this reason that, in the surveys carried out within the framework of the evaluation work, the use of this term has been omitted, although, to a certain extent, the intention is to assess to what extent the LOCS system could contribute to this group feeling less alone. The average number of assessments has fallen by **7.4%, but when we look at the percentages we see that the data is fairly balanced, as 52% have stated that they have reduced their social life, while the remaining 48% remain at previous levels.** It is likely that this figure is influenced

[5] The evolution is measured as the average obtained before and after the project

[6] Size of "balls" based on the number of respondents in the District, colour is a conditional format based on average response:

RED: Evolution below zero (level has dropped after the project)

GREEN: Evolution above zero (the level has risen after the project) by the isolation to which the entire population of the State was subjected due to the declaration of the state of alarm and the consequent confinement of citizens in their homes. On the other hand, it could also be that, because caregivers can observe the movements of their elders through the application, they have reduced the number of calls and visits to their elders, causing a greater sense of loneliness in the latter.

Self-perception Quality of Life

The average **value of self-perception of quality of life has decreased over this period by 4.83%.** And it is logical to think that this is the case. It must be taken into account that the evolution of time, in the case of older people, plays against them. The physical deterioration of the elderly and the loss of certain capacities and autonomy resulting from the simple passage of time is the reason that could explain this fact. And, although it is true that there are other factors that could influence the perception of quality of life, it is also true that the decline in capabilities associated with age is a key factor that could be taking precedence over others.

Time spent in the elderly's home

The time at which an older person leaves his/her home to move either to a residence or to a relative's home depends on the conjunction of several variables, many of which are observed in this study. The main reasons are due to the state of fragility of the elderly person, his/her degree of autonomy and the level of concern of the person or persons who are responsible for providing care and attention.

What we look at in this study to assess the time in which older people stay in their homes is the number of withdrawals and absences during the project's execution period. The data provided by the associated entities indicate that the number of leaves produced by the transfer of elderly persons to a residence is 14, due to death they amount to 33, 12 leaves are due to reasons of dissatisfaction with the solution, 22 for moving to live with their carers and another 2 due to other reasons. In total, 88 people have left the residence, which means that **16.76% of the total number of users have abandoned this solution.**

In any case, the interesting thing about this point has to do with the cancellations produced by the transfer either to old people's homes or to the carer's home. In this case, the total figure is 36, which is 40% of the total. In relation to the total number of users, **the percentage of people who have moved to a home other than their own is 6%.**

In this sense, if we take into account that the age of the elderly persons who have taken part in this experiment is handled in high age groups (remember that 50% of the users are between 83 and 89 years old) we would be in a position to accept that the figure of those who remain in their homes is more than acceptable, although this statement cannot be categorical due to the fact that we do not have a control group with which to compare and there are no previous studies that indicate the evolution of this variable over time.

Nevertheless, we can make a comparison with what happens in the rest of the country. In 2019, 19.4% of the population was over 65 years old, 3.53% of which lived in a residence. The institutionalized population is strongly aging. This is its main demographic characteristic. In fact, those aged 80 and over account for 79% of the entire population living in residences (i.e. 254,000 people out of the 322,000 living in residences are over 80), whose average age as a whole rose from 85 to 86 between 2011 and 2019. If we compare this data with the data on the number of elderly people who have participated in the project who have moved into homes, we can get an idea of whether the project's objective of keeping elderly people in their homes has been achieved or not. And it seems that, **if we look at the fact that 50% of those who have participated in the sample are over 80 years old, the percentage of transfers would be below the national average.**

IMPACT ON CARERS

Time spent on care

The responses obtained with respect to the evolution of this item show **that 11.11% of the caregivers have spent less time in care from the LOCS facility in the homes of their elderly**. It could be that this decrease is due to the fact that thanks to the use of this system and the information received through the APP, calls and visits to the elderly are reduced when checking that there is movement in the home and that everything is working well.

Figure 30: DS VLC time spent on care with IoT

Care Costs

Although in a lower percentage than in the previous case, there is a certain percentage of caregivers who responded to a lower cost range than that expressed before starting to take part in the pilot test of the operation of the LOCS system.

In this case, **the percentage of caregivers who have reduced their expenses for care is 4.91%.** We would be in a position to state that this saving is a direct cause of the use of the solution since we did not find other variables, unrelated to the project, that could have influenced this fact.

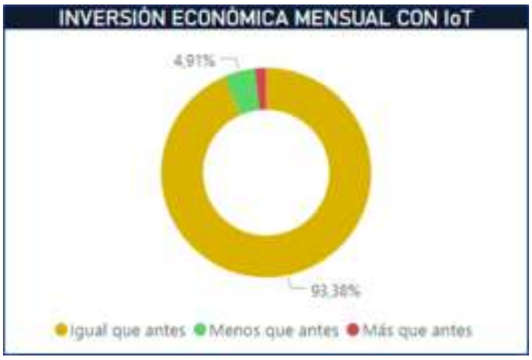


Figure 31: DS VLC monthly financial investment with IoT

Concern for the elderly

In order to measure the evolution of the caregiver's level of concern with respect to the older person, the former were asked to rate, on a scale of 0 to 10 (where zero is no concern and 10 is the maximum concern), how they would rate this aspect of their caregiving role before and after the project. **The average of the responses obtained before was 7.98, while after was 7.94**, which implies a variation of 0.04%. This slight variation could be attributed to the use of the LOCS system. And although it is true that the figure is very low, it should be borne in mind that the logical thing to do in these cases is for the concern of family members and caregivers to increase over time. **That is, under normal conditions this number should have increased.**

In this case, not only has the average been maintained, but also a slight decrease has been achieved.

Impact on Quality of Life

Once the project was completed, the caregivers were asked about the impact they believe this solution has had on their quality of life, measured on a scale of 0 to 10. **The average obtained as a result of the answers is 7.55**, that is, the people surveyed consider that the LOCS solution has a notable impact on their quality of life.

The figure that results in the calculation of the average of the responses obtained is striking since the concrete benefits that we have observed in this study do not seem to be as notable in light of what is explained in the previous points. It is likely, therefore, that this study is overlooking some issues that have a direct impact on the lives of carers. Whatever the case, the data is positive and is one more sample of how the participants value this technology positively.

4.2.4.5 Other aspects to consider

Evaluation of the solution

Apart from the study of the changes generated as a consequence of the use of this solution, this evaluation foresaw to know which is the assessment that the people who have participated in this pilot test make of this new technological solution. Once again, the response to is surprising when compared to the slight impact it seems to have generated in terms of the monitoring of the indicators analysed in the previous section. Thus**, the average figure is 8.7**7 on a scale ranging from 0 to 10, which is close to excellence.

Furthermore, it should be taken into account that during the process in which the caregivers surveyed have participated in this solution, numerous incidents and failures in the operation of the system have occurred. In this sense, it is understood that the communication between the users has been clear and categorical, with almost all of them understanding that this was an exploratory project and that their role was to contribute to the better development of the LOCS system.

On the other hand, this notable evaluation is in line with the **very low percentage of abandonments which,** as mentioned above, **only represent 2.2%** of the total number of installations and slightly more than 13% of the total number of withdrawals that have taken place throughout the period studied.

4.2.5 Conclusions and recommendations

1) **The solution is absolutely relevant** since it seeks to provide answers to a real problem, felt by society and of which the public administration itself is aware, to which solutions must be provided in the short term.

2) The **actions carried out in the search for potential users have been very successful** in view of the results obtained. Not only has it been possible to reach the total number of expected users, but it has also been possible to deploy the solution in all the city's districts and achieve a representative sample of the elderly.

3) The time during which this pilot experience has been carried out has allowed the operation of **the LOCS system** to be improved and adjusted to a point of maturity that indicates that it could be **ready to be launched on the market.**

4) In addition to the information it provides, the fact that it **does not require any interaction** on the part of the elderly and the ease and **simplicity of the associated APP** are the two greatest values of the **LOCS system.**

5) Thinking in terms of replicability and future scalability of the LOCS solution, the development of the **incident resolution protocol is one of the achievements of this experience.**

6) It is observed that the **LOCS solution has the potential to generate local employment** in technical positions, but also in positions that would not require university training. One part of these jobs is associated with the fact that the sensors are produced locally while another would be associated with the fact of installing and monitoring the systems once they are working in the homes of the elderly. Contrary to what might be thought, **this solution does not seem to destroy jobs associated with care**, since the degree of fragility of the people who would be likely to make use of this solution and the socio-economic conditions of those who have resorted to it indicate that it is not a substitute.

7) The price of the system, without considering the costs associated with the installation and maintenance of the service, is reasonable. However, if we take into account the target population to which it should be directed, they raise the cost of the **initial investment that the public administration should make to a figure that would represent 7% of the annual budget for social services** in the year 2020, taking into account that it would only be installed in around 6000 homes that currently have the telecare service. This amount would be in addition to the expenses derived from the services already provided by the public protection system, since the LOCS system is not a substitute for them but rather a complement aimed more at improving care tasks, even though, on the other hand, but very much in the long term, it would mean a saving in the state coffers due to the decrease in the occupation of public residential places.

8) The LOCS **solution has not been shown to have an impact on the quality of life and other aspects associated with it in the elderly.** Neither the self-perception of quality of life, nor the sense of security or social life seems to have improved after the use of this system.

9) According to the observed data and in comparison with what happens in the whole of the Spanish State, everything indicates that the **objective of extending the time of stay in the home of the elderly person could be achieved** through the use of this system.

10) Neither do the caregivers seem to have improved their quality of life. However, **changes and impacts have been observed** in some of them in terms of the **reduction of costs derived from care** (nearly 5% claim to have reduced them during this time) and the **time** dedicated to it (more than 11% claim to have dedicated fewer hours). **The degree of concern for the elderly** remains practically stable, which is good news considering that this concern is highly influenced by the passage of time and the age of the elderly.

11) **The LOCS solution is highly valued by all users**, so we could recommend that this initiative be scaled and that this service be incorporated into the City Council's own social services portfolio, taking into account the recommendations detailed in this report.

RECOMMENDATIONS

1) To study the possibility of **increasing the functionalities** of the LOCS solution, with the capacity even to integrate an emergency call system to replace the current telecare, in order to make it more attractive to the public administration and for marketing in general. In addition, the capacity to incorporate other types of warnings and the development of behaviour patterns that help to prevent or detect some age-related diseases early should be analysed. Likewise, some applications or other types of functions should be included that contribute to the maintenance of an active life on the part of the elderly, which could lead to a better perception of their quality of life and social life.

2) To **develop a "model" of a unified and complete operating system** manual based on the documents developed by the entities participating in this pilot.

3) To establish the **incident resolution protocol,** with the pertinent improvements and including the times foreseen for each one of them, as the "model" of the monitoring and maintenance system to be followed for the externalization and generalization of this service.

4) When the LOCS system is ready to make the leap into the market, it **would be advisable to consider its sale, avoiding the need for the public administration to make an initial investment** that involves the acquisition of depreciable assets and a high budgetary percentage of expenditure allocated to social services. A commercial proposal must also be considered, which will guarantee that this service can be incorporated as such by small and medium-sized social services companies. On the other hand, we must avoid the idea that it is the families themselves who have to make this investment, since we would be running the risk of excluding those families with fewer resources.

5) Establish a series of filters and a system to **ensure that those who participate in the outdoor system do so voluntarily.**

6) To look for an **alternative system to the mobile** one for the follow-up of the elderly people outside the home.

7) **To apply Las Naves' own Transfer Methodology** so that this technological solution can be known and adopted by all those agents who might be interested either because they are responsible for providing solutions to society's public problems, or because they are interested in expanding their business or as a result of belonging to the groups affected by care and the ageing of the population.

4.3 Local sustainability plan

4.3.1 Product/Service Definition

THE ACTIVAGE SERVICE

SERVICE KEYS FOR THE ELDERLY:

1. **Improving the quality of life of our elders** is possible by providing the specific technology and services for it.

2. The main problem that technology encounters in this area is that the elderly are **reluctant to change and unfamiliar with new technologies.**

3 The Activage Service starts from this premise, and is **defined to be "transparent" towards the eldery**, so that it does not interfere in their day to day or invasive, while positively influencing the increase in their degree of independence and safety, in the prevention and detection of risk situations, and in lengthening the time and quality of stay in the home and in its comfort environment.

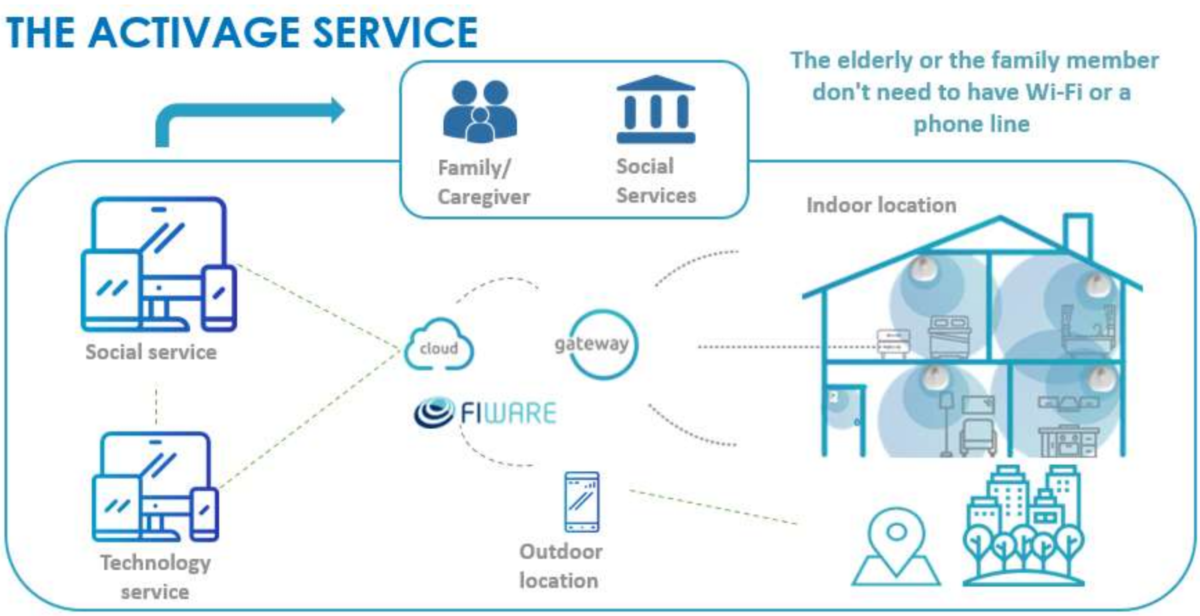
SERVICE KEYS FOR FAMILY/CAREGIVERS:

1. The Activage service is defined to respond to a **real, current and future problem that has to do with an ageing population.**

2. In an increasingly ageing and long-serving society, **the average age of caregivers is also rising** (especially people over the age of 80, who are also the ones in need of more care).

3. There is a **need to support families, and especially women**, of the tasks involved in providing care and facilitating the sharing of such tasks among family members.

4. **APP for easy use and simplicity** that the family member/caregivers can use efficiently regardless of their level of technological knowledge.



For the elderly

Indoor Service: Designed to be transparent to the elderly

Outdoor Service: Currently smartphone device

For the family members / caregivers

Easy-to-use technology, with customizable alarms

For the Social Service Entities / Professional Caregivers

Service adaptable to the needs of the eldest person according to their natural evolution and present state

4.3.2 Market Analysis

4.3.2.1 PESTEL analysis

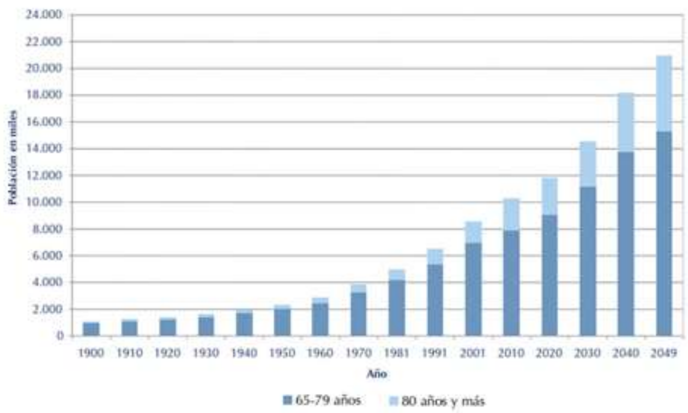
EXTERNAL ANALYSIS – ENVIRONMENT

P (Political)	E (Economical)	S (Social)	T (Technological)	E (Environmental)	L (Legal)
Policies to stimulate competition and innovation will be essential to boost the country's growth in the coming years. **General tendency,** especially in systems of a universal nature, to stabilize and, as far as possible, reduce the number of people receiving care at the institutional level and **favor home care.** The crisis caused by Covid19 represents an added challenge in the field of care for the elderly.	Spain faces a series of demographic challenges, which **could lead to a significant increase in spending related to aging,** such as direct spending on health, long-term care and pensions. Health spending increased by 3.45% in Spain in 2019, and the percentage of spending on ICTs by 4.78%. Despite this, spending on ICTs is still much lower than in neighboring countries. Tensions between fiscal sustainability and political viability.	**The aging of the population in Spain** will accelerate and the rate of dependency on the elderly will more than double between 2015 and 2050, which is the **second highest expected dependency rate of the OECD.** **Aging at home is a trend for the future,** since elderly residences, in addition to having a much higher cost, supposes a break with the closest context to the older person, with what is known, comfortable and familiar for them.	One of the greatest technological innovations that has favored care for people in situations of dependency have been Information and Communication Technologies (ICTs). Innovation in the care of the elderly aims not only to create tools where the user is the elderly person, but also seeks to facilitate the day-to-day caregivers, optimizing their time and work, while achieving savings of care costs and better coverage.	Population aging together with environmental change are, and will be even more, two key challenges that must be addressed to ensure a safe, equitable and sustainable future for all. Among the environmental factors, many of them have a direct impact on the quality of life of the elderly: housing, facilities, neighborhood, problems of coexistence, noise and traffic. Older people are very sensitive to environmental change..	The competence of policies related to older people is responsibility of the Autonomous Communities. Law 39/2006, of December 14, on the Promotion of Personal Autonomy and Attention to people on dependence situation. European Data Protection Regulation 2016/679. Data Protection and Digital Rights Guarantee Law (LOPDGDD) 2018.

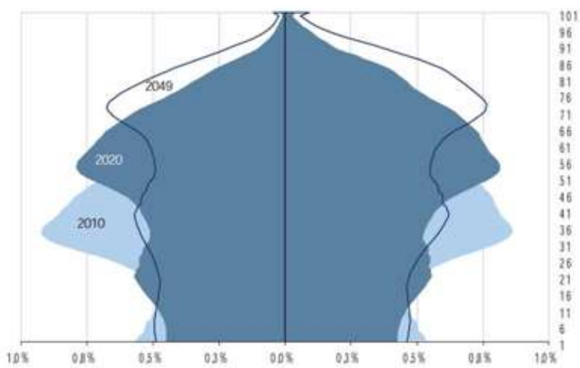
4.3.2.2 Market characterization

SOCIAL AND DEMOGRAPHIC FACTORS

Spain: trend average annual growth of over 65s



Spain: Population Pyramid 2010-2049



Population growth over 65 years has been over 3% and is expected to be above 2% until the middle of this century, causing a spread at the top of the country's population pyramid.

Source: Active Aging White Paper. Imserso

SOCIAL AND DEMOGRAPHIC FACTORS - VALÈNCIA

POPULATION OVER 64 BY AGE
València 2020

	TOTAL	MEN	%	WOMEN	%
65-69	43.953	19.267	43,8%	24.686	56,2%
70-74	41.274	17.891	43,3%	23.383	56,7%
75-79	33.231	13.771	41,4%	19.460	58,6%
80-84	23.324	8.871	38,0%	14.453	62,0%
85-89	16.975	5.686	33,5%	11.289	66,5%
90-94	7.413	2.083	28,1%	5.330	71,9%
95 y más	2.158	485	22,5%	1.673	77,5%
TOTAL	**168.328**	**68.054**	**40,4%**	**100.274**	**59,6%**

The total Población in Valencia in 2020 are of 801,545 persons. The population over 64 years old in Valencia is 168,328 people (21% of the total). The percentage of males is 40.45 and 59.6% are women.
* We have no information on people over 64 without a functional family member.

PEOPLE LIVING ALONE - OVER 64 YEARS OLD
València 2020

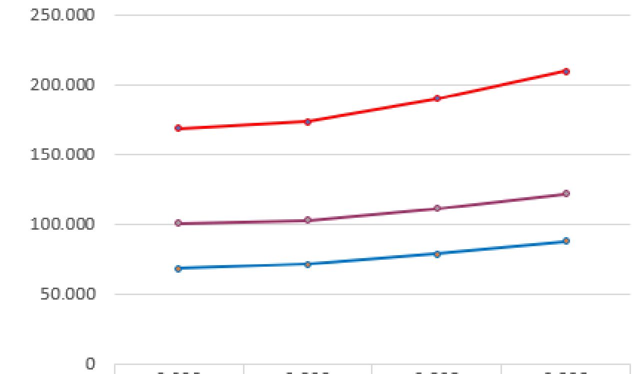
	TOTAL	MEN	%	WOMEN	%
65-69	8.530	2.861	33,5%	5.669	66,5%
70-74	8.732	2.494	28,6%	6.238	71,4%
75-79	8.394	1.900	22,6%	6.494	77,4%
80-84	7.464	1.458	19,5%	6.006	80,5%
85-89	6.751	1.222	18,1%	5.529	81,9%
>=90	4.422	834	18,9%	3.588	81,1%
TOTAL	**44.293**	**10.769**	**24,3%**	**33.524**	**75,7%**

There are 44,294 people over the age of 64 living alone in Valencia and 75.7% are women.
18,637 people over the age of 80 live alone in Valencia.

Source: Census Valencia 2020

SOCIAL AND DEMOGRAPHIC FACTORS - VALÈNCIA

POPULATION PROJECTIONS OVER 64 2020-2033 - VALENCIA



	2.020	2.023	2.028	2.030
TOTAL	168.328	173.385	189.801	209.468
MEN	68.064	71.078	78.577	87.654
WOMEN	100.274	102.307	111.224	121.814

PROJECTIONS OVER 64 YEARS IN VALENCIA:

By 2020, the over-64s in Valencia accounted for 21% of the total population.

In 2028 this proportion will rise to 23%.

By 2033, people over the age of 64 will make up 25.1% of the total population.

In addition, the percentage of women will remain higher than that of males, reaching 27.6% compared to 22.3% of males compared to the total population by sex.

Source: Valencia townhall Statistics Office 2019 and 2020

MUNICIPAL PUBLIC SERVICES:

Tele-attendance: (7,665 users in 2019)

Home Help Service (2,150 users in 2019)

Estimated total: 9,815 users (23% of the elderly alone)

"Menjar a casa" – eat at home (681 users in 2019)

Waiting lists

4.3.3 Competition/sector Analysis

4.3.3.1 Competition profile analysis

EXTERNAL ANALYSIS – COMPETITORS

	VALUE PROPOSITION	INDOOR FORMAT	OUTDOOR FORMAT	INDEPENDENT OF A PHONE FIXED LINE OR WI-FI	TRANSPARENCY FOR THE ELDERLY	SERVICE ADAPTED TO THE EVOLUTION OF THE ELDERY	SCALABILITY / INTEROPERABILITY (FUTURE NEW SERVICES)
Beprevent	⊖	✓	✗	✓	⊖	✗	✗
True-Kare GPS TRACKER	✓	✗	✓	✓	✓	✗	✗
Cruz Roja Cuídate+ carelife	✓	✓	✗	✗	✗	✓	✓
Cruz Roja LoPe	✓	✗	✓	✓	✓	✗	✗
Serena orange	⊖	⊖	✓	✓	✓	✗	✗
ACTIVAGE VALENCIA	✓	✓	✓	✓	✓	✓	✓

Figure 32: DS VLC competitors analysis

4.3.3.2 Porter's 5 forces analysis

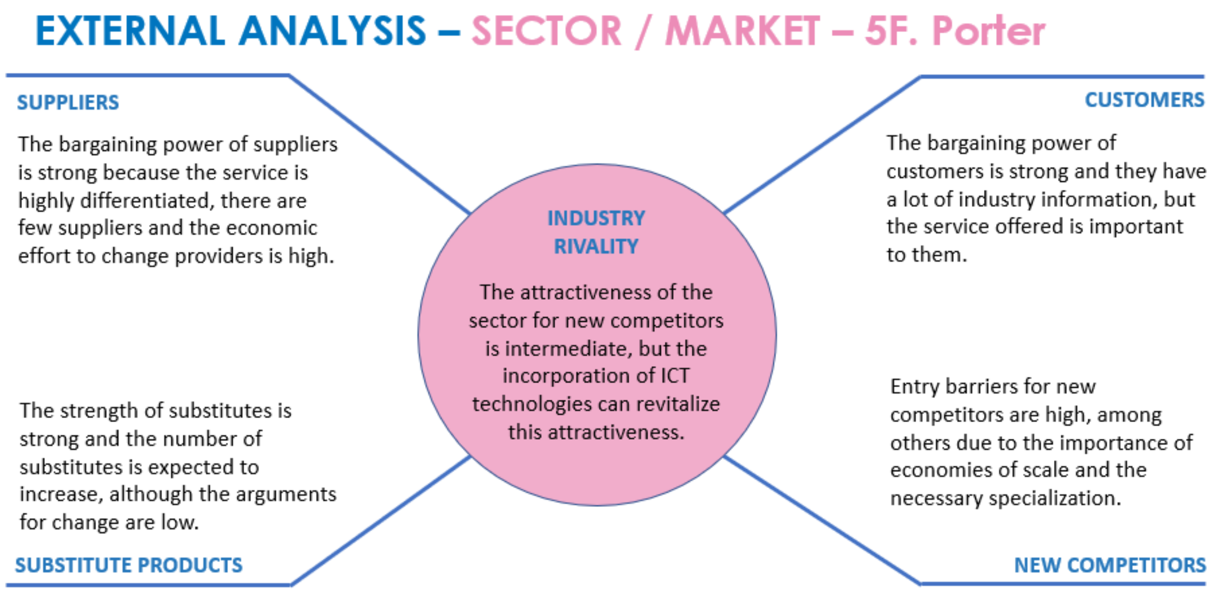


Figure 33: DS VLC Porter's 5 forces analysis

4.3.3.3 SWOT analysis

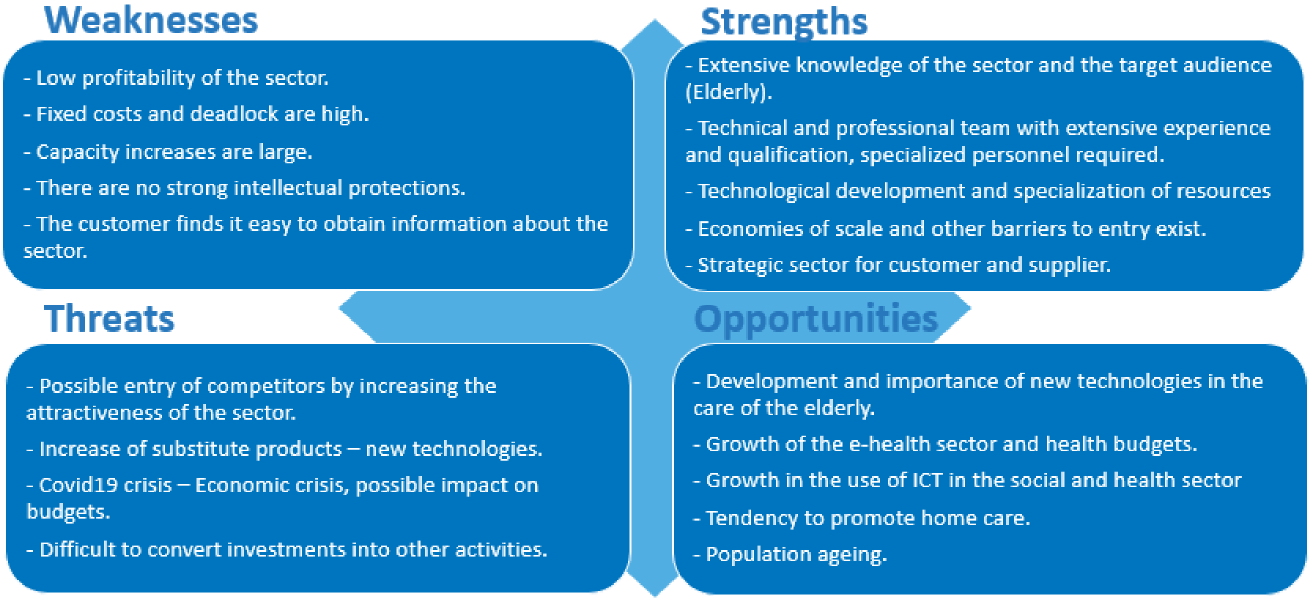


Figure 34: DS VLC SWOT analysis

4.3.4 Value proposition and Targeted Customers

TARGET CUSTOMER:

Persons over 65 years of age or dependents (of any age) residing alone and fulfilling any of these characteristics:

- Medium or high degree of fragility.
- Phase of incipient, mild or moderate cognitive impairment.
- No family members or functional family members in charge of your care.
- With medium/low purchasing power.
- With and without pets (specific "Pet Kit" required).
- Possibility to monitor older couples living together.

The monitoring of the elderly for the detection of risk situations and early detection of problems together with a service adapted to the individual needs of the elderly, **promote their independence and quality of life, increasing social welfare and promoting savings and better social coverage by the administration.**

THE ACTIVAGE SERVICE - ADDED VALUE FOR THE FAMILY

VALUE PROPOSITION CANVAS RESULTS

Direct Benefits:

1. Tranquility to know the real routines of the elderly and that is well attended and controlled in case of any eventuality.
2. Allows you to distribute care time with other informal caregivers.
3. Lengthen the time that the elderly can live in their home, properly cared for and controlled.
4. It allows to care for and monitor the elderly even if the family member is far away.
5. Ensures the comfort conditions of the elderly.

Problems solved:

1. Alert of possible worsening, cognitive decline or other complications.
2. Warning of serious situations.
3. Support in the care and vigilance of the elderly (loneliness of the caregiver – usually woman, also older).
4. It relieves the caregiver's sense of guilt.
5. Introduce technology by avoiding the technology gap..
6. The eldest person does not need to pay for Wi-Fi or a phone line.
7. Increases their self-perception of quality of life.

THE ACTIVAGE SERVICE - ADDED VALUE FOR THE ELDERLY

VALUE PROPOSITION CANVAS RESULTS

Direct benefits:

1. Increased safety and autonomy at home (Indoor version).
2. And on the outside (Outdoor version).
3. It extends the time that the elderly can live in their home and environment known, cared for and controlled properly.
4. Early detection of possible worsening and other complications.
5. Improves the self-perception of quality of life for the elderly.

Problems solved:

1. Their family / caregiver is calmer and it is reflected in their relationship, helping not to feel a burden.
2. They don't want to go to a residence or his children's house, and the service allows them to gain some autonomy.
3. They don't need to interact with the technology solution to work properly (avoid the technology gap).
4. It increases the chances of maintaining the independent life of people over the age of 65.
5. (For the non-family elderly: Assured that someone is looking after their well-being at home.

THE ACTIVAGE PILOT RESULTS - ELDERLY

IMPACT ON QUALITY OF LIFE ACCORDING TO DEGREE OF FRAGILITY (ASSESSMENT OF THE ELDERLY)

PUNTUACIÓN	Between 0 and 4	Between 5 and 7	Between 8 and 10
Fragility 1	0%	100%	0%
Fragility 2	17%	30%	**53%**
Fragility 3	8%	42%	**49%**
Fragility 4	26%	42%	**32%**
Fragility 5	49%	45%	6%

The elderly people who are most impacted by the service are the ones who maintain greater mobility and activity. With high fragility the impact on the quality of life of the solution decreases (increasing in the case of their family members).

DEGREE OF SATISFACTION WITH THE SERVICE (ASSESSMENT OF THE ELDERLY)

	Between 0 and 4	Between 5 and 7	Between 8 and 10
NUMBER OF PARTICIPANTS IN THE SURVEY	22	40	231
SATISFACTION GRADE OF THE ELDERLY	10,2%	17,2%	**72,7%**

Of the 293 seniors surveyed, 72.7% report having a level of service satisfaction of between 8 and 10 points out of 10.

The average age of the pilot's senior users is 85.9 years
86.8% are female and 13.25% are male

THE ACTIVAGE PILOT RESULTS - FAMILY / CAREGIVER

UTILITY OF THE SERVICE ACCORDING TO YOUR EXPERIENCE IN THE PILOT (ASSESSMENT OF FAMILY)

	Between 0 and 4	Between 5 and 7	Between 8 and 10
NUMBER OF RELATIVES PARTICIPANTS IN THE SURVEY	3	45	306
DEGREE OF USEFULNESS FROM THE EXPERIENCE OF THE FAMILY	0,7%	7,2%	**92,1%**

92.1% of family members participating in the pilot value that the service has a utility level of between 8 and 10 points out of 10.

DEGREE OF SATISFACTION WITH SERVICE (FAMILY ASSESSMENT)

	Between 0 and 4	Between 5 and 7	Between 8 and 10
NUMBER OF RELATIVES PARTICIPANTS IN THE SURVEY	2	53	300
FAMILY SATISFACTION DEGREE	0,7%	9,6%	**90,2%**

Of the 355 family members participating in the pilot surveyed, 90.2% report having a degree of satisfaction with the service of between 8 and 10 points out of 10.

The average age of the family/caregivers pilot users is 55.6 years
58.5% are female and 41.5% are male

THE ACTIVAGE PILOT
RESULTS - FAMILY / CAREGIVER

DISPOSITION TO THE PAYMENT OF THE FAMILY MEMBER/CAREGIVER ACCORDING TO THE LEVEL OF FRAGILITY OF THEIR ELDERLY

Willing to pay /FRAGILITY	fragility/ If willing to pay	fragility/ Unwilling to pay	fragility/ depends
Fragility 1	2 66,7%	- 0,0%	1 33,3%
Fragility 2	17 53,1%	4 12,5%	11 34,4%
Fragility 3	71 **68,9%**	14 13,6%	18 17,5%
Fragility 4	65 **56,5%**	23 20,0%	27 23,5%
Fragility 5	30 53,6%	13 **23,2%**	13 23,2%
TOTAL	187	54	71
% willingness to pay according to fragility	**59,9%**	17,4%	22,7%

The relatives with the most willingness to pay are those who have older people with fragility levels 3 and 4, although contrary to what we could think in the initial way, also those of fragility 5 would have a high disposition to the payment of the service.

The price variable is one of the main factors when it comes to indecision in possible payment.
Only 17.4% of the family members participating in the pilot would not be willing to pay for the service and the less willing would be those of relatives with fragility 5 (public service?).

4.3.5 Strategy for local sustainability

4.3.5.1 Open Data strategy

Table 35: DS VLC dataset participants information

Dataset name	**DS2.Participants_information**
Data identification	
Data set description	This dataset contains information on the socio-demographic characteristics of each participant. The data maintains the general format of these characteristics collected by other DSs and allows their association to any DS VLC study dataset from the link with a unique identifier "uid". It includes 20 specific fields with societal and economical aspects including information about topics such as education level, living conditions and other relevant information to carry out sociological studies and contextualize other datasets.
Source (i.e. which device?)	This dataset was obtained from anamnesis of patients and caregivers from information collected by ACTIVAGE users.
Partners responsibilities	
Owner of the device	The dataset was obtained by physical means and later digitized for exploitation.
Partner in charge of data collection (if different)	ATENZIA, GESMED, ISI

Partner in charge of data analysis (if different)	LAS NAVES
Partner in charge of data storage (if different)	LAS NAVES
Standards and metadata	
Info about metadata (Production and storage dates, places) and documentation?	Data collected on the dataset has been transformed to cope with JSON format and validated through ingestion tools form DS2 in order to ensure the uniqueness and conformity with the data model of the collected instances.
Standards, Format, Estimated volume of data	Data will be provided in csv format; Each data will be encompassed with each related metadata to provide the information corresponding to the type of data; that is: string, date (ISO-8601), Int64, float64, bool, etc.
Data exploitation and sharing	
Data exploitation (purpose/use of the data analysis)	This dataset provides sociodemographic context to collected data from DS VLC. The exploitation purpose includes the characterisation of ACTIVAGE end users to be able to obtain particular results for specific small cohorts that may be relevant for exploitation models by applying studies on specific target groups.
Data access policy / Dissemination level (Confidential, only for members of the Consortium and the Commission Services) / Public	The full dataset will be confidential and only the members of the DS and/or Consortium will have access on it. Furthermore, if the dataset or specific portions of it (e.g. metadata, statistics, etc.) are decided to become of widely open access, it will be uploaded to the ACTIVAGE open data platform. Of course, these data will be anonymized, so as not to have any potential ethical issues with their publication and dissemination.
Data sharing, re-use and distribution (How?)	The data sharing policy will be based on the specific licence established in D1.13. It will be based on a permissive base licence that allows the negotiation of sub-licences in the style of MIT-type licences, allowing the exploitation and level of access and specific use for each request for access to the data. In addition, public access will be given to the metadata describing the dataset to encourage its search, interoperability, preservation and dissemination, as well as the assignment of a DOI.
Embargo periods (if any)	In order to ensure data quality and to produce original and genuine studies DS VLC embargo period will be set in 1 months from the time of publication (after concluding data collection). Data access will be fully controlled by DS VLC policies.
Archiving and preservation (including storage and backup)	

Data storage (including backup): where? For how long?	Data is collected and backed up in Las Naves servers. It will be available through the open data repository for future studies.

Table 36: DS VLC dataset location

Dataset name	**DS2.Locations**
Data identification	
Data set description	This dataset is composed of instantaneous location instances obtained from the LOCS application for the real time monitoring of the users participating in the DS Valencia study. The data is obtained from sensors installed at the houses of the participants. Sensors register presence in the different rooms, as well as main door opening, and algorithms in the backend process sensors information and infer locations.
Source (i.e. which device?)	This dataset was collected automatically through the use of a gateway that send the information to the IoT platform, where process and storage takes place.
Partners responsibilities	
Owner of the device	MYSPHERA
Partner in charge of data collection (if different)	same
Partner in charge of data analysis (if different)	same
Partner in charge of data storage (if different)	same
Standards and metadata	
Info about metadata (Production and storage dates, places) and documentation?	Data collected on the dataset has been transformed to cope with JSON format.
Standards, Format, Estimated volume of data	Data will be provided in csv format; Each data will be encompassed with each related metadata to provide the information corresponding to the type of data; that is: string, date (ISO-8601), Int64, float64, bool, etc.
Data exploitation and sharing	
Data exploitation (purpose/use of the data analysis)	This dataset provides room location positions as a result from collected data in Valencia DS.

	The exploitation of the data will be based on the production of academic studies in which it will be applied to test the hypotheses set out in the study protocol and to extend the information relating to this domain in the field of active ageing.
Data access policy / Dissemination level (Confidential, only for members of the Consortium and the Commission Services) / Public	The full dataset will be uploaded to the ACTIVAGE open data platform. Of course, these data will be anonymized, so as not to have any potential ethical issues with their publication and dissemination.
Data sharing, re-use and distribution (How?)	The data sharing policy will be based on the specific licence established in D1.13. It will be based on a permissive base licence that allows the negotiation of sub-licences in the style of MIT-type licences, allowing the exploitation and level of access and specific use for each request for access to the data. In addition, public access will be given to the metadata describing the dataset to encourage its search, interoperability, preservation and dissemination, as well as the assignment of a DOI.
Embargo periods (if any)	In order to ensure data quality and to produce original and genuine studies Valencia DS embargo period will be set in 3 months from the time of publication (after concluding data collection). Data access will be fully controlled by Valencia DS policies.
Archiving and preservation (including storage and backup)	
Data storage (including backup): where? For how long?	Data is collected and backed up in Mysphera servers. It will be available through the open data repository for future studies.

Table 37. DS VLC Dataset Evaluation

Dataset name	**DS2.Evaluation**
Data identification	
Data set description	This dataset contains the results of the evaluation questionnaires carried out in DS VLC evaluation. Specifically, the dataset is composed of the results of the following tests: UTAUT, Eq5d3l, and carerqol7d. Refer to each of the tests for more information.
Source (i.e. which device?)	This dataset was obtained from anamnesis of patients and caregivers from information collected through electronic record system software Rotator.
Partners responsibilities	
Owner of the device	Las Naves

Partner in charge of data collection (if different)	ATENZIA, GESMED, ISI
Partner in charge of data analysis (if different)	LAS NAVES
Partner in charge of data storage (if different)	LAS NAVES
Standards and metadata	
Info about metadata (Production and storage dates, places) and documentation?	All the questionnaires are provided with the relevant metadata regarding the questions and option choices as well as the score and procedure to obtain it/ or documentation.
Standards, Format, Estimated volume of data	All the questionnaires in use have been validated for clinical research as well as the data collection tool.
Data exploitation and sharing	
Data exploitation (purpose/use of the data analysis)	This dataset provides results of the gathered information from evaluation questionnaires carried out in DS VLC. The exploitation of the data will be based on the production of academic studies in which it will be applied to test the hypotheses set out in the study protocol and to extend the information relating to this domain in the field of active ageing.
Data access policy / Dissemination level (Confidential, only for members of the Consortium and the Commission Services) / Public	The full dataset will be confidential and only the members of the DS and/or Consortium will have access on it. Furthermore, if the dataset or specific portions of it (e.g. metadata, statistics, etc.) are decided to become of widely open access, it will be uploaded to the ACTIVAGE open data platform. Of course, these data will be anonymized, so as not to have any potential ethical issues with their publication and dissemination.
Data sharing, re-use and distribution (How?)	The data sharing policy will be based on the specific licence established in D1.13. It will be based on a permissive base licence that allows the negotiation of sub-licences in the style of MIT-type licences, allowing the exploitation and level of access and specific use for each request for access to the data. In addition, public access will be given to the metadata describing the dataset to encourage its search, interoperability, preservation and dissemination, as well as the assignment of a DOI.
Embargo periods (if any)	In order to ensure data quality and to produce original and genuine studies DS VLC embargo period will be set in 1 months from the time of publication (after concluding data collection). Data access will be fully controlled by DS VLC policies.

Archiving and preservation (including storage and backup)	
Data storage (including backup): where? For how long?	Data is collected and backed up in Las Naves servers. It will be uploaded to the open data repository for future studies.

4.3.5.2 Continuation strategy

The continuation strategy is based on the following lines of actions that have been worked during the last months of the project:

- To ensure the service of the pilot until the end of the project.
- To generate awareness and knowledge about the ACTIVAGE solution and, especially its benefits during COVID19 confinement.
- To prepare strategies to ensure the continuation of the service in the face of different possible scenarios of financing.

Given that the project Tasks concerning operation of the service deployed within users finished by June 30th, Las Naves, the DS Leader, decided to finance the costs of the current service for three additional months, through its municipal budget, until the end of the project in September 30th. Thus, it would allow to go on progressing in the exploration of sustainability planning. This is currently running for the 460 installations still in operation. The interest of City Council in maintaining the pilot and the service is clear, but the continuity scenarios of getting funding once the project ends are conditioned to the regulations to be applied to comply with the Public Sector Contract Act.

During the months in confinement because of COVID19, partners identified the opportunity to put into value and generate awareness around ACTIVAGE solution and how it had helped the participants, contributing both to decrease the digital divide providing smartphone for social interactions to those older adults without any, and also to increase the peace of mind of the relatives. Thanks to the ACTIVAGE solution, they received valuable information about their older people activities each day, something even more relevant in a situation of mobility restrictions and interruption of physical visits and care pathways. An informal questionnaire and participants testimonials were collected by care service providers. Hence, Las Naves, DS leader, carried out a communication campaign on media (radio, press) and social networks to support this objective. MYSPHERA organised a successful webinar to present ACTIVAGE pilot and solution tested in València with the attendance of representatives of public administrations, private sector and citizens interested in the service.

It was planned to organise and hold a massive event for ACTIVAGE participants in València, in a public open place for end of September to generate awareness on the project, and to thanks participation of more than 1500 people in the project. The Mayor was confirmed, and other relevant local representatives, but this event has been cancelled due to COVID19 pandemics and risks of infection of this vulnerable population.

Also a final local event to present the results of the project will be organised by the end of the project, targeted to other municipalities, Public Administration, health and care professionals, provided the evolution of pandemics allows it, in person or in remote.

In order to tackle with the situation of uncertain funding after the end of the project, partners have developed several actions:

- Accessing to market, private sector funding:
    - To explore the interest of the participants, specially relatives or informal caregivers, to continue with the service after the end of the project, and their availability to pay

for it, in case of a scenario on funding by private sector or purchase of the service, without public funding.

  - Partners (technological firm and care service providers) have been defining (as seen in previous parts of this document) possible levels of services according to the value proposition developed within the business model definition process (described above) and how to introduce them and ACTIVAGE results in their individual company's strategies. Obviously this is confidential and sensitive information that has not been shared with the rest of the local partners, but it has been done in preparation for a scenario without public funding and sustainability supported by private sector / market.
  - In September, partners will organise some Focus Groups to deep on some conclusions stemming from local evaluation, that have to deal with the value perceived from the solution by relatives or informal caregivers. This will contribute to empower the value proposition and service definition to keep engaged prescribers of the ACTIVAGE solution.

- Accessing to public sector funding:
  - Las Naves has organised informal meetings with representatives and policy makers for municipal Social Services in order to detect their needs and those that ACTIVAGE could meet. These representatives have been continuously informed on the progress of ACTIVAGE and have participated in several actions within the project.
  - Partners have been jointly working on the definition of services, costs, and so on to be prepared for an eventual future public procurement related to care and social services aligned with ACTIVAGE solution. They are also exploring the possibility of creating a joint venture to go together.
  - Las Naves has included ACTIVAGE as a project pilot to be analysed as case study for a possible Innovative Public Procurement process, within the framework of a grant from AVI (Regional Innovation Agency).
  - Las Naves plans to carry out its own methodology for transfer of good practices to public policies for ACTIVAGE project. This will be after the project.

4.3.5.3 Replication strategy

The Regional Government (Generalitat Valenciana) stated its interest in ACTIVAGE DS_VLC pilot and suggested its replication as new pilot not only in more users in the city of València, but also in another municipality of Alicante province, and a rural area of the North of Castellón province. This new pilot sites would test the solution in other environments such as rural areas, large size municipality and medium size municipalities. The idea in this case was to replicate the service tested within ACTIVAGE project, but also tailored to the specific needs of each kind of municipality (different sizes and geographical environments). Thus, local ACTIVAGE partners worked and developed a proposal to fulfil this requirement. This was before the pandemics, the state of alarm and the confinement. The proposal has been developed, but the Regional Government is attending other priorities and this alternative way is currently in stand-by.

On the other side, each partner is also exploring the possibilities of business in other municipalities around València, as possible market.

4.3.5.4 Scaling-up strategy

DS _VLC strategy for scaling-up is based on reaching new users and also new services.

As for reaching new users, the main milestone achieved is that ACTIVAGE services and technology have been included in the Municipal Post-COVID Reconstruction Plan for the city of

València, as one of the measures to implement in the following years, to reach the objective of 5000 users. This Plan has been recently approved by all parties of Local Government at València City Council. The Plan has to be developed before the end of the year to a more operative level to allocate the resources needed.

As for deploying new services, the pilot has allowed to identify improvements and new functionalities necessary to fulfil users' needs. Thus, these are some examples of improvements to be included within the next months into ACTIVAGE solution:

- New kind of gateway device, different form the current tablet used as gateway, that has caused most of the incidences attended during the project;
- The current Outdoor product is a smartphone format and a technological evolution is taking place to allow the use of a key ring or pendant that is cheaper and easier to carry for the elderly;
- Introduction of new device that will allow the system to distinguish presence of pets and another person in the room, including thus new type of customers,
- Data mining and AI for early detection.

5 DS 3 MAD final report

5.1 DS experiment report

5.1.1 User engagement report

5.1.1.1 User engagement strategy

From the very first moment at Madrid Deployment Site (Madrid DS) we understood that with the Use Cases that we were deploying and the technology that was involved we needed a very strong and powerful User Engagement strategy because users had to be very active in order to collect reliable data.

Madrid DS is based on the early detection and prevention of cognitive and physical decline using an IoT based solution to monitor and consequently provide interventions to maintain the independent living in a smart environment.

In this sense we designed a first user engagement strategy for our phase I involving Reference Use Cases 5 and 6 and then with the COVID-19 outbreak we designed a second one for Reference Use Cases 1 and 7 deployed in phases 2 and 3.

User engagement strategy inspirational driver: The creation of MAHA

Our first target was the creation of MAHA, a community in which not only older adults were involved in Active and Healthy Aging practices with the use of IoT technologies but also, a community in which there was a rethinking of the process of aging in terms of life purpose and identity.

MAHA was created to give a step further: To avoid the loss of identity and motivation in the third age and create a new identity for the older adults in which they became empowered citizens with capability to plan their own ageing process, being a fundamental pillar of their society and becoming part of the IoT-AHA community.

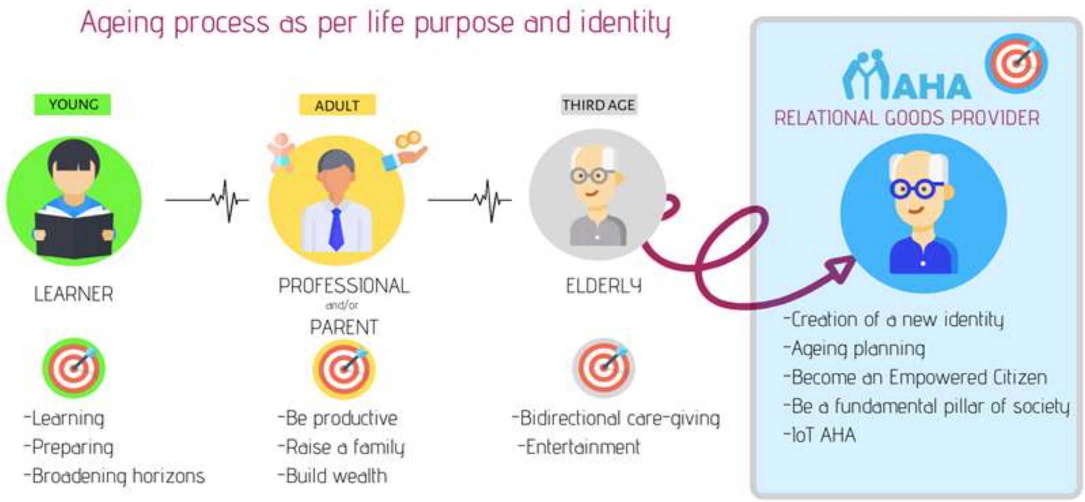


Figure 35. DS MAD ageing process involving MAHA

At the same time, MAHA puts up a flag in order to obtain the recognition from our society, based on the fact that older adults are the main providers of relational goods and services (i.e. companionship, time sharing…) , and the importance that these goods (i.e. companionship, time sharing, etc.) have for the sustainability of the building of our societies. Figure 36 shows two models of understanding and approaching ageing.

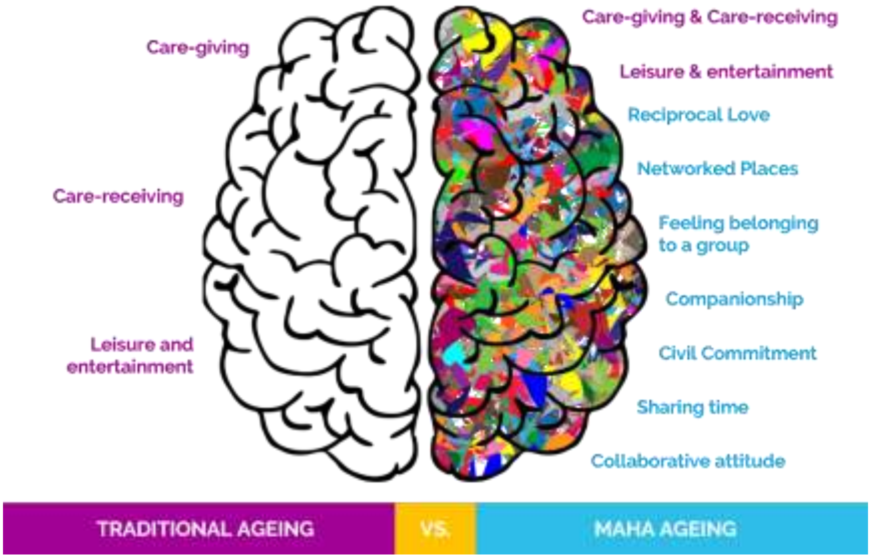


Figure 36. DS MAD Traditional ageing vs. MAHA ageing

In MAHA we decided to gradually introduce and use the methodology based on the End- User engagement toolkit U4IoT with the following steps.

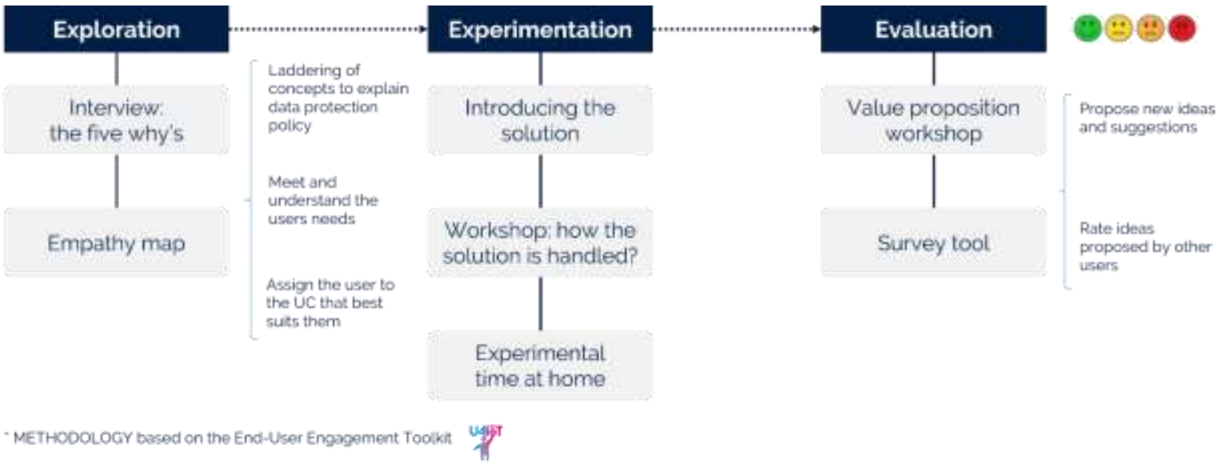


Figure 37. DS MAD User engagement methodology

We have also designed a set of actions focused to promote the user engagement experience at the different levels defined for the local ecosystem:

- Inspiring Events
- Creative & Leisure Activities
- Institutional partnerships
- International Scale Up

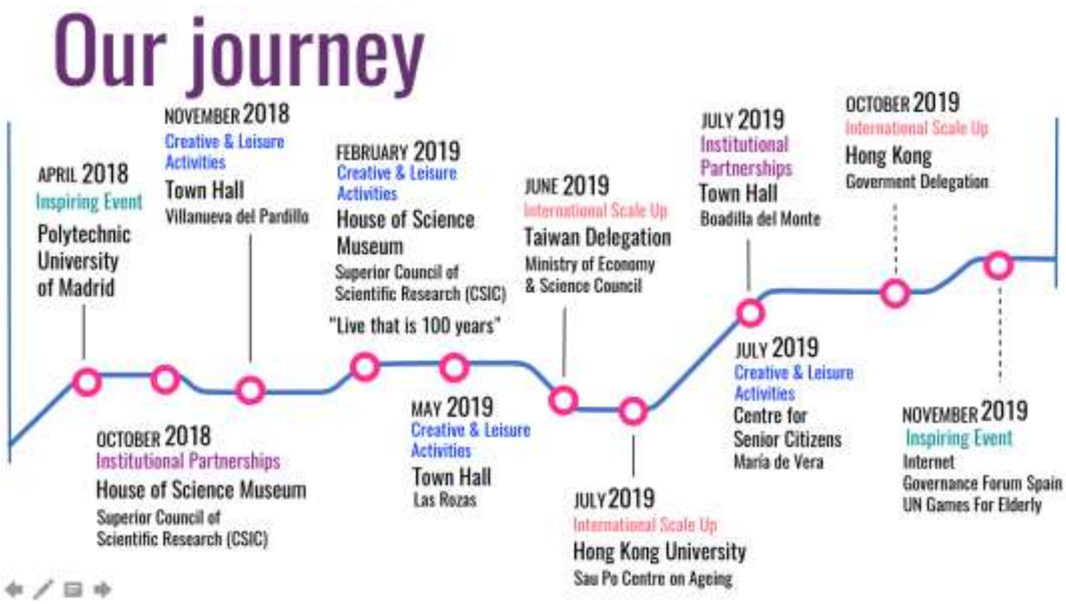


Figure 38. DS MAD User engagement - one year example of our journey

User engagement strategy in times of COVID: reorientation and new ways

The impact of COVID-19 Outbreak on the user engagement strategy was critical, so we had to cancel all the activities that were being held and forced to think of new tools.

From the first moment it was decided that it was very important to continue keeping in touch with our MAHA community to keep the sense of a community, especially during the COVID-19 lockdown complicated circumstances. Our strategy was based on phone calls and at the same time we decided to enhance our dashboard as our main tool for engagement and complement it with WhatsApp groups.

In fact, during the COVID-19 outbreak, MAHA dashboard became even more relevant due to the difficulty of direct contact with the elderly. This tool provides caregivers with the possibility of a daily monitoring of the elderly without a direct contact, giving them personalized attention according to their needs and carrying out the intervention considered appropriate for each situation. It also includes a direct communication with the users, so advice and personal intervention can be done using this channel. In addition, the MAHA dashboard uses several techniques of visual analytics of the data, so carers can easily discover risk situations or follow up the usage of the solutions to intervene whenever needed.

For example, the MAHA dashboard allows caregivers to identify if a user with a cognitive training program prescribed, in which he has to play games three times per week, is performing his sessions and what the results he is getting. With this information, the caregiver is able to intervene, according to the defined protocol of attention: sending a message through the dashboard or contacting him by phone.

Together with the MAHA dashboard, private WhatsApp groups have become a very strategic tool also because we can send notifications intended to encourage the user engagement as well as widening the scope to notifications concerning COVID-19, rules to follow, official telephones for psychological attendance, existing official apps to be downloaded in their smartphones (that they could have) to help diagnosis etc.

Figure 39 depicts some of MAHA creative and leisure activities examples involving end-users allocated in the different facilities such as municipalities, day-care centres and residences before the COVID-19 outbreak.

Figure 39. DS MAD Learn & Play

Figure 40 shows some examples in which DS MAD scale up to international and strategic actions aiming to enlarge the MAHA ecosystem relations.

Figure 40. DS MAD Scale Up & Institutional partnerships

5.1.1.2 Summary

Three different stakeholders have been recruited in the DS MAD: elderly, formal caregivers and informal caregivers. The total number of users recruited is 1029, considering both control and experimental groups. The table below shows the distribution of recruited users per Reference Use Case (RUC) and type of group:

Table 38. DS MAD User recruitment summary

RUC	Elderly		Informal caregiver		Formal caregiver	
	Control	Experimental	Control	Experimental	Control	Experimental
RUC1	52	52	-	-	19 (all RUCs)	19 (all RUCs)
RUC5	154	154	-	-		
RUC6	138	138	-	-		
RUC7	101	102	50	50		
	445	446	50	50	19	19
TOTAL	**891**		**100**		**38**	

Table 39 summarizes the distribution of facilities by RUC along the different piloting phases, having a total number of 335 facilities confirmed including: private homes, personal environment (a person wearing and using IoT device anywhere, without being associated with a specific physical place), day-care centres and residences, municipalities facilities such as libraries, green parks or gyms, and also Madrid as smart city.

Table 39. DS MAD Facilities summary

RUC	Private homes	Personal environment	Residences	Day-care centres	Smart city	Municipality facilities
RUC1	-	52	-	-	1 (all RUCs)	6 (all RUCs)
RUC5	-	30	2	4		
RUC6	-	138	-	-		
RUC7	52	50	-	-		
TOTAL	**52**	**270**	**2**	**4**	**1**	**6**

Distribution of RUCs deployed.

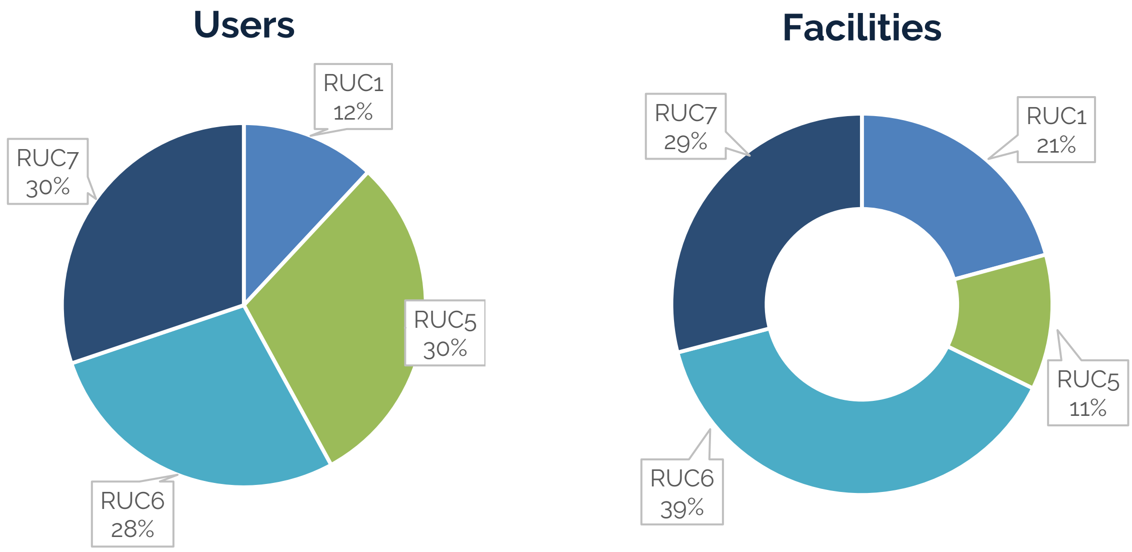


Figure 41. DS MAD Distribution of users and facilities per RUC

5.1.2 IoT infrastructure deployment

The IoT Infrastructure of DS Madrid has been updated since the deliverable D9.1 in which the first architecture definition was reported. The infrastructure has shifted focus towards running services on smartphones and tablets. While the home environment and shared infrastructures (ACTIVAGE Centres) are being provided by other providers or integrated through AIOTES. Figure 8 represents the Madrid DS architecture specified in the different domains. This architecture classifies the different devices, explaining how they are connected to the different gateways (edge computing hardware which purpose is to route the IoT Information to the cloud/applications); highlights the features the middleware (universAAL IoT) brings to the DS; and finally lists the applications and services showing how they interact with different users.

Figure 42. DS MAD architecture

The core of the IoT infrastructure is the DS MAD Middleware, running in a private cloud, which includes the deployment of the MAHA Dashboard, as well as all the backend services required for it to work (e.g. push notification services, to send messages to the users through the dashboard). The central services deployed are the master instance of universAAL IoT which is also connected to the deployed instance of AIOTES. The other solutions, those that provide services to end users, not only run on top of the Middleware (providing interoperability between these solutions), most run across the gateways with support of specific IoT devices. The following table summarizes all the Madrid DS solutions as well as how they are deployed over the architecture and how they are mapped with RUCs.

Table 40. DS MAD solutions

Solution	Description	Deployment in Architecture	Related RUC
Equimetrix	An equilibrium training and assessing system composed by a floor mat device, and a tracing camera. The accompanying software helps in the assessment of equilibrium and Training through games.	Equimetrix balance training device + software in ACTIVAGE Centre	RUC5
Exergames	Games based on Microsoft Kinect input. Centred on exercise promotion, equilibrium and motor control.	Microsoft Kinect + Software in ACTIVAGE Centre	RUC5
MAHA Dashboard	A web application to visualize and access all the services as well as provide feedback and track the progress of end users.	Is the Caregiver Dashboard, running in DS MAD Cloud Platform	RUC1, RUC5, RUC6, RUC7
Hoop	Motor control training games and monitoring, specifically designed for Parkinson's but useful for anyone.	Optionally sensors + software in Smartphone or Tablet	RUC6

¿Cómo estás?	A self-perception questionnaire and assessment tool which classifies users according to their needs.	App in Smartphone or Tablet	RUC1, RUC5, RUC6, RUC7
Brain Training Games	A set of games to train cognitive abilities (memory, calculation, perception, etc...).	App in Smartphone or Tablet	RUC6
BehavAuth	A security library for android which ensures only the registered user is using the device; this is particularly useful to certify the data.	App in Smartphone or Tablet + third party cloud	RUC6
Fitbit + EMT	Monitoring outdoors activities: physical activity and the usage of the public transportation	Fitbit Device + App in Smartphone	RUC1
Diviértete	Recommends personalized activities in the neighbourhood of the user, encouraging proactive behaviour	App in Smartphone or Tablet	RUC1
Smartwatch	Monitoring outdoors activities: physical activity, GPS and leisure events offered	New Smartwatch device connected to Smartphone or Tablet	RUC1
Mindfulness	Pre-recorded mindfulness sessions, for relaxation and self-perception, the system monitors different biometric parameters to ensure exercises are performed correctly	App in Smartphone or Tablet	RUC7
LOCs	Home monitoring system, detects abnormal and isolation behaviour triggering interventions to avoid degradation.	Presence sensors + Software in tablet, connected to third party cloud	RUC7

In the case of Madrid DS, every individual facility represents a single installation. Take for example the mobile phone, it is the main way for users to interact with the system, one phone (or tablet) is provided to a user covering their home, these users do not interact with other facilities thus the installation is restricted to the phone. Similarly, each ACTIVAGE centre, a public accessible facility, has one single installation serving a set of users, there are never more than one installation in any given facility. Therefore, the final total number of installations summary table repeats some of the numbers reported on the Table 39 related to the number of facilities.

Table 41.DS MAD Total number installations

RUC	Private homes	Personal environment	Residences	Day-care centres	Smart city	Municipality facilities
RUC1	-	71	-	-	1 (all RUCs)	6 (all RUCs)
RUC5	-	30	2	4		

RUC6	-	138	-	-		
RUC7	52	50	-	-		
TOTAL	**52**	**289**	**2**	**4**	**1**	**6**

A total of 595 diverse devices have been installed. Depending on the IoT solution deployed and the RUC, the category of the devices as well as the number of elements installed can vary. For instance, in the case of the RUC6 - Brain Training Games solution runs on a tablet or Android smartphone while the RUC7 - LOCs solution includes 4 presence sensors, 1 door sensor and 1 tablet acting as a gateway for each user. The following table summarizes the number of devices, individualized per category, associated with each RUC and the number of devices with User Interfaces.

Table 42. DS MAD Devices per categories installed

RUC	Gateways	Environment sensors	Wearables	Health/Alarm devices	Communication devices	UI devices
RUC1	51	-	20	-	-	71
RUC5	6	3	40	-	-	49
RUC6	138	-	-	-	-	138
RUC7	102	235	-	-	-	102
all RUCs	-	-	-	-	-	19
TOTAL	**297**	**238**	**60**	**0**	**0**	**379**

Two graphics representing the percentage of installations and devices per RUC are depicted in Figure 43. The numbers are similar in all cases except in the RUC7 because the deployed solution includes a higher average of devices per installation than the other cases.

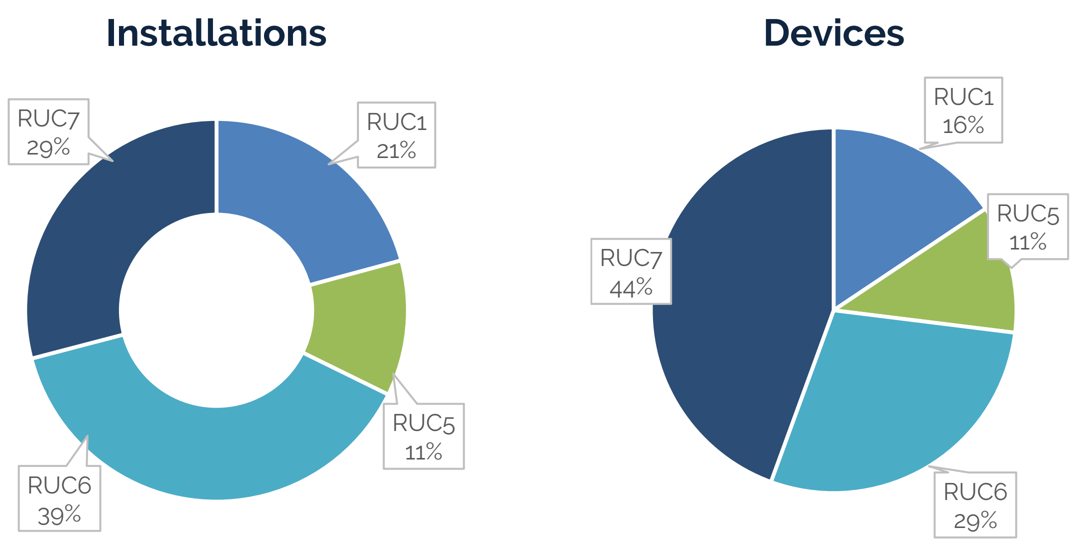


Figure 43. DS MAD Distribution of installations and devices per RUC

5.1.3 Experiment running report

5.1.3.1 Users participation

As we have explained in section 5.1.1, the number of recruited users was 1029, but during the experiment, we have 177 (+associated control users) dropouts (by 30th June). The following table represents the number and reasons of drop-offs.

Table 43. DS MAD Drop-offs

RUC	Reasons for drop-offs	Number of drop-offs
RUC1	These drop-offs belong to the group using "Diviértete" solution. Some users did not find events attractive enough or close enough to their place of residence. On the other hand, this solution was adapted at the beginning of the confinement by providing virtual events that could be enjoyed from home. However, it was not appreciated by all users and they did not perceive this technology as very useful.	60
RUC5	All the drop-offs from the RUC5 are related to the Equimetrix and Exergames solution. The main reasons are the lack of safety with the accessories of Equimetrix solution and the difficulty to use it. And impossibility to use Exergames due to COVID-19 restrictions.	80
RUC6	The main reason why users drop-out the study was the lack of engagement with the technical solution. Even though Brain Training Games includes 3 levels of difficulty, some elderly people were bored with the games while others perceived the games too complex.	35
RUC7	The main requirement for the deployed solution in the social isolation RUC is that the monitored person lives alone. In this case, 2 users stopped living alone and therefore the algorithms did not work properly so we uninstalled it.	2
TOTAL	**177** (+associated control users)	

The users in operation belong to the phase 3 of the DS MAD experiment, which has been strongly affected by the COVID-19 lockdown. These users are involved in RUC5 with the HOOP solution and RUC7 with Mindfulness and LOCs. The latter solution was the most affected one by the COVID-19 lock-down, because it could not be deployed at the scheduled time, due to the impossibility to access participants' homes. Table 44 presents the number of users in operation by 30th of June per RUC.

Table 44. DS MAD Users in operation

RUC	Elderly		Informal caregiver		Formal caregiver	
	Control	Experimental	Control	Experimental	Control	Experimental
RUC1	-	-	-	-		

RUC5	30	30	-	-	19 (all RUCs)	19 (all RUCs)
RUC6	-	-	-	-		
RUC7	100	100	50	50		
	130	130	50	50	19	19
TOTAL	**260**		**100**		**38**	

The following table summarizes the average usage level of the solutions by the experimental group, depending on the use case and what is understood by regular use according to the literature in each of the use cases, for each type of the solution. This regular use was defined in the Madrid DS experiment local evaluation protocol and presented in next section 5.2.

Table 45. DS MAD Average usage level of technical solutions

Solution	Rule applied for regular use	Number of regular users	Related RUC
Equimetrix	Every time there is a session on the Day Care Centre	0 (51 drop-off)	RUC5
Exergames	Every time there is a session on the Day Care Centre	0 (73 drop-off or declined to participate)	RUC5
MAHA Dashboard	Daily use (by formal caregivers)	19 formal caregivers	RUC1, RUC5, RUC6, RUC7
Ejercicio Físico	Daily use	30	RUC5
Cómo estás?	Daily use	80	RUC1, RUC5, RUC6, RUC7
Brain Training Games	Two times per week on average	86 older adults	RUC6
Behavauth	Two times per week on average	8 older adults	RUC6
Fitbit + EMT	Daily use	0 (20 declined to participate)	RUC 1
Diviértete	Two times per month on average	26 older adults	RUC1
Mindfulness	Three times per week on average	50 older adults	RUC7
LOCs	Does not need user interaction (passive use)	50 older adults	RUC7

5.1.3.2 Operational effectiveness

In this section, the following table presents the operational and technical issues that have occurred, both with the solutions that were deployed in the different RUCs, as well as with the technological infrastructure of the DS MAD.

Table 46. DS MAD Issues experienced

RUC	Number of issues	Description of main issues experienced
Common to all RUCs	3	Break of hardware devices, solution updates problems, low technology knowledge of the users
Common infrastructure	4	Services/Servers down, API-related problems, deconfiguration of solutions in the device, functionality problems in MAHA dashboard
TOTAL	7	

End-user requests/inquiries can be divided into three categories:

1. Software. This type of requests/inquiries is mainly related to low technology knowledge of the users. Due to these issues were very specific (e.g. questions about a solution or how to perform an action), it was possible to solve them remotely in a short period of time (though a phone call or a message). This response time was not affected by COVID-19. Average time: less than 1 hour.

2. Hardware. Screen breaks, battery discharge and other issues related to the hardware devices used by end-users are included in this category. The solution was to replace the broken devices with another, so it was necessary to schedule a personal meeting with the user in the shortest possible time. This response time was highly affected by COVID-19. Average time: 2-3 days

3. Infrastructure. This type of requests/inquiries includes all technical issues like APIs-related problems or server down. This type of issues was solved remotely in a short period of time. This response time was not affected by COVID-19. Average time: less than 1 hour.

Different forms of incidence reporting were implemented between users and formal caregivers, as well as between formal caregivers and the technical team to improve communication and thus resolve reported incidences in the shortest possible time:

- Formal caregivers can report technical incidences using the MAHA dashboard to the technical support team.

- Users can report an incidence to their formal caregivers through a phone call or a message.

- All reported incidences were registered by formal caregivers and technical support time both locally and in a common online document. This online document is used to manage the incidences in the shortest possible time:

- When an end-user reports an incidence, it is automatically registered in the common document. Then, depending on the type of incidence it is managed by the technical support team or by the formal caregiver. When the incidence is solved, the solution is registered in the common document and reported to the end-user through phone call or a message (in case the end-user is not a formal caregiver).

- 100% of the reported incidences were successfully solved.

Average response time to technical/ operational issues.

Technical/operational issues are mainly related to the backend infrastructure (servers, APIs…). This type of issue (e.g. as a server down) was solved remotely in a short period of time. This response time was not affected by COVID-19. Average time: less than 1 hour

Nr. of solution updates/ upgrades (per RUC).

The different solutions deployed, were updated during the experiment according to the users feedback and the new situation due to the COVID-19 outbreak.

RUC1

An application was implemented as a solution for RUC1. It was updated twice:

- First release. The solution, named Fitbit, was used to measure in the backend the physical activity of the user through a Fitbit wristband with any direct interaction from the user with the technology.

- Second release. Diviértete is a new solution implemented to increase the engagement and the interaction of the user with the technology. Several events organized by different councils of Madrid region are shown to the users according to their distance to the user. These events are divided into different categories of interest.

RUC5

The solution for RUC5 was the implementation of an application and the use of different technologies (Equimetrix and Exergames (from the Finish DS))

The application, named Ejercicio Físico, was updated three times:

- First release. The application is implemented to promote the physical activity of the users by the performance of easy body training and coordination exercises when they want and they need.

- Second release. Integration of inertial sensors to the application in order to monitor and guide the users during the performance of the body training exercises.

- Third release. Due to COVID-19, it was not possible to distribute the inertial sensor to the users, so the application was updated to be used by a greater number of users (inertial sensors are not required). The main aim of this update was to promote the physical activity at home.

RUC6

An application, named Brain Games, was implemented as a solution for RUC6. It was updated three times:

- First release. Implementation of a validated evaluation test as well as different cognitive games to reinforce the categories according to the evaluation test results.
- Second release. Several cognitive games were added to the application to increase the engagement of the users.
- Third release. Integration of an Open Caller solution. Facial recognition provided by BehavAuth solution was used to assure the identity of the user during the performance of the evaluation test.

RUC7

The LOCs technology from Valencia DS and the application, named Mindfulness, was implemented as a solution for RUC7. The Mindfulness app was updated three times:

- First release. Different mindfulness practices were included in the application based on a learning algorithm to increase the user experience.
- Second release. A post-practice questionnaire was included to assess the experience of the user after the practice performance.
- Third release. After learning the mindfulness techniques provided by the initial version, a new version of the application was implemented without the learning algorithm to promote the user engagement. New practices were included in this version.

Common to RUC1, RUC5, RUC6 and RUC7:

3 applications were implemented as a common solution for RUC1, RUC5, RUC6 and RUC7: ¿Cómo estás? Launcher and an integrated version to be used in smartphones instead of tablets.

¿Cómo estás? was updated twice:

- First release. A self-assessment questionnaire was implemented. Users should answer a single question each 3 days and a battery of 5 questions each 21 days.
- Second release. Due to COVID-19, it was necessary to reinforce the follow up of the self-assessment of the users. A new version was implemented to ask daily different questions based on an algorithm to detect when an intervention of the formal caregivers is necessary.

Launcher was updated 3 times:

- First release. Initially, all the users used the same solutions independently of their use case. All measurements from the different applications were saved in text files and sent directly to the server. The text files were analysed manually.
- Second release. As each use case requires their specific applications, each user should use a different number of applications. So, it was necessary to implement a dynamic solution to configure and provide the applications to be used by the users according to their use case.
- Third release. Integration of data measured with a Mongo database. In this version, data from each application is sent directly to the database to be automatically analysed.

- Fourth release. The information of the user action through the different applications is also registered and sent to the database for analysis.

Smartphone solution was updated once:

- Due to COVID-19, it was not possible to distribute the tablets to the users, so an alternative application to download and use on a smartphone instead of a tablet was implemented.

Also, in case of technical or operating system requirement, the applications have been updated. All applications are up to date.

5.1.3.3 Use case exchange report

In the Madrid DS, two services have been imported from two different DSs, and two services were also offered for export to the other DSs in the project, although in the end only one was exported.

Specifically, the imported services were as follows:

From the Finish DS: The GoodLife TV Trainer (Exergames), consisting of a gamified exercise system, exercises and physiotherapy for elderly was imported to complement RUC 5 on exercise promotion.

- The solution was deployed in 2 Day Care Centres in the Madrid region.
- The number of users involved in this solution: 146 older adults (73 control / 73 experimental).
- 3 Kinects and 3 laptops were acquired to test and deploy this service.

From Valencia DS: The service (LOCs) for the detection of abnormal patterns indoors (at home), that allowed the collection, processing and visualization of behaviour patterns indoors was imported to complement RUC 7 on social isolation.

- The solution is being deployed in 50 older adults' homes.
- The number of users involved in this solution: 100 older adults (50 control / 50 experimental) and 100 informal caregivers (50 control / 50 experimental).
- Adaptation of LOCs data to detect isolation.
    - Development of the algorithm with medical staff about increased risk of loneliness.
- 50 LOCs kits were acquired from MySphera to deploy this service.

The services offered for export to the different DSs were:

- The Equimetrix service, providing equilibrium training and assessing system composed by a floor mat device, and a tracing camera. The accompanying software helps in the assessment of equilibrium and Training through games. This service that finally was not deployed in other DSs implemented RUC 5.
- The Brain Training games, providing a set of games to train cognitive abilities (memory, calculation, perception, etc..) was deployed in the Leeds DS implementing RUC 6.

New services deployed

One new service has been deployed from the Open Caller Quadible, called BehavAuth. The initial use case RUC 6 on cognitive stimulation in which Brain Training games are used, has been extended with the integration of the BehavAuth application in the tool of cognitive evaluation. This tool allows the user to select if they want to do the cognitive evaluation that is part of the brain training games application, with the authentication provided by the BehavAuth application or not. If the user chooses to use BehavAuth, after doing a selfie for facial recognition and allowing the collection of behavioural data (only once), the tablet will be automatically locked if he stops using it or someone else uses it instead, and unlocks the tablet when the authorised user uses it. BehavAuth new service was deployed to complement RUC 6. BehavAuth: “Human-behaviour based authentication for IoT”, integrates and deploys a multi-modal continuous behavioural authentication at the ACTIVAGE framework to improve the security, privacy, trustworthiness, and user acceptance.

It was integrated with MAHA app and deployed with 16 users, within the Brain Training games solution. The BehavAuth service was integrated with the security and privacy module, the service also provides integrated authentication with the centralised authentication system employed in the DS and managed through AIOTES.

Number of new users / devices / data integrated in DS as consequence of expand phase

The number of new users that have joined the expansion phase due to the inclusion of new services from the other DSs and the Open Caller are as follows:

- Using Exergames solution:146 older adults (73 control / 73 experimental).
- Using LOCs solution: 100 older adults (50 control / 50 experimental) and 100 informal caregivers (50 control / 50 experimental).
- Using BehavAuth solution: 16 older adults (8 control and 8 experimental).

The numbers of new devices that have been incorporated into the MAD DS in the expansion phase are as follows:

- For deploying Exergames solution: 3 Kinects and 3 laptops.
- For deploying LOCs solution: 50 LOCs kits composed (each kit) by 4 presence sensors, 1 door sensor and 1 tablet
- For deploying BehavAuth solution: 15 tablets.

Furthermore, we can say that the data on the use of the services: LOCs, Exergames and BehavAuth, has been incorporated into the databases of use of the MAD DS services, in order to evaluate their use.

5.2 Local evaluation report

This section includes the local evaluation of Madrid DS including the objectives, the criteria selected for the evaluation and the results of the evaluation carried out.

5.2.1 Goal of local evaluation: primary and secondary endpoints

The main goal of Madrid DS is to demonstrate that smart living environments based on Internet of Things (IoT) technologies can contribute to and have beneficial effects in quality of life in terms of self-perceived QoL, physical status perception and social engagement in an active and healthy aging of people over 65 years old.

As secondary endpoints, we aim to demonstrate following outcomes:

- The use of IoT-based solutions for monitoring and promotion of outdoor activities can provide substantial support to people over 65 years enhancing and maintaining their physical conditions to prevent augmented risk of frailty.
- The use of IoT-based solutions for monitoring home behaviour and providing self-perception tools can provide substantial support to people over 65 years enhancing and maintaining their social conditions to prevent augmented risk of isolation.
- The use of IoT-based mental brain training games can have an impact on the prevention of cognitive deterioration in people over 65 years.
- The use of IoT-based guided physical exercises can have an impact on the prevention of physical deterioration in people over 65 years.
- The use of a Dashboard for professionals, formal caregivers in this case, for the management and monitoring of the status of users and the IoT services offered, respecting the privacy and security of users, can have a positive impact on the burden perceived by the formal caregivers that provide care services to people over 65 years.

5.2.2 Local KPI collected

To collect the necessary information apart from the GLOCAL questionnaires (Demographic data, EQ5D3L, Self-Assessment Questionnaire, Unified Theory of Acceptance and Use of Technology (UTAUT), University of California Los Angeles loneliness Scale (UCLA), and Carerqol7d), we have collected a set of data that support our secondary goals as well as reinforce the outcomes and analysis of our primary goal. The following table incorporates the summary of the local KPIS collected during the experiment duration, their purpose and the RUC that applied.

Table 47. DS MAD Local KPIs

Data source	Description	RUC
Frailty status	Description of the frailty status according to the FRAIL scale measured at baseline and final stage of the experiment	All
Cognitive status	Measured using the Mini-Mental State Exam (MMSE) questionnaire (spanish version) measured at baseline and final stage of the experiment	RUC6
IoT impact on QoL	Logs of IoT technology usage (measure as number of applications and time spent in each of the applications and functionalities)	All
IoT impact on QoL	Type of cognitive game, time stamp, solved or not solved, score related measure (number of exercise solved, errors, etc)	RUC6
IoT impact on QoL	Type of physical exercise done, time stamp, time stam, finished or not finished	RUC1
IoT impact on QoL	Event assisted, time stamp,confirmation of assistance	RUC5
IoT impact on QoL	Type of session, time stamp,finished or not finished	RUC7
IoT impact on QoL	Algorithms of isolation risk results	RUC7
IoT impact on QoL	Self-assessment diary questionnaire results, time stamp,	All
Acceptance	Willing to pay	All
Drop-out	Reasons of dropping out	All

5.2.3 Local evaluation protocol

With the collected data, outcomes and goal, the local protocol can be defined as follows. Madrid DS performed a quasi-experimental study with 2 groups: (1) Control group; and (2) Experimental group with technology and personalized interventions. This is a quasi-experimental study because there is no randomness in the users' selection, but there is a control group. The sample of users is stratified in four subgroups to assign them to specific use cases and the users must meet a series of requirements for their inclusion: (1) fragile (not full dependent but living in residences or use to go to day care centres with Clinical Frailty Scale(CFS) of 4 - 6); (2), active (assume their circumstances but want to remain active); (3) proactive (very active, much more than the average of their age); and (4) isolated (older adults living alone without motivation to socialise).

Our study has involved 1029 people, 483 of the control group and 495 of the experimental group, and 38 formal caregivers (for both groups).

5.2.3.1 Study design

The study objective is to prolong and support independent living of elderly people in their living environments using an IoT ecosystem that promotes mental and physical active and healthy aging, measuring the impact of IoT in quality of life, social life and physical activity. In this sense, the study has the following primary and secondary hypotheses:

A. Primary study hypothesis

Smart living environments based on Internet of Things (IoT) technologies can contribute to and have beneficial effects in quality of life in terms of self-perceived QoL, physical status perception and social engagement (measured with EQ-5D-3L and a Global self-assessment questionnaire) in an active and healthy aging of people over 65 years old.

B. Secondary study hypothesis

- The use of IoT-based solutions for monitoring and promotion of outdoor activities can provide substantial support to people over 65 years enhancing and/or preserving their physical conditions to prevent augmented risk of frailty (frailty status, physical activity and technology acceptance with CFS, global self-assessment and UTAUT tests, and IoT solutions usage logs).
- The use of IoT-based solutions for monitoring home behaviour and providing self-perception tools can provide substantial support to people over 65 years enhancing and maintaining their social conditions to prevent augmented risk of isolation (social isolation and technology acceptance with UCLA, global self-assessment and UTAUT tests, and IoT solutions usage logs).
- The use of IoT-based mental brain training games can have an impact on the prevention of cognitive deterioration in people over 65 years (measuring cognitive status and technology acceptance with MMSE, global self-assessment and UTAUT tests, and IoT solutions usage logs).
- The use of IoT-based guided physical exercises can have an impact on the prevention of physical deterioration in people over 65 years (measuring fear of falling, balance, physical activity and technology acceptance with FES-I, Tinetti, global self-assessment and UTAUT tests, and IoT solutions usage logs).
- The use of a Dashboard for formal caregivers, for the management and monitoring of the status of users and the IoT services offered, respecting the privacy and security of users, can have a positive impact on the burden perceived by the formal caregivers that provide care services to people over 65 years (measuring the caregiver’s QoL, caregiver's burden, the caregivers feedback and the use of the platform, with CarerQoL-7D, Short Form Zarit Burden Interview (ZBI-12), interviews and usage logs).

We have divided our study in three phases, in the first and second phase planned 350 people involved in each phase and in the third phase have planned 300 participants. 38 formal caregivers were involved in the three phases. Each phase was characterized by the introduction of a new IoT technology/service for AHA, which was tested for six months at least by users of the experimental group.

The technologies/services to be tested with the older adults during the study were divided into four different RUCs: RUC1 (Monitoring assisted persons outside home), RUC5 (Exercise promotion for fall prevention and physical activeness), RUC6 (Cognitive stimulation for mental decline prevention) and RUC7 (Prevention of social isolation).

Study population: Elderly people + 65 years old with a degree of frailty between 1 and 6 in the Clinical Frailty Scale (CFS), MMSE ≥ 23 and without severe health conditions or mental diseases. Available at least for 6 months' time frame observation, living in Madrid Region.

Table 48. DS MAD Inclusion and exclusion criteria

Enrolment criteria	• +65 years old • Living in Madrid • CFS between 1-6 • MMSE ≥ 23 (only for UC6) • Without severe health condition
Exclusion criteria	• Dependent users (Recognized with grade III in the Spanish dependency law) • Severe health conditions • MMSE results < 23

5.2.4 Summary Assessments and Tests

Depending on the RUCs assigned to each participant group a set of questionnaires were used to measure qualitative and quantitative variables to assess the hypothesis planned within the proposed experiment. The following table, Table 49, presents the questionnaire used at baseline (B), intermediate (I) and final (F) with both elderly users and caregivers.

Table 49. DS MAD Mapping questionnaires, users and timeline

	Elderly Control Group												**Elderly Experimental Group**												**Caregiver**			
	RUC1			***RUC5***			***RUC6***			***RUC7***			***RUC1***			***RUC5***			***RUC6***			***RUC7***			***All RUCs***			
	B	I	F	B	I	F	B	I	F	B	I	F	B	I	F	B	I	F	B	I	F	B	I	F	P	B	I	F
SOCIO-DEMO	x			x			x			x			x			x			x			x				x		
EQ5D-3L	x		x	x		x	x		x	x		x	x		x	x		x	x		x	x		x				
GLOBAL (Self-perception)	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x				
UTAUT														x	x		x	x		x	x		x	x				
MMSE	x			x			x	x	x	x			x			x			x	x	x	x						
CFS	x		x	x		x	x		x	x		x	x		x	x		x	x		x	x		x				

UCLA							X		X	X		X							X		X	X		X				
WILLING TO PAY															X			X			X			X				
IoT USE (LOGS)														X	X		X	X		X	X		X	X			X	X
CarerQoL-7D																										X		X
Dashboard SUS																												X
Caregivers Training Feedback																									X			
Solutions Feedback																									X			
Dashboard Questionnaire																												X

Apart from these questionnaires, a set of focus groups were done with a selected group of participants in those RUCs with i.e. high number of dropouts, to discover hidden problems that are not revealed by the proposed questionnaires. Following figure, Figure 44, represents the protocol flow.

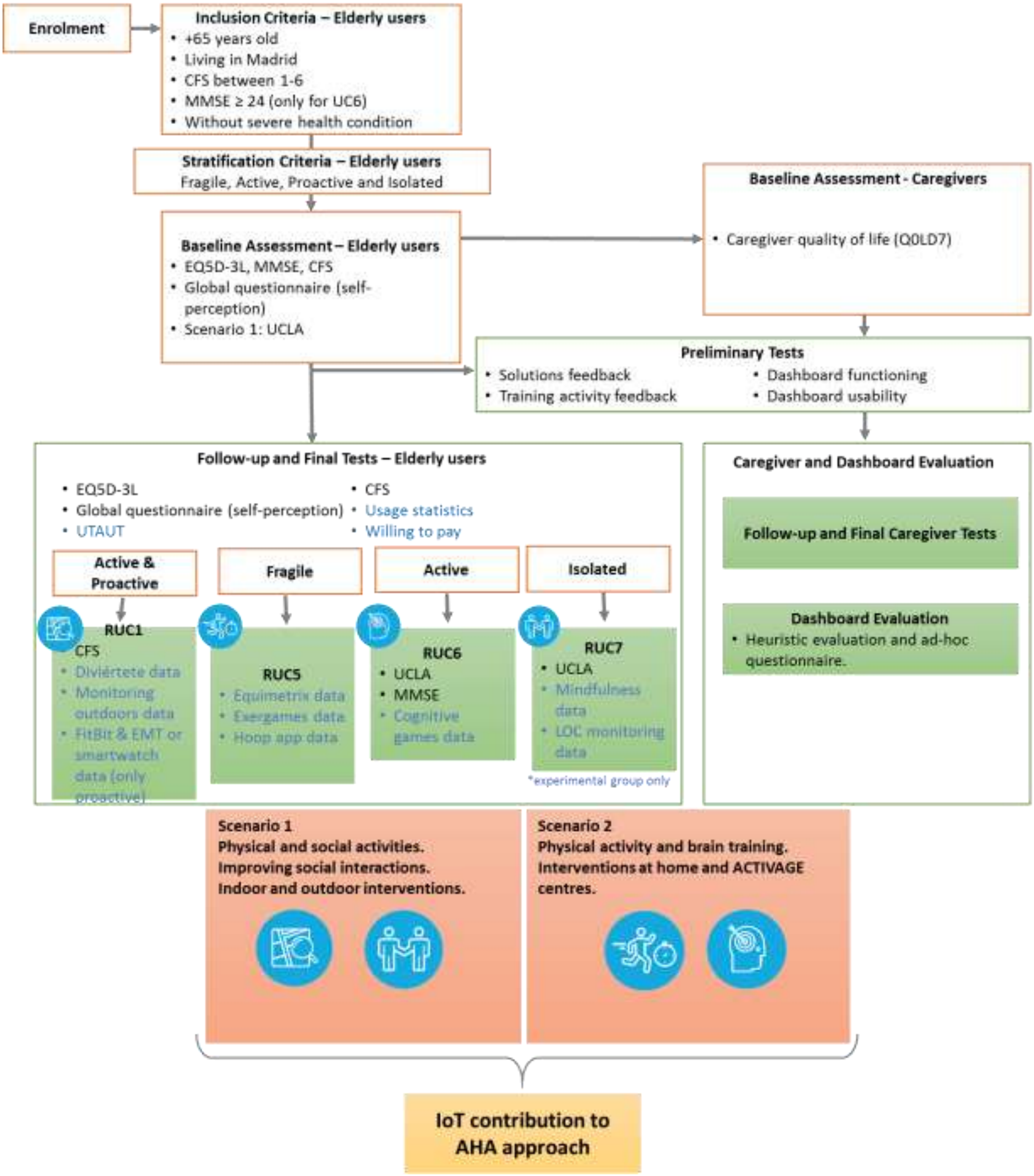


Figure 44. DS MAD protocol

Orange boxes represent the recruitment and screening stage while green boxes include the operations performed during the experiment execution stage.

5.2.5 Statistical plan and experimental sample description

5.2.5.1 Statistical Plan for elderly users

Madrid DS statistical plan analyses the study outcomes comparing the baseline results with the result of the questionnaires after completing the tests and with the usage of IoT technology/services, to evaluate if the study hypothesis were reached for each of the indicators.

Data was collected from questionnaires (described in the previous section), usage logs (collecting automatically through the deployed IoT solutions) and indicators (from the ACTIVAGE global evaluation definition). After cleaning, transforming and curating the data, statistical data analysis was carried out starting from the tabulation and description of the variables, calculation of relative frequencies of each variable, measures of centralization and dispersion, study of the interrelation between variables and performing the statistical inference.

The analysis of the data was done per use case and per phase. Finally, the results of the different RUCs and phases were compared in order to differentiate the variables that more influence on the acceptance and rejection of the proposed hypothesis.

In every of the RUCs, Sociodemographic and clinical baseline properties (defined by EQ5D3L, Self-Perception Questionnaire (SPQ) and CFS, incorporating MMSE and UCLA for RUC6) for the groups were characterised by descriptive methods (standard error of the mean, a.k.a. mean [SD], and standard deviation) and presented in a table, for both control group and experimental group at it is shown in Table 50. A similar table compares those who dropped out versus those who completed the primary outcome.

Table 50. DS MAD Socio-demo and clinical baseline properties

Characteristics	Experimental	Control	Total
Female/male	N/N	N/N	N/N
Age	mean [SD]	mean [SD]	mean [SD]
Minimental	mean [SD]	mean [SD]	mean [SD]
Frailty	mean [SD]	mean [SD]	mean [SD]

Primary study hypothesis statistical plan

To report the EQ5D3L results, the simplest way was reporting the number and proportion of the users' sample reporting each of the levels on each of the dimensions as it is shown in Table 51. Same approach was used in case of the SPQ.

Table 51. DS MAD EQ5D3L analysis - statistical plan

	MOBILITY				SELF-CARE				USUAL ACTIVITIES				PAIN / DISCOMFORT				ANXIETY / DEPRESSION			
	PRE		POST		PRE		POST		PRE		POST		PRE		POST		PRE		POST	
	E	C	E	C	E	C	E	C	E	C	E	C	E	C	E	C	E	C	E	C
LEVEL 1: without problems	N%	N%	N%	N%	N%	N%	N%	N%	N%	N%	N%	N%	N%	N%	N%	N%	N%	N%	N%	N%

LEVEL 2: with some problems	N%	N%	N%	N%	N%	N%	N%	N%	N%	N%	N%	N%	N%	N%	N%	N%	N%	N%	N%	N%
LEVEL 3: many problems	N%	N%	N%	N%	N%	N%	N%	N%	N%	N%	N%	N%	N%	N%	N%	N%	N%	N%	N%	N%

First analysis was planned in terms of comparison of the experimental group (receiving IoT based intervention) with the control group (receiving traditional interventions). The changes in the QoL profile measured by the EQ5D3L between the baseline results and the final results were analysed using the Pareto principle: that there is an improvement if at least one person is made better off and no one is made worse off (Chang, 2000). Translated to the health profile context, this suggests the following:

- A health profile is better than another if it is better in at least one dimension and is no worse in any other dimension.
- A health profile is worse than another if it is worse in at least one dimension and is no better in any other dimension.

The SPQ and EQ5D3L scores were analysed using the delta value (defined as final score - baseline score) considering the value is better if the delta value result is positive. Table 52 summarized the first analysis proposal

Table 52. DS MAD First analysis proposal

Variable	Instrument	Analysis
QoL	EQ5D3L Profile	Variations in the QoL profile
QoL	EQ5D3L score	Variations in the QoL profile
Self-perception	SPQ	Variations in the QoL profile

All the first analysis was based on a comparison between the results in the experimental group versus experimental group, in order to analyse the impact of the IoT based intervention on the results of the questionnaires.

Second analysis was planned in terms of analysing how the usage of the IoT influenced this QoL improvement. In this sense, the measurement collected directly from the use of the IoT technology was incorporated into the analysis of the data. The following table summarizes type of variables used to perform this analysis depending on the RUCs.

Table 53. DS MAD Second analysis proposal

RUC1	RUC5	RUC6	RUC7
Number of sessions	Number of completed sessions	Number of completed sessions	Number of sessions
Age	Average score	Number of correct exercises	Number of detected alerts

In this case, we have applied the following reduction rules on the participants' data that finalize the experiment periods and fill the final questionnaire battery. These reduction rules were based on the definition of regular use explained in section 5.1.3.

- RUC1 we have defined regular use as two or more app requests in a month in different weeks.
- RUC5 we did not apply reduction rules

- RUC6 we have defined regular use as two or more complete exercises weekly, or at least 8 individual usages (with one or more completed exercise) in a month, without no more than one week without any usage per week.
- RUC7 - Mindfulness at least 1 weekly session without more than 2 weeks without practice any session
- RUC7 - LOCs we did not apply reduction rules

This analysis has also taken into account the potential differences between the early drop out questionnaires results, users that did not follow the reduction rules and those that had more intensive use of the solution in order to define if there exists a statistically significant correlation between a more intensive usage and the increment of the QoL.

Finally, third analysis is the acceptance analysis. We have performed a correlation matrix with the variables of the UTAUT questionnaire and the use of the technology (number of sessions).

In all the three types of analysis, the correlation between the educational level and/or technological level and their impact on the results were also analysed to establish the influence of the sociodemographic and cultural variables on the obtained results.

Secondary study hypotheses statistical plan

1. IoT based solutions support elderly in maintaining physical conditions. This Hypothesis was supported by the RUC5 mainly, but also RUC6 and RUC1.

In case of RUC5 we compare the SPQ (physical) baseline with the SPQ (physical activity) final in the experimental group with the control group.

In the RUC6 and RUC3 we performed a correlation analysis (correlation matrix) between EQ5D3L (mobility) baseline and relation with EQ5D3L(mobility) final, SPQ (physical activity)_final and SPQ (IoT impact on physical activity) only for experimental group.

2. The use of IoT-based solutions prevents augmented risk of isolation. The hypothesis was supported by RUC7.

We have performed a correlation analysis between the number of risk alerts detected and solved and the SPQ (final) variables in case on LOCs solution

In case of Mindfulness, we make an analysis of the EQ5D3L (anxiety) and the SPQ (social) final and SPQ (IoT impact social) with the number of successful Mindfulness sessions.

3. The use of IoT-based mental brain training games can have an impact on the prevention of cognitive deterioration in people over 65 years. The hypothesis was supported by RUC6.

We have performed a correlation analysis of MMSE results at the final stage with the number of sessions.

4. The use of IoT-based guided physical exercises can have an impact on the prevention of physical deterioration in people over 65 years. The hypothesis was supported by RUC5.

We have performed a correlation analysis of FES results at final stage with the number of sessions and their results

5. The use of a Dashboard for formal caregivers, for the management and monitoring of the status of users and the IoT services offered, respecting the privacy and security of users, can have a positive impact on the burden perceived by the formal caregivers that provide care services to people over 65 years.

We have performed a correlational study with the results of the CarerQoL-7D and number of interventions successfully finished using the dashboard.

As well as the primary hypothesis, we have also analysed the influence of sociodemographic and cultural variables on the results and impact of IoT solutions.

5.2.5.2 Sample description and data collected

As it was explained in the protocol, the collection and analysis of the data were done in phases. At the end of the project phase I and phase II were totally analysed, and results have fed the phase III that runs into sustainability plan. This section highlights the main data collected.

Phase 1

In the Phase 1, RUC6 with Brain Training Game solution and RUC5 with Equimetrix solution were analysed.

In the RUC6, a total of 250 participants were recruited to participate in different areas, towns, and cities from Madrid Region (Madrid City, Villanueva del Pardillo, Las Rozas). The following picture represents the recruitment process and the final users that results as valid for data analysis.

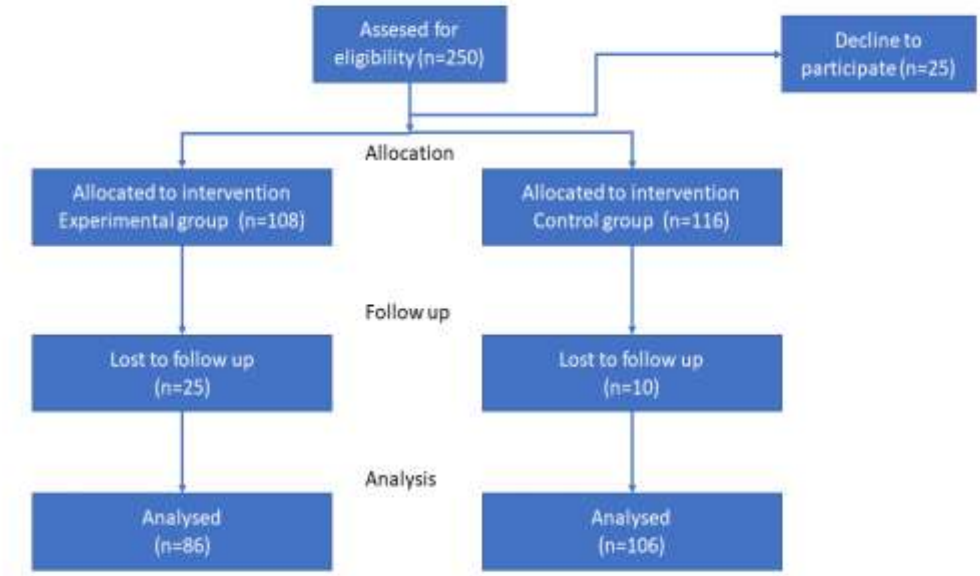


Figure 45. DS MAD Phase 1 - RUC6

A total of 108 installations were made, 86 of them were analysed, with a total of more than 56500 game sessions recorded.

In case of the RUC5, 102 participants were recruited, that participate in 3 different installations at the “Dolores Soria" day care centre in Pinto (Madrid), the "Montserrat Caballé" day care centre in Madrid, and in the Villanueva municipality. Following figure represents the recruitment process. All participants were dropped out.

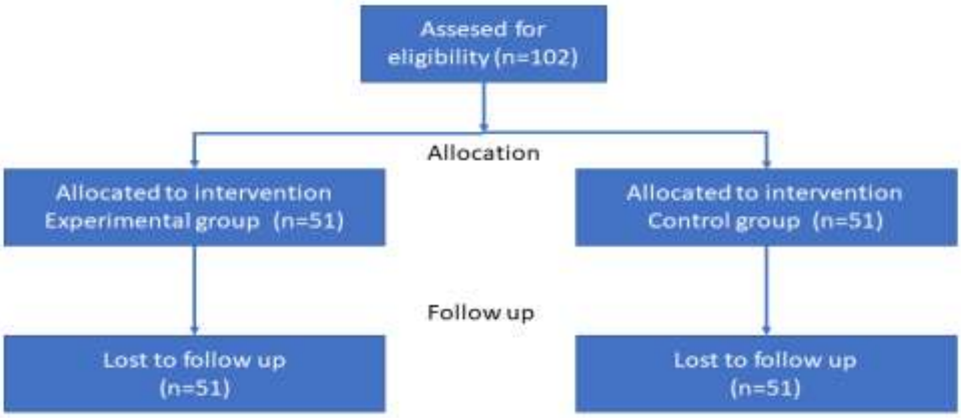


Figure 46. DS MAD Phase 1 - RUC5

A series of focus groups were done with participants in order to discover the causes of the big amount of dropping out. In addition, a statistical analysis was performed to discover statistical differences among participants in the three different installations and time to drop out. In addition, we have data from 6 different collective sessions, but the results were not valid to be analysed individually.

Phase 2

In the case of the RUC1 with Diviertete plus Brain Training Games, a total of 104 participants were recruited and finally allocated 49 in the experimental group and 51 in the control group. The following picture represents the recruitment process and the final users that results as valid for data analysis.

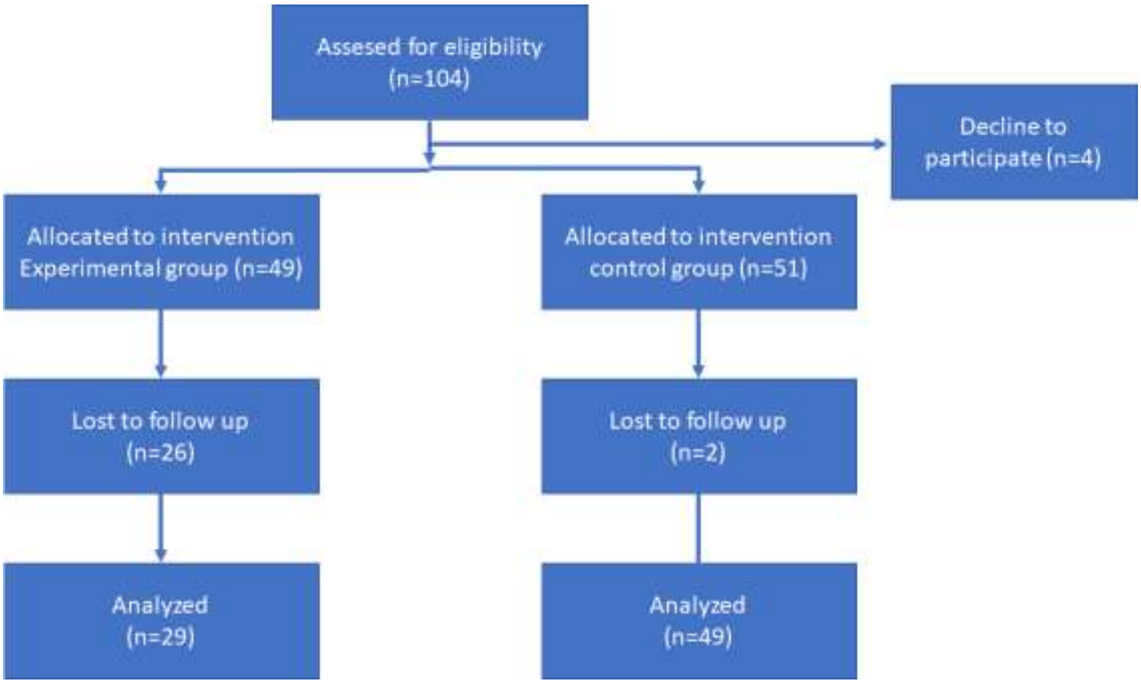


Figure 47. DS MAD Phase 2 - RUC1

In this case, more than 1500 events were published from the Madrid City municipality services, thanks to the Madrid Open Data files. In addition, an average of 10 events for the municipality of

Las Rozas were published monthly. During the COVID-19 confinement a series of online events were published to maintain the engagement of the participants.

A total of more than 2600 consultations to events were done during the experimental periods and in addition more than 9000 brain training sessions were recorded from these participants in the same period.

A total of 146 participants were enrolled in the participation using Exergames solutions in two different installations ("Centro de Dia Rafael Alberti " in Mejorada del Campo and "Centro de Dia Torrejón de Ardoz" in Torrejón de Ardoz").

In this case, COVID-19 pandemic has affected the data collection hardly and the number of sessions per user were drastically reduced and only 58 users finally participate in the experiment, since the others decline to participate. On average, we have collected 3 sessions per participant in the two installations deployed before the pandemic outbreak. The following picture represents the recruitment process and the final users that results as valid for data analysis purposes.

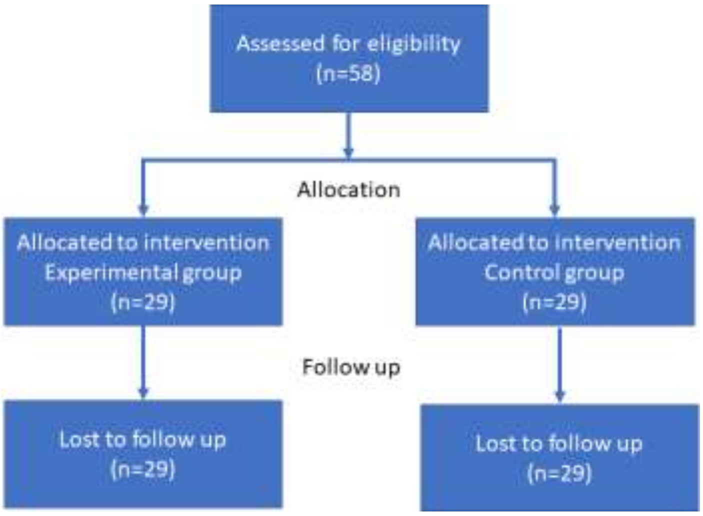


Figure 48. DS MAD Phase 2 - RUC5

Finally, RUC7 enrolled 100 participants that use a Mindfulness based intervention to reduce anxiety and promote the social engagement of the participants within their neighbourhood. The following picture represents the recruitment process and the final users that results as valid for data analysis.

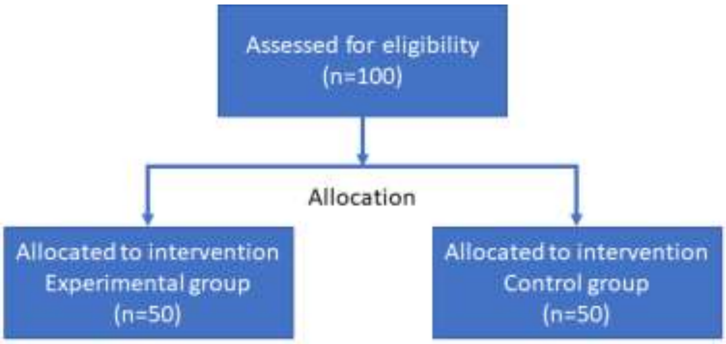


Figure 49. DS MAD Phase 2 - RUC7

We have recorded more than 200 individual sessions at the moment of this deliverable submission.

Phase 3

Phase 3 involved RUC5 with the HOOP solution, RUC6 with the open caller BehavAuth integration in the Brain Training solution and RUC7 with LOCs solution from Valencia DS.

In case of the RUC5, the HOOP solution aims to favour daily practice of balance exercises among frailty users, so avoid falls and keep them physically active. The solution finally involved 60 users, collecting more than 1000 individual sessions at the date of this deliverable submission.

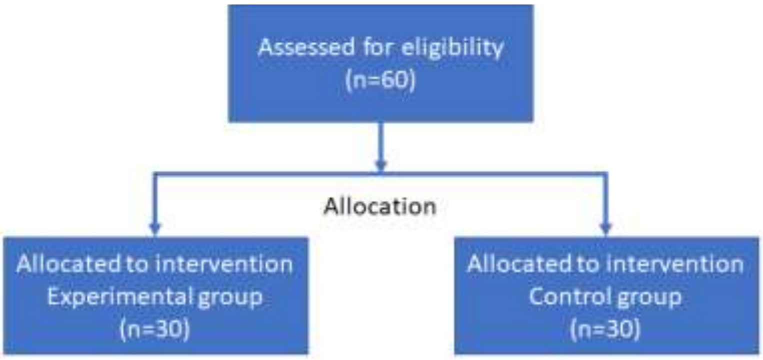


Figure 50. DS MAD Phase 3 - RUC5

RUC6 aims to validate the usability of a security system based on face recognition in order to ensure the elderly user is doing the exercises. The solution involved 16 users.

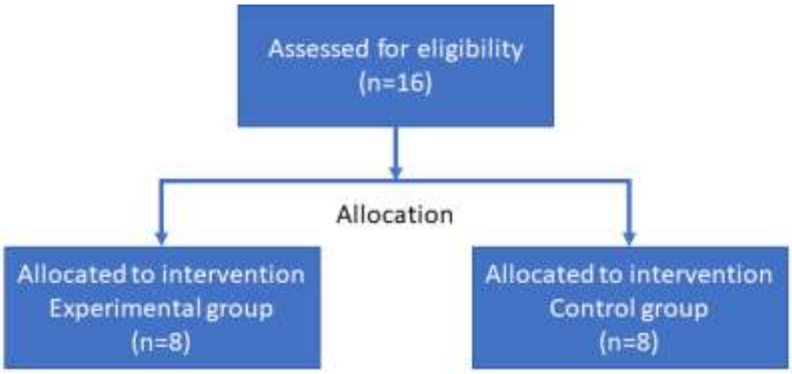


Figure 51. DS MAD Phase 3 - RUC6

Finally, RUC7 imported the LOCs solution from Valencia DS, incorporating the behaviour patterns recognition to the social isolation augmented risk algorithm developed by the UPM. In this case, 100 elderly users and 100 informal caregivers were involved in the experiment.

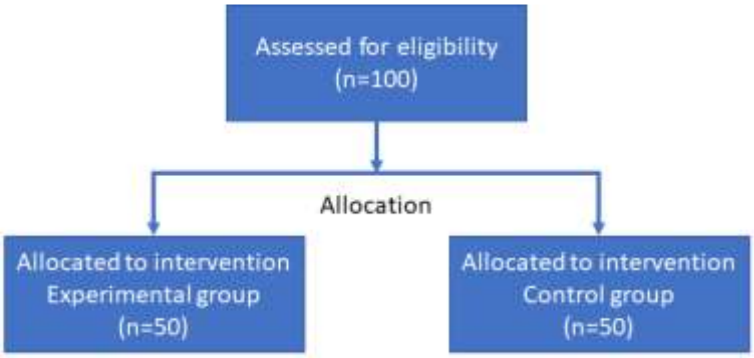


Figure 52. DS MAD Phase 3 - RUC7

Careers statistical plan and data sources

In addition to the elderly users' analysis, the experiment involved 38 formal careers that monitor and follow up the involved users during the three phases using the MAHA dashboard. The objective of the experiment is to determine the overload of the carers (or the lack of overload) using the IoT tools deployed in the different phases of Madrid DS experiment.

The Sociodemographic and baseline properties (defined by QoLD7) was characterised by descriptive methods (mean [SD], and standard deviation) and presented in a table, for both control group and experimental group at it is shown in Table 54. A similar table compares those who dropped out versus those who completed the primary outcome.

Table 54. DS MAD Socio-demo and clinical baseline properties

Characteristics	Experimental	Control	Total
Female/male	N/N	N/N	N/N
Age	mean [SD]	mean [SD]	mean [SD]
Minimental	mean [SD]	mean [SD]	mean [SD]
Frailty	mean [SD]	mean [SD]	mean [SD]

To report the QoLD7 results, the simplest way was reporting the number and proportion of the users' sample reporting each of the levels on each of the dimensions as it is shown in Table 55.

Table 55. DS MAD QOLD7 analysis - statistical plan

	TASK				RELATIONAL PROBLEMS				MENTAL HEALTH				DAILY ACTIVITIES				FINANCIAL PROBLEMS				SUPPORT				PHYSICAL HEALTH			
	PRE		POST		PRE		POST		PRE		POST		PRE		POST		PRE		POST		PRE		POST		PRE		POST	
	E	C	E	C	E	C	E	C	E	C	E	C	E	C	E	C	E	C	E	C	E	C	E	C				
LEVEL 1: without problems	N%	N%	N%	N%	N%	N%	N%	N%	N%	N%	N%	N%	N%	N%	N%	N%	N%	N%	N%	N%	N%	N%	N%	N%	N%	N%	N%	N%
LEVEL 2: with some problems	N%	N%	N%	N%	N%	N%	N%	N%	N%	N%	N%	N%	N%	N%	N%	N%	N%	N%	N%	N%	N%	N%	N%	N%	N%	N%	N%	N%
LEVEL 3: many problems	N%	N%	N%	N%	N%	N%	N%	N%	N%	N%	N%	N%	N%	N%	N%	N%	N%	N%	N%	N%	N%	N%	N%	N%	N%	N%	N%	N%

As well as we planned for EQ5D3L, we have used the Pareto principle to analyse the results in comparison to the baseline results.

Finally, the analysis of SUS and dashboard questionnaire results were analysed individually and correlated with the results of the QoL questionnaire.

5.2.6 Results

At the moment of this document delivery, Phase 1 and Phase 2 are completely finished and analysed. Users in phase 3 continues in operation as part of our sustainability plan. This section summarises the results,

5.2.6.1 RUC6 Results

Analysis of the QoL

According the processes explained before in this section, the quality of life was assessed using the Pareto principle with the results presented in Table 56:

Table 56. DS MAD Number of users that experiment changes in their health profile in RUC6

	MOBILITY		SELF-CARE		USUAL ACTIVITIES		PAIN		ANXIETY	
	EXP	CONT	EXP	CONT	EXP	CON	EXP	CONT	EXP	CONT
Users that maintain conditions	82	52	83	52	83	37	83	48	73	32
Users reporting more problems	1	28	0	28	0	36	0	28	4	37
Users reporting less problems	0	26	0	26	0	33	0	30	0	36

In general terms, the control group has experimented more variabilities and worsening in their status. Therefore, there is an important number of users that has improved their health status with no direct IoT interventions. Deeply analysing the causes of those participants that have improve their health status we have the following results. In case of the experimental group the improvement was only in one of the 5 dimensions, in most of the users' anxiety and depression (67%), together with mobility (17%) and pain (17%). In case of control group, the improvements were usually multidimensional (90% of the users that have improvements in their health status, have improved two or more dimensions).

It was found that SPQ of the dropouts and those participants that refused the RUC6 solution, have a positive correlation (p=0,0096, F(4,83), while there existed no statistically significant association between those participants self-perceived QoL and the ones that continue using RUC6 solution after the experiment completion (p>0,05). This association is not seen in social activity or physical activity (with p>0,05 in both cases). In this way, we can consider that a low self-perceived QoL can be considered a predictor of early dropouts or low adherence to the system (also analysed with UTAUT questionnaire). In this last case, the participants that returned the RUC6 solution after experiment ends (status=finished), are more frequently not compliance with the applied reduction rules (about 78% of the participants compared to the 38% of the participants that maintain the tablet (status=completed)).

Impact of technology on QoL of the users

Analysing the results of the QoL (EQ5D3L and SPQ) and data collected from the direct usage of the proposed solutions, it was found that the use of the technology frequently could have a positive effect on the QoL perception of the participants, but more use does not increment this positive effect in a significant manner.

In particular, it was found that there do not exist any statistically significant association between the results of QoL (EQ5D3L profile or score) and time of usage, number of sessions or number of correct exercises (p>0,05 in all the cases) with a confidence interval of 95%.

We have also compared the QoL with the MMSE delta, and error rate of the exercises and there does not exist a significant relation between these variables (p>0,05 in all the cases).

In addition to this, the impact of the IoT is more positive in those users that maintain the usage of the technology after the experiment ends. This can show that those users that are more engaged with the technological solutions, value more positive the impact of the IoT on their maintenance of their QoL, the improvement on the cognitive status, could have a positive effect on their mobility. No statistically significant correlation was found with time of usage, number of completed sessions, or error in those cases (p>0,05 in all the cases), as we can see on the analysis of SPQ (IoT impact physical activity) has a strong correlation with the status of the user (dropout, finalized, completed) (F=10,73, p=0,016). Analysing the effect of the status on the EQ5D3L (Mobility), it is found a strong relation between the EQ5D3L (Mobility final) and the SPQ (IoT impact physical activity) (F=7,59, p=0), depending of the status of the users.

Analysing the effect of the self-perceived impact of the IoT on the EQ5D3L (Anxiety) baseline, it is found a strong relation between the EQ5D3L (Anxiety) final and the SPQ (IoT impact on Social) (F=2,41, p=0,0213), independently of the status of the user. No statistically significant correlation was found with time of usage, number of completed sessions, or error in those cases (p>0,05 in all the cases)

This can show that those users that are more engaged with the technological solutions, value more positive the impact of the IoT on their maintenance of their QoL, the improvement on the cognitive status, could have a positive effect on their mobility and social life.

UTAUT analysis

In general terms, participants in RUC6 valued as positive the use of IoT with results over 5 in all the categories according the UTAUT results at it shown in Table 57.

Table 57. DS MAD RUC6 UTAUT results

QUESTIONS		COMPLETED	FINISHED
EE1 My interaction with the IoT device is clear and understandable	5,82±1,13 [3,7]	6’02±1,07	5,66±1,17
EE2 It is easy for me to become skilful at using the IoT device	5,184 ±1,637 [1,7]	5,78±1’2	4,68±1,75
EE3: I find the IoT device easy to use	5,52±1,41 [1,7]	5,88±1,2	5,22±1,75
EE4: Learning to operate the IoT device is easy for me	5,68 ± 1,45 [1,7]	5,719±0,9	5,62±1,24
PE1: I find the IoT device useful for my purposes (daily living/job).	5,71±1,19 [2,7]	6,238±1,05	5,28±1,14
PE2: Using the IoT device enables me to accomplish tasks more quickly	5,63±1,27 [2,7]	6,14±1,13	5,2±1,22
PE3: Using the IoT device increases my productivity.	5,72±1,23 [2,7]	6,26±1,06	5.28±1,19
PE4: If I use the IoT device, I will increase my chances of getting a better quality of life	5,73±1,25[2,7]	6,3±0,97	5,26±1,27
AT1: Using the IoT device is a good idea	5,92±1,18	6,3±1,02	5,6±1,22
AT2: The IoT device makes study more interesting.	5,48±1,5	5,7±1,68	5,3±1,3
AT3: Working with the IoT device is fun	5,47±1,55	5,6±1,84	5,36±1,24

AT4: I like working/using with the IoT device	5,7±1,43	6,08±1,5	5,4±1,29
SI1: People who influence my behavior think that I should use the IoT device.	5,05±2,15	5,8±1,9	4,42±2,15
SI2: People who are important to me think that I should use the IoT device.	5,5±1,9	6,09±1,57	5±2
FC1: I have the resources necessary to use the IoT device.	6,05±1,04	6,47±0,91	5,7±1,01
FC2: I have the knowledge necessary to use the IoT device	5,79 ± 1,04	6,26±1,3	5,4±1,51
FC3: The IoT device is not compatible with other systems I use.	5,5±1,76	5,6±1,91	5,34±1,63
FC4: A specific person (or group) is available for assistance with the IoT device difficulties.	5,9±1,42	5,92±1,87	6,02±0,91
SE1: I can complete a job or task using the IoT device, if there is no one around to tell me what to do as I go.	5,38±1,61	5,66±1,86	5,14±1,34
SE2: I can complete a job or task using the IoT device, if I can call someone for help if I get stuck.	5,54±1,67	5,76±1,97	5,28±1,35
SE3: I can complete a job or task using the IoT device, if I have a lot of time to complete the job for which the software is provided.	5,45±1,81	5,71±1,95	5,24±1,68
SE4: I can complete a job or task using the IoT device, if I have just the built-in help facility for assistance	5,76±1,57	5,90±1,81	5,64±1,32
AX1: I feel apprehensive about using the IoT device.	1,76±1,13	1,52±0,99	1,96±1,21
AX2: It scares me to think that I could lose a lot of information using the IoT device by hitting the wrong key.	2,03±1,4	2,04±1,65	2,02±1,18
AX3: I hesitate to use the IoT device for fear of making mistakes I cannot correct.	2,02±1,39	2,07±1,64	1,98±1,16
AX4: The IoT device is somewhat intimidating to me.	1,8±1,25	1,57±1,25	2±1,22
BI1: I intend to use the IoT device in the next semesters	6,07±1,16	6,5±0,84	5,74±1,27
BI2: I predict I would use the IoT device in the next semesters	6,03±1,15	6,5±0,81	5,66±1,25
BI3: I plan to use the IoT device in the next semesters	6,04±1,23	6,42±0,98	5,74±1,33

A correlation analysis on these results shown that those users that have positive results on behaviour intention, are those that consider the IoT solution more useful and with more impact on their QoL, and the IoT device caused them less anxiety or problems. In addition, those users that consider the IoT device more useful are those that consider easier to use the system.

Therefore, these are not related with the International Standard Classification of EDucation (ISCED) level or the technological level, so the facilitating conditions and performance expectancy depends on external factors that should be analysed in the future.

5.2.6.2 RUC5 Results

Every of the users in UC5, both in phase 1 and phase 2 drop out the experiment before its ends and no statistical analysis were performed.

Phase 1 qualitative assessment showed that the main cause of dropping out was users found the solution uncomfortable and difficult to use.

5.2.6.3 RUC1 Results

Analysis of the QoL

In general terms, the control group has experimented more variabilities and worsening in their status. In case of the experimental group the improvement was only in one of the 5 dimensions (Pain 100%). In case of control group, the worsening was usually in pain and anxiety.

Table 58. DS MAD Number of users that experiment changes in their health profile in RUC1

	MOBILITY		SELF-CARE		USUAL ACTIVITIES		PAIN		ANXIETY	
	EXP	CONT	EXP	CONT	EXP	CONT	EXP	CONT	EXP	CONT
Number of maintain conditions (number/%)	23	48	23	48	23	47	20	43	22	40
Number of reporting more problems	0	2	0	2	0	3	1	7	1	8
Number of reporting less problems	0	0	0	0	0	0	2	0	0	2

In general terms, the control group has experimented more variabilities and worsening in their status. In case of the experimental group the improvement was only in one of the 5 dimensions (Pain 100%). In case of control group, the worsening was usually in pain and anxiety.

The dropout users have in general terms poorest SPQ in all the cases (0.75 less in average). In this way, we can consider that a low self-perceived QoL can be considered a predictor of early dropouts or low adherence to the system (also analysed with UTAUT questionnaire). In this last case, the participants that finally do not continue in the experiment were more frequently not compliance with the applied reduction rules (about 70% of the participants compared to the 30% of the participants that finished the experiment).

Table 59. DS MAD Self-perceive QoL of participants at baseline depending on their status at the end of the experiment

QoL	
DROP OUT	6,778±1,36

CONTINUE UNTIL EXPERIMENT ENDS	7.6±1,52
PHYSICAL ACTIVITY	
DROP OUT	6.48±2,17
CONTINUE AFTER EXPERIMENT ENDS	7,30±1.6
SOCIAL INTERACTION	
DROP OUT	6,10±2.04
CONTINUE AFTER EXPERIMENT ENDS	6.73±2.17

Impact of technology on QoL of the users

Analysing the results of the QoL (EQ5D3L and SPQ) and data collected from the direct usage of the proposed solutions, it was found that the use of the technology frequently could have a positive effect on the QoL perception of the participants, but more use does not increment this positive effect in a significant manner.

In particular, it was found that there do not exist any statistically significant association between the results of QoL (EQ5D3L profile or score) and time of usage, or number of monthly sessions (p>0,05 in all the cases) with a confidence interval of 95%.

UTAUT analysis

In general terms, participants in RUC1 valued as positive the use of IoT with results over 5 in all the categories according the UTAUT results at it shown in Table 60. It is especially relevant the high values in the questions PE1: I find the IoT device useful for my purposes (daily living/job) and PE4: If I use the IoT device, I will increase my chances of getting a better quality of life, with all values over 5, so we can consider, people engaged with the solution feels the proposed system support them in their daily living better that the traditional solutions they know.

Table 60. DS MAD RUC1 UTAUT results

QUESTIONS	
EE1 My interaction with the IoT device is clear and understandable	5,17±1,33 [3,7]
EE2 It is easy for me to become skilful at using the IoT device	4.95 ±1,87 [0,7]
EE3: I find the IoT device easy to use	5,04±1,14 [2,7]
EE4: Learning to operate the IoT device is easy for me	5,13 ± 1,39 [2,7]
PE1: I find the IoT device useful for my purposes (daily living/job).	5,65±0,89 [2,7]
PE2: Using the IoT device enables me to accomplish tasks more quickly	5,63±1,27 [4,7]
PE3: Using the IoT device increases my productivity.	5,39±1,33 [2,7]
PE4: If I use the IoT device, I will increase my chances of getting a better quality of life	5,56±1,16[4,7]
AT1: Using the IoT device is a good idea	5,43±1,23[4,7]
AT2: The IoT device makes study more interesting.	5,13±1,27[4,7]
AT3: Working with the IoT device is fun	5,32±1,11[4,7]

AT4: I like working/using with the IoT device	5,78±1,2[4,7]
SI1: People who influence my behavior think that I should use the IoT device.	5,05±2,15[5,7]
SI2: People who are important to me think that I should use the IoT device.	5,26±1,81 [1,7]
FC1: I have the resources necessary to use the IoT device.	5,82±1,33[1,7]
FC2: I have the knowledge necessary to use the IoT device	6,08 ± 0,84[4,7]
FC3: The IoT device is not compatible with other systems I use.	5,5±1,76[4,7]
FC4: A specific person (or group) is available for assistance with the IoT device difficulties.	5,82±0,88 [4,7]
SE1: I can complete a job or task using the IoT device, if there is no one around to tell me what to do as I go.	5,95±0,70 [5,7]
SE2: I can complete a job or task using the IoT device, if I can call someone for help if I get stuck.	5,73±1,09 [2,7]
SE3: I can complete a job or task using the IoT device, if I have a lot of time to complete the job for which the software is provided.	5,95±0,76 [4,7]
SE4: I can complete a job or task using the IoT device, if I have just the built-in help facility for assistance	5,43±1,44[2,7]
AX1: I feel apprehensive about using the IoT device.	3,39±2,12 [1,7]
AX2: It scares me to think that I could lose a lot of information using the IoT device by hitting the wrong key.	3,26±1,95 [1,7]
AX3: I hesitate to use the IoT device for fear of making mistakes I cannot correct.	3,30±1,98 [1,7]
AX4: The IoT device is somewhat intimidating to me.	3,30±2,03 [1,7]
BI1: I intend to use the IoT device in the next semesters	5,56±1,23[3,7]
BI2: I predict I would use the IoT device in the next semesters	5,60±1,26[3,7]
BI3: I plan to use the IoT device in the next semesters	5,56±1,27[3,7]

A correlation analysis on these results shown that those users that have positive results on behaviour intention, are those that consider the IoT solution more useful and with more impact on their QoL, and the IoT device caused them less anxiety or problems. In addition, those users that consider the IoT device more useful are those that consider easier to use the system. Social influence has not strong correlation with behaviour intention or aptitude towards technology, but it exits a strong positive correlation between users with higher values in the question FC4: A specific person (or group) is available for assistance with the IoT device difficulties and AT1: Using the IoT device is a good idea. This results, together an analysis of the users that have more positive answers can be explained as the users that had or found better support to use the technology and overcome technological barriers consider the solution more useful for their daily living.

5.2.7 Local evaluation findings

The quasi experimental design of the Madrid DS experiment has allowed us to propose IoT based interventions to address real problems of the Madrid elderly population, based on traditional care services frailty segmentation and compare the results of these new interventions with the similar ones done currently without the use of the technology. These comparative studies have allowed us to discover the most promising solutions in terms of impact on the different dimensions of the elderly quality of life, acceptability of the solutions and engagement with the solution.

The Madrid DS participants sample heterogeneity allowed us to discover what of the sociodemographic and cultural, even regional differences and/or barriers to adopt the proposed technological solutions and discover those elements that have more impact on the sustainability of the DS. All the results of these analyses were used to define and elaborate the sustainability plan of the DS.

In addition to this, the experiment protocol and the proposed analysis aim to discover correlations between the different solutions and how an intervention on a specific frailty dimension (i.e. cognition) affects and improves other dimensions (i.e. socialization). Moreover, the stratification according to frailty status (active, frailty, social isolation, etc.) allows us to compare and analyse when, how and who are more permeable to an specific type of intervention, so maximize the results of the proposed IoT interventions with objective of maintaining higher self-perceived quality of life as much as possible.

The complete analysis results will be reported on WP6 (D6.5) and a summary of these results will be published on the Public Evidence Website (http://evidence.activage.lst.tfo.upm.es). As the main conclusion of this analysis we can advance that in general terms, in Madrid DS the IoT technology has a positive impact on the quality of life of the elderly users, because they have contributed to maintain the elderly participants QoL profile.

In terms of participation objectives, a total of 1029 participants were enrolled in the Madrid DS during the 18 months duration. This is more than the expected participation, with the incorporation of 100 informal careers, initially not defined. Elderly users were close to the planned participation with 891 participants, and a low rate of drop out (about 25%). The number of formal careers incorporated into the study was finally 38.

In spite of the high impact that COVID-19 pandemic has in some of the solutions especially in those planned as collective sessions, the engagement of participants with the proposed solutions was high, but some measures should take in place that affect the study definition, and the data analysis. The adaptation of the recruitment protocol during this period allow us to analyse the impact of this specific situation, and others more common situations in the AHA services provision such as how to access to IoT services in rural areas, how to promote the access to social engagement services to elderly adults living in old flats without elevators, or after a complicated medical situation and how IoT-AHA services could have positive impact on the quality of life maintenance of the elderly population and has the potential to alleviate the functional decline deterioration due to these situations.

The lessons learned supported by the qualitative and quantitative results obtained during this period will enable us to adapt our solutions to remote administration of social care specific intervention based on IoT technology on elderly users that have potential problems or barriers to access to social care services on a daily basis, and deeply impact on the Madrid DS sustainability plan.

5.3 Local sustainability plan

Introduction: Madrid Pilot Quadruple Helix Innovation System

DS Madrid is contextualized within the Madrid Regional Health department, which is also an EIP on AHA Reference Site with 4 stars; whose ecosystem facilitates the close communication between all relevant actors, such as institutions, public and private service providers, companies, investors, research, citizens, etc. thus generating the *quadruple helix* collaboration, see Figure 53. The main goals of this collaboration are: to take advantage of common infrastructures and economies of scale, to strengthen relations with Industry and Social Actors; promote training on health for health professionals and citizens, with special focus on the older adults and fragile population; and integrate civil society in health care activities and strategies.

Figure 53. DS MAD Quadruple Helix Innovation System

The specific list of stakeholders in DS Madrid is composed of: *end-users* who use the IoT solutions including its services and applications; *assistance providers*, professionals of the health and social environment; *technology providers*, developers and deployers of the technical solution; and *infrastructure providers*, who provide access to the Madrid city infrastructure and its open data resources. The integration of these groups into the pilot ensures that all stakeholders involved in each issue have the potential to influence the processes and decisions, or at least have access to relevant information of the whole concept.

A new stakeholder: ACTIVAGE.ORG, as an environment for expanding and strengthening DS MAD and sustainability of results in a European context

ACTIVAGE.ORG enters our ecosystem as a strategic point in the European market. It assists in the provision of solutions for active and healthy ageing, generating value and guaranteeing the accessibility of all elderly people to the offer of service providers and technology providers in the field of AHA-IoT. Providers which were associated through the local/regional network generated throughout Europe during the development of the Project.

In this sense as first step, ACTIVAGE.ORG will assume ownership of all assets produced in the project, both technical and knowledge-based; it will also expand the initial ecosystem allowing project members to maximize the return on investment and continues contributing to the promotion of the activity and values of the organization in the active and healthy European aging environment.

Madrid DS Business Model: Sharing Economy

Our business model is a **shared economy model because it is** an economic model defined as a peer-to-peer (P2P) based activity of acquiring, providing, and/or **sharing** access to goods and services. It is facilitated by a community-based on-line platform.

Another important characteristic, is that we have our **triple sustainability target**, i.e. the economic sustainability, which is the aim of any business model; the environmental sustainability, because we are working on proximity access and delivery of services within neighbourhoods; and social sustainability, because we create a healthy liveable and connected community for elder to engage, integrate and evolve.

These two main characteristics of our business model, sharing economy and triple sustainability is the very core of our "Local Sustainability Plan".

Main Characteristics of Madrid DS Sustainability Plan

Madrid will continue with the Pilot and MAHA community. Our 1000 pilot users, from the very first moment, have shown interest to continue with the health and active aging activities provided by us through different use cases. In our next phase of sustainability, DS MAD intends to scale up our initial pilot by incorporating 200 new users using the solutions already in place through the acquisition of technology. it also foresees the incorporation of 300 new users who will provide their own technology (i.e., technology particular to each user such as mobile phones). In addition, it is considered that during this stage about 30 facilities such as day centres, residences, primary care centres and government offices, among others, will be reached. These actions will be carried out by replicating MAHA community at the scale of a neighbourhood.

But Madrid DS sustainability phase is not only about older adults using IoT devices for active aging practices; it is our aim to continue and deepen the community MAHA in which we consider that the traditional ageing identity has to change to a new vision. This vision is based on the acknowledgement that older adults provide relational goods and that our communities need these goods for their own sustainability.

The expected benefits from the implementation of the sustainability phase are four: 1) to improve the quality of life of older adults through the use of IoT solutions; 2) to generate a dataset that will be available for future research and exploitation; 3) to convert MAHA and our initial pilot in Madrid into a link between users and real life environments where the different technological solutions will be deployed; and 4) to promote a series of programmes that involve the commitment of the City Council and the main organisations involved in Active and Healthy Ageing (AHA), guaranteeing the sustainability of the project on the basis of the convergence of government, community, academia and citizens.

5.3.1 Product/Service Definition

The new situation of COVID-19 has left us with great lessons learned from which to strengthen our sustainability, such as the need for creating safe environments indoor and outdoor; promoting home care and delay institutionalization; and riding on the new awareness of the importance of IoT domain and enhancing self-caring. Starting from these considerations, and deepening the initial approach of our DS MAD, we can define the sustainability of the pilot in the field that is defined between three fundamental pillars of the Madrid ecosystem, which are:

The geographical meeting point: the neighbourhood as a key environment

Neighbourhoods are the great catalyst for public and private organizations, entities and services. They are the basic space for coexistence in cities, where the day-to-day life of people is developed through their social interaction, producing phenomena of integration or exclusion that mark the lives of citizens.

The new role of the elderly as providers of relational goods

At MAHA we began to define a new approach where all relationships and social activities strengthen our community. This vision promotes active and healthy aging by empowering the elderly and providing the fertile ground to unfold their full potential as providers of critical social goods for the development of our society and enhance their altruism.

A new concept of service provision: personalized intervention through IoT

It conforms a new foundational space where technology becomes a bridge between those who have already lived most part of their lives and those who have their whole lives ahead of them. Technology as a value that allows personalized intervention (through a dashboard) for the custom configuration of the services required by each elderly person from the monitoring and accompaniment of the caregivers.

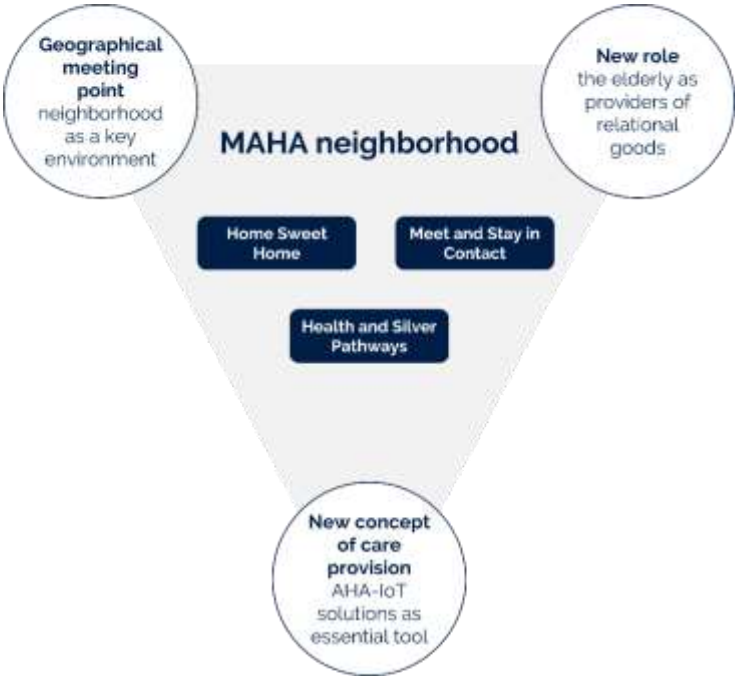


Figure 54. DS MAD MAHA Ecosystem: landscape and action levels

Figure 54 presents the three lines of action under the MAHA neighbourhood environment but contextualized in the MAHA's ecosystem fundamental pillars.

5.3.1.1 Sustainability Phase: Lines of Action

It is in the territory defined by these three points where MAD DS will replicate and will make it grow the experience of the project with three levels of action represented by different scenarios:

1. Home Sweet Home: this scenario proposes the deployment of solutions to strengthen the in-house environment of the elderly through three main objectives. Monitoring of the Activities of Daily Living (ADL) (RUC1), basic and instrumental, for the support of informal caregivers and for the follow-up and self-management of formal caregivers. Detection of specific behaviours or situations that require immediate attention (RUC4). And finally, increase safety and comfort at home.

2. Health and Silver Pathways: This scenario proposes the deployment of solutions to support, promote and strengthen the confidence of older adults to leave home, as well as proposing activities they can carry out on their way to their destination.

3. Meet and Stay in Contact: This scenario proposes the deployment of solutions to strengthen the promotion of activities for social interaction to counteract the social isolation, cognitive deterioration and sedentary lifestyle of older adults.

5.3.1.2 DS MAD Services Portfolio

In these three scenarios we will continue to deploy our RUCs 1, 5, 6 and 7 but we are going to add RUC4, RUC8 and RUC9. For this purpose, two kinds of products will be offered to the different interested entities or users: the DS MAD already deployed services (see description below) and the complementary global ACTIVAGE assets such as the AIOTES framework or the datasets produced by the DSs of the Project. In addition, new adapted IoT solutions will be added like the solution *#LAZOTEA* together with the MAHA dashboard, and some new devices like smartwatch will be introduced.

COMMUNICATION: MAHA dashboard notifications

The one-way communication channel from caregivers to the elderly serves to reinforce the interventions made through the rest of the solutions, as well as to facilitate access to reliable sources of information of interest and personalized content according to each person's circumstances.

The service provides support in educational activities in an indirect way since it allows the dissemination of material such as prevention measures in health, content on active aging, exercise plans, healthy recipes, or news with the possibility of including multimedia content such as audios, images and videos.

STATE of MIND: How are you? v2.0 (¿Cómo estás? v2.0)

It is a tool for self-perception of the state of mind that allows detecting situations of cognitive and psychic risk that can potentially put the user's health at risk. The intervention protocol manages 3 levels of intervention, helps to reduce the cause of the user's discomfort, and allows the necessary interventions to be made to resolve the situation before it becomes irreversible.

The caregiver, through the MAHA dashboard, has the possibility of consulting the questions that the user has answered and their response, as well as knowing the level of intervention in which they are. He or she will receive alerts automatically generated by the system when there is a change in the level of intervention, a set of responses indicating an increased level of risk, or if he or she does not answer/access the questionnaires.

COGNITIVE TRAINING: Brain training games v2.0

Is a service that helps to delay the onset of cognitive impairment and to extend the time of independence of older people while they enjoy playing. Cognitive abilities can be worked on and enhanced to keep them at a good level and promote active and healthy ageing. These capacities are orientation, memory, calculation, attention, executive functions, visuospatial ability and language.

Based on a cognitive assessment test that is integrated into the solution, the system identifies the skills that the user should train and suggests the most appropriate games to strengthen those categories, including puzzle, Sudoku, alphabet soup, pairs, mastermind, London towers, rotated drum, complete the series, guess the colour, find the partner, look for the different and follow the hand.

ENTERTAINMENT: Diviértete

A service, initially oriented towards leisure outside the home, expands its functionalities to become a window to the wide range of cultural events, entertainment and leisure. The objective is to offer the user a single point of access to this entire offer, facilitating their search according to their criteria, preferences and tastes. Some examples include opera, magic shows, virtual visits to museums, concerts and storytelling events.

Although the application is mainly fed by the Madrid City Council's open data RSS feeds, other entities can provide information and direct access to both physical and virtual events, through the MAHA dashboard. It is possible to consult which events are or have been active in order to recommend them through a notification system, as well as user attendance at such events.

PHYSICAL ACTIVITY: Physical exercise

Exercise is one of the main strategies for healthy aging. It helps to maintain balance and stretching, which are essential to avoid falls and loss of muscle mass, indicators of increased risk of fragility. The system provides a training program aimed at improving or maintaining balance and strength, depending on the user's physical conditions.

It is an ideal complement for exercise outside the home or in situations that require further rehabilitation. The user follows the program suggested by the system where he can visualize the exercise he is doing and the number of repetitions for each one. At the end of the session, the user can give his or her assessment of how difficult or easy it was to adapt the next session; this allows the caregiver to detect physical deterioration before a risky event (i.e. fall) can occur.

FULL ATTENTION: Mindfulness

The physical and psychological benefits associated with the practice of mindfulness in older people at risk of depression associated with loneliness are diverse, such as greater calm, less stress and better sleep. The proposed program is an introduction to mindfulness, endorsed by professionals, so that older people can incorporate it into their daily lives as a therapy to counteract stress and loneliness.

The system provides a complete program of guided voice sessions that will help the user to incorporate the practices and use of the lessons learned in their daily life. Every practice session, whether completed or not, incorporates a user self-perception questionnaire. In parallel with this practice session, a series of motivational messages are introduced to encourage an improvement in the user's social relations.

The innovation of a new offer: a set of technologies and personalized services

Based on this detailed service offer, a new segmented service portfolio for each user was consolidated in phases 2 and 3 of DS MAD.

Based on the results of the detailed evaluation, and in accordance with the protocol, a set of technologies and services are combined from the dashboard that allows us to provide a personalized response depending on the user's conditions. This intervention is monitored daily by the caregivers from the MAHA Dashboard.

This implementation represents a very important innovation as it makes contributions to the sustainability of the provision of social services.

Figure 55. DS MAD New AHA-IoT services

As an example of our AHA-IoT portfolio, should we be facing a “social isolation- depression use case” we would be using the (1) Physical Activity, (2) Cognitive training, (3) Mindfulness solutions (described above) that as can be seen in the figure could be used on different devices like a tablet or smartphone.

Figure 56 represents the protocol of the apps to use after the evaluation of a user indicating social isolation and depression. Depending on the level of risk of the user, we can have different combinations of applications to be used, as well of different possibilities in the periodicity of usage. All this work, both evaluation and monitoring of the personalised plan, will be monitored by a caregiver.

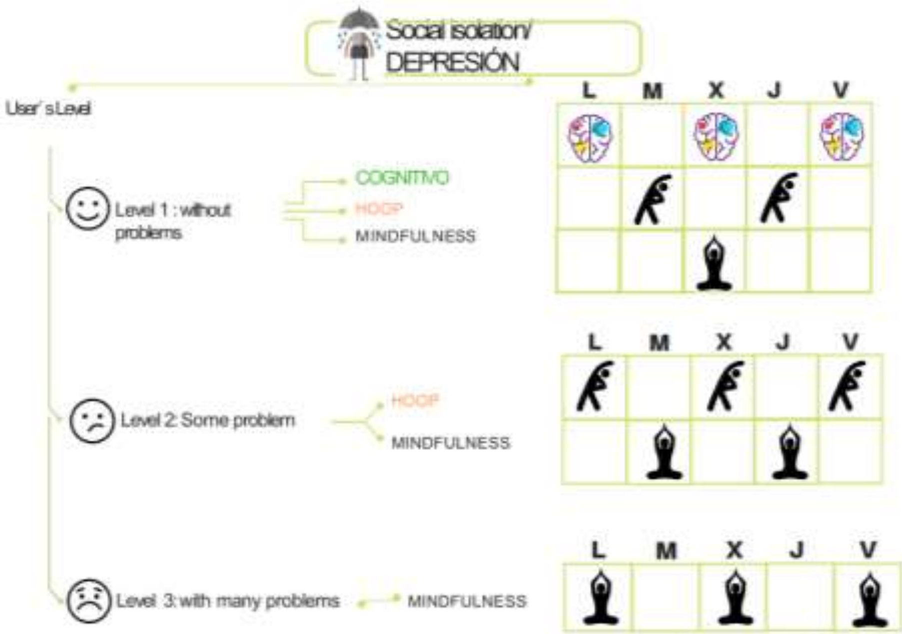


Figure 56. DS MAD AHA-IoT services - protocol of use - example

Moreover, a global evaluation considering the four main pillars of active aging (i.e. mobility, cognitive impairment, social isolation and pain or discomfort) can be performed. An example of the complete protocol for a given user to be monitored by caregivers is represented in Figure 57.

As can be seen the different areas are tackled depending on the level of intervention they receive by a doing a weekly schedule of AHA activities.

Figure 57. DS MAD AHA global evaluation and protocol of use

5.3.2 Cross-pillars to carry this forward

MAHA dashboard, the essential tool for a new concept of care provision

The MAHA dashboard has been an important tool throughout the project. In the sustainability stage, due to the impact of COVID-19, it takes on a neuralgic relevance since the new normality implies enhancing the strategy of personalization of services for each user and the permanent monitoring of the elderly with a reduction of face-to-face contact. MAHA dashboard needs the presence of caregivers to manage the different levels of alarm received and maintain our interaction with users.

MAHA 2.0 contemplates a series of monitoring applications and active aging practices which launch alarms to the dashboard allowing an interaction with the user; being this interaction a differential concept with the rest of the applications that exist nowadays. This interaction therefore allows each user to have a virtual day centre with which to carry out active ageing practices in a more continuous and complementary way to all those taking place in the neighbourhood.

Synergies to leverage existing resources

#Lazotea: is a website of the Madrid City Council that connects you with your neighbours in your neighbourhood, an ecosystem of proximity. It is a new space to create neighbourhood communities. Search for your community and open topics for debate, share your opinion, create bonds of solidarity, ideas for improvement and everything that can improve life in your immediate surroundings. There are 131 neighbourhoods in Madrid and 131 neighbourhood communities in *#LAZOTEA* (see https://decide.madrid.es/debates).

#COMPARTIMOS BARRIO is an initiative that was born to make trade and essential services which are operative in each district visible during the COVID-19. It is also open to the neighbourhood associations that are giving their support and solidarity to many Madrid citizens in this crisis. Its aim is to become a proximity ecosystem that serves to unite the forces of associations and companies, and thus supply the population that for various reasons cannot go out on the streets or cannot cope on its own with situations derived of COVID-19.

Providers of essential products or services are expected to register themselves and their business. For example delivery man, a carrier or a delivery service provider, a neighbourhood association that offers help and solidarity to people who need home supplies.

MAHA launcher would add an icon with a link to *#Lazotea.* We share in this case with the Chamberí neighbourhood the two lines of action of care provision, the one related to their everyday activities and the one related to AHA practices within the IoT domain being MAHA neighbourhood the link.

Opening a door to altruism in the elderly

A characteristic of ageing is the progressive awareness of asymmetric dependence on others, especially on the family environment, which is perceived as a loss of initiative and identity. One way of addressing these concerns is the social integration of a certain group of older people who, because of their age and state of health, are able to provide care to other older people by helping them not to become asymmetrically dependent on family care.

The people who provide this care would have an important benefit from this activity thanks to the creation of an identity of commitment with other elderly people and the exercise of a voluntary work, which is increasingly growing as we have already mentioned. The possibility of the caregiver being exercised by other elders provides undoubted benefits of providing intangible assets, commitment and identity building while providing sustainability to MAHA 2.0 Neighbourhood.

A network with social responsibility

There are countless companies today that, while not NGOs, can contribute through CSR to MAHA Neighbourhood. In essence, corporate social responsibility refers to the moral and ethical obligation of companies in their relations with employees, the environment, competitors, the economy and other areas such as children and the elderly.

This concept that unifies the practice of economic activity with true altruism would reinforce "the new provision of care" through discounts on their services to all those elderly people who collaborate altruistically in MAHA 2.0 Neighbourhood.

STEPS for enlarge MAHA 2.0 NEIGHBOURHOOD

The cross pillars that we have described as essential for our “sharing economy business model” will be key aspects on the different phases as shown in Table 61.

Table 61. DS MAD Enlarge MAHA 2.0 neighbourhood

Phase	Action
Activation · Creation of MAHA neighbourhood	ACTIVAGE recruitment: Elderly Volunteering. Deployment of AHA IoT services. Municipality advertisement: service and products providers within neighbourhood such as shops or cinemas

Creation of synergies that leverage existing resources	Key service providers companies' involvement: Iberdrola, Enagas, Correos, etc. Enhance the two existing channels, MAHA Dashboard and #Lazotea.
Consolidation	Creating Quality: Elaboration of protocols for participation. Creating Trust: Development of processes and structures to meet needs based on fair economic practices
Triple sustainability	Environmental: Wide range of AHA-IoT services within the neighbourhood Social: network with social responsibility Economic: Volunteering caregiving. The door to altruism.

5.3.3 Market Analysis

MAHA neighbourhood is not a new product, is about mobilizing ecosystems that already exist

We need to mobilize ecosystems because there is a lot of pressure on them derived from the fact that there is a progressive increase in the number of elder; there is a need of sustainability on the provision of care giving system; the appearance of a new frailty to which all elder are subject COVID-19; there is a need to understand aging in a more comprehensive way moving away from the "clichés" largely held until now and promote their social integration; there is a need to deepen and enhance self-caring and active aging; there is new awareness of the importance of IoT; and the creation of safe environments to avoid social isolation.

5.3.3.1 PESTEL analysis

Table 62. DS MAD PESTEL analysis

Element	Factor	Business Impact
Political	Municipality as a central stakeholder	Neighbourhood is a great catalyst for public and private organizations, entities and services being the municipality the core of all of them
Economic	Mobilizing ecosystem with its existing transactions	Sustainability for the care provision system
Sociological	Network of social responsibility	The concept of Corporate social responsibility unifies the practice of economic activity with true altruism
Technological	AHA practices within the IoT domain	A new concept of service provision for older adults: personalized intervention through IoT
Environmental	Neighbourhoods are the basic space for coexistence in cities,	Within a limited space of action to enhance as much as activities as

	where the day-to-day life of people is developed	possible will bring a positive environmental effect
Legal	Fulfilment of ethical requirements and data protection law	Provides a safe background for MAHA neighbourhood

5.3.3.2 Market characterization

The Community of Madrid is the third most populated Community in Spain with 6,778,382[7] inhabitants (January 2020). Currently the population of people aged 65+ in Madrid represents 17.72%[8] of the total population, that is, 1.2 million people. Most of them live with relatives or in residential homes, while 273,400 elderly people (23%)[9] live independently in their homes.

The municipality of Madrid is the main social services provider with the following services and population attended as presented in Table 63[10]

Table 63. DS MAD Services offered by Madrid Municipality

Services	Number of people attended
Panic button	115.000
Home care services (SAD)	71.000
Day care centres	7.000
Residences (CCAA)	48.000
TOTAL	**193.000 (72.3%)**

Taking this into consideration, and considering the first explorations of the districts of Madrid, the analysis for the sustainability phase have led us to focus on the Chamberí neighborhood as the main assumption according to its characteristics. Chamberí is one of the historical central districts of the city of Madrid and the one with the oldest population in the city in comparison with the rest of the districts.

- Mainly residential neighborhood with a wide range of commercial and public services[13], with a population of almost 150,000 inhabitants and a surface area of 4.69 km² (31,043 inhabitants/km²)[11].
- The average age of the inhabitants is 3.45 years above the average for Madrid (42.33 years) [11].
- The percentage of people over 65 is 24.8%[11], higher than the average for Madrid.

7 Instituto Nacional de Estadística de España - INE. A
8 Instituto de Estadística de la Comunidad de Madrid. Link
9 Instituto Nacional de Estadística de España - INE. B
10 Anuario Estadístico Municipal · Ayuntamiento Madrid (www.madrid.es)
11 Ayuntamiento de Madrid. Área de Finanzas Públicas y Administración Pública. Subdirección General de Estadística. Censo Municipal de Habitantes. **A**

- It has some 33,552 residents +65 years, representing 24.24%[12] of the total population of the neighborhood and with a similar rate of older people living independently (28.8%).
- Wide purchasing power, it is the fifth district of Madrid in the ranking of highest pensions with a difference of 14.19%[13] over the average income level and a high level of education.

5.3.4 Competition/sector Analysis

The following sections show the SWOT Analysis and potential market gap.

5.3.4.1 Potential market gap

Currently the elder care provision system has a set of characteristics that do not allow us to propose a new product within this market but a new concept of care provision:

1. Most of the social care provision is done by the municipality through the Dependency Law[14] on a public procurement basis that relies mainly in lowering prices and has had important effects on the quality of the provided services.
2. Portfolio services are exclusively based in face to face services provided by poorly qualified and paid workforce
3. Older adults are considered only as subject of care provisions and without any other social identity.
4. The terrible difficulties in adapting to the new scenario of COVID-19.
5. Lack of sustainability in the long term with the expected increase in the aged population because of the baby boom of the 60´s

In this sense when referring to the core of the triple sustainability, we speak of overcoming this situation of elder care provision system and understanding aging in a more comprehensive way; moving away from the “clichés” largely held until now, while promoting their social integration. Our motto is to deepen and enhance self-caring and active aging as well as boost the creation of safe environments to avoid social isolation. In the context of the ACTIVAGE project, we ride the awareness of the importance of IoT to sustain all these elements in a long-term perspective.

The AHA-IoT market has the following challenges

- A multiplicity of actors operating in silos i.e. fragmented supply.
- Lack of impact in the ecosystem
- Social assistance is built on tight lines, often difficult to break, therefore limiting positive impacts of innovation or collaboration
- The “ageing well” market, even if perceived as a solid emerging market, is not yet perceived as sustainable.
- There is a need to work on their convergence, beyond the creation of products and services, to match demand requirements of a demand which is deeply misinformed.

Within this market the services that the demand could be prepared to ask from the supply, and that at this moment only ACTIVAGE MAHA 2.0 neighbourhood would be prepared to supply,

12 Ayuntamiento de Madrid. Área de Finanzas Públicas y Administración Pública. Subdirección General de Estadística. Censo Municipal de Habitantes. **B**
13 Ortega, E., Martín, B., Nuñez, E., & Ezquerra, A. (2015). Urban fragmentation map of the Chamberí district in Madrid. Journal of Maps, 11(5), 788-797.
14 Ley 39/2006 de 14 de diciembre, de Promoción de la Autonomía Personal y Atención a las personas en situación de dependencia.(https://www.boe.es/buscar/pdf/2006/BOE-A-2006-21990-consolidado.pdf)

would be those seen in the NRO chart. As we can see in Figure 58 all the actors involved in the demand can be attended in their specific use cases by MAHA neighbourhood.

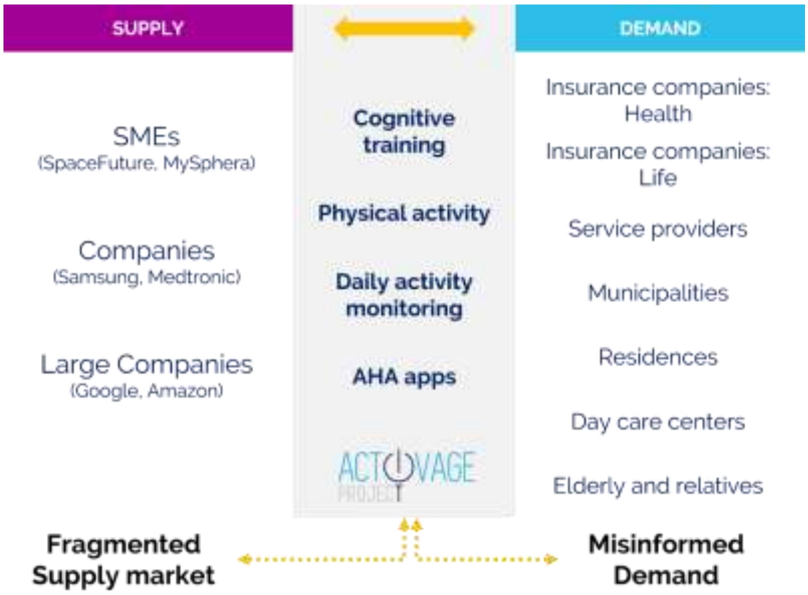


Figure 58. DS MAD MAHA 2.0 neighbourhood in AHA-IoT market

5.3.4.2 SWOT analysis

Table 64. DS MAD SWOT analysis

STRENGTHS	WEAKNESSES
Mobilizing of ecosystems to create safe environments for older adults Social integration of Older Adults Social awareness of relational goods provided by elder and enhancing their altruism. Creation of new AHA-IoT Service Portfolio	Acquisition process must be successful Not enough recruitment of elder and infrastructure providers could lead to failure Retention may also result a weak point
OPPORTUNITIES	**THREATS**
Boosting of the AHA-IoT market Possibility of new business for stakeholders created from their collaboration New pathways to face COVID-19	Lack of motivation of stakeholders to participate if channels do not prove safe and useful Trust is not as strong as needed

5.3.5 Value proposition and Targeted Customers

Table 65. DS MAD Lean Canvas

Lean Canvas				
Problem Progressive increase in the number of elder Need of sustainability on the provision of care giving system. The appearance of a new frailty to which all elder are subject: COVID-19	**Solution** Silver Paths Home sweet home Meet and stay connected	**Unique Value Proposition** Mobilizing ecosystem and all the stakeholders with the aim of creating a safe environment for older adults their social integration and provision of cares for them while enhancing the neighbourhood networking with an innovation prospect.	**Unfair Advantage** Previous ACTIVAGE experience	**Customer Segments** Elderly from the neighbourhood of Chamberi
Existing Alternatives There is no existing alternative	**Key Metrics.** List of ACTIVAGE KPI´s	**High-Level Concept**	**Channels** #Lazotea MAHA Dashboard Town Hall	**Early Adopters** Participant users in Madrid DS i 1,2 and 3

Traditional caregiving by social services, without AHA practices or IoT.	AHA practices Social Isolation Exercise Cognitive exercises Monitoring indoor and outdoor Wellbeing practices	Older adults in Neighbourhood = Safe environment created by care services delivery through a network of stakeholders.	Acquisition Recruitment Advertising	Elder who want to get involved in AHA-IoT practices

Cost Structure Acquisition costs Maintenance #Lazotea Maintenance MAHA Dashboard Coordination	**Revenue Structure** Possible incomes in #Lazotea for publicity.

The benefits that MAHA 2.0 Neighborhood for each of the stakeholders involved can be seem through the motivation Matrix shown in Table 66. With this matrix if there should be spaces in blank that is to say that that one of the stakeholders involved would not have any motivation for making any kind of transactions with the rest of the stakeholders would mean that there would be no benefit involved in participating in MAHA 2.0 neighborhood.

Table 66. DS MAD Ecosystem motivation matrix for transactions

	Elderly	Volunteering elderly	IoT provider	Infrastructure provider	Municipality provider
Elderly	Interaction Avoid social isolation	Caregiving	New services Installations	Products and services needed on daily basis	Safe environments
Volunteering elderly	Relational goods	Relational goods Peer feedback	Working tools	Non-monetary incomes Discounts on services	Non-monetary incomes Discounts on services
IoT provider	Possible income Reputation Feedback	Feedback Collaboration	Peer feedback Collaboration Possible income	Possible incomes	Possible incomes
Infrastructure provider.	Incomes	Incomes	Collaboration	Peer feedback	Reputation Access to municipal channels
Municipality provider	Reputation	Sustainability	Creation of new services	Collaboration Reputation Sustainability	-
Service provider	Possible income Reputation	Feedback Collaboration	New possible services	-	Collaboration Access to municipal channels

5.3.6 Strategy for local sustainability

5.3.6.1 Open Data strategy

As part of ACTIVAGE's dissemination strategy, sharing research data promotes transparency, reproducibility, and progress. In the case of DS Madrid, particular care has been taken to ensure that this task can be carried out in an appropriate way to meet the potential demands of other researchers/actors in the AHA world and to comply with the requirements of anonymity and data privacy. To this end, a set of datasets will be published that will allow all the actors to tackle this task from multiple perspectives given the multifactorial nature of the data.

The set of datasets will be composed of a main dataset, see Table 67, with the information required for the socio-economic dimensioning of the data that allows stratification in different dimensions of the domain. Seven datasets corresponding to different typologies of metrics collected from users from IoT devices composed of data from self-assessment, brain-games, mindfulness, coordination exercises, geo-locations, digital phenotyping and social-isolation gathered though mobile apps and sensors can be found in this section and are described in the next tables, Tables 61-68. Finally, a dataset is included of the data collected as an objective variable from standardized questionnaires on quality of life and perception of technology constituted by UTAUT, Eq5d3l, UCLA, carerqol7d and SPQ (more information can be found in Table 75). All datasets will be published at a stable location address or DOI (which will provide a persistent link to the location of the datasets) accompanied by sufficient metadata to facilitate understanding, transparency and reproducibility of the experiments. In addition, the metadata will be optimized to facilitate their discovery from search engines.

Table 67. DS MAD Dataset Participants information

Dataset name	**DS3.Participants_information**
Data identification	
Data set description	This dataset contains information on the socio-demographic characteristics of each participant. The data maintains the general format of these characteristics collected by other DSs and allows their association to any DS Madrid study dataset from the link with a unique identifier "uid". It includes 20 specific fields with societal and economical aspects including information about topics such as education level, living conditions and other relevant information to carry out sociological studies and contextualize other datasets.
Source (i.e. which device?)	This dataset was obtained from anamnesis of patients and caregivers from information collected by ACTIVAGE users.
Partners responsibilities	
Owner of the device	The dataset was obtained by physical means and later digitized for exploitation.
Partner in charge of data collection (if different)	Tercera Edad Activa
Partner in charge of data analysis (if different)	LifeSTech-UPM
Partner in charge of data storage (if different)	LifeSTech-UPM
Standards and metadata	
Info about metadata (Production and storage dates, places) and documentation?	Data collected on the dataset has been transformed to cope with JSON format and validated through ingestion tools form DS3 in order to ensure the uniqueness and conformity with the data model of the collected instances.
Standards, Format, Estimated volume of data	Data will be provided in csv format; Each data will be encompassed with each related metadata to provide the

	information corresponding to the type of data; that is: string, date (ISO-8601), Int64, float64, bool, etc. Instances available (31/07/2020): 918
Data exploitation and sharing	
Data exploitation (purpose/use of the data analysis)	This dataset provides sociodemographic context to collected data from Madrid DS. The exploitation purpose includes the characterisation of ACTIVAGE end users to be able to obtain particular results for specific small cohorts that may be relevant for exploitation models by applying studies on specific target groups.
Data access policy / Dissemination level (Confidential, only for members of the Consortium and the Commission Services) / Public	The full dataset will be confidential and only the members of the DS and/or Consortium will have access on it. Furthermore, if the dataset or specific portions of it (e.g. metadata, statistics, etc.) are decided to become of widely open access, it will be uploaded to the ACTIVAGE open data platform. Of course, these data will be anonymized, so as not to have any potential ethical issues with their publication and dissemination.
Data sharing, re-use and distribution (How?)	The data sharing policy will be based on the specific licence established in D1.13. It will be based on a permissive base licence that allows the negotiation of sub-licences in the style of MIT-type licences, allowing the exploitation and level of access and specific use for each request for access to the data. In addition, public access will be given to the metadata describing the dataset to encourage its search, interoperability, preservation and dissemination, as well as the assignment of a DOI.
Embargo periods (if any)	In order to ensure data quality and to produce original and genuine studies Madrid DS embargo period will be set in 1 months from the time of publication (after concluding data collection). Data access will be fully controlled by Madrid DS policies.
Archiving and preservation (including storage and backup)	
Data storage (including backup): where? For how long?	Data is collected and backed up in UPM servers. It will be available from the contractual time of the project and extended with future studies.

Table 68. DS MAD Dataset Self-assessment Questionnaires

Dataset name	**DS3.Self-assesment_Questionnaires**
Data identification	
Data set description	This dataset includes the information related to the personal questions asked from the MAHA application to the study participants in order to estimate their mood or emotional state. From questions asked in temporal frequencies and order based on the protocol defined by Active Elderly, questions are asked that have been stored based on their corresponding categorical value.

	Therefore, the information stored has no interpretative value without the accompanying metadata.
Source (i.e. which device?)	This dataset was collected through MAHA App by periodic in-app surveys.
Partners responsibilities	
Owner of the device	LifeSTech-UPM
Partner in charge of data collection (if different)	Tercera Edad Activa and LifeSTech-UPM
Partner in charge of data analysis (if different)	LifeSTech-UPM
Partner in charge of data storage (if different)	LifeSTech-UPM
Standards and metadata	
Info about metadata (Production and storage dates, places) and documentation?	Data collected on the dataset has been transformed to cope with JSON format and validated through ingestion tools form DS3 in order to ensure the uniqueness and conformity with the data model of the collected instances.
Standards, Format, Estimated volume of data	Data will be provided in csv format; Each data will be encompassed with each related metadata to provide the information corresponding to the type of data; that is: string, date (ISO-8601), Int64, float64, bool, etc. Instances available (31/07/2020): ~1600
Data exploitation and sharing	
Data exploitation (purpose/use of the data analysis)	This dataset provides self-assessed answers about emotional status from collected data in Madrid DS. The exploitation of the data will be based on the production of academic studies in which it will be applied to test the hypotheses set out in the study protocol and to extend the information relating to this domain in the field of active ageing.
Data access policy / Dissemination level (Confidential, only for members of the Consortium and the Commission Services) / Public	The full dataset will be confidential and only the members of the DS and/or Consortium will have access on it. Furthermore, if the dataset or specific portions of it (e.g. metadata, statistics, etc.) are decided to become of widely open access, it will be uploaded to the ACTIVAGE open data platform. Of course, these data will be anonymized, so as not to have any potential ethical issues with their publication and dissemination.
Data sharing, re-use and distribution (How?)	The data sharing policy will be based on the specific licence established in D1.13. It will be based on a permissive base licence that allows the negotiation of sub-licences in the style of MIT-type licences, allowing the exploitation and level of access and specific

	use for each request for access to the data. In addition, public access will be given to the metadata describing the dataset to encourage its search, interoperability, preservation and dissemination, as well as the assignment of a DOI.
Embargo periods (if any)	In order to ensure data quality and to produce original and genuine studies Madrid DS embargo period will be set in 1 months from the time of publication (after concluding data collection). Data access will be fully controlled by Madrid DS policies.
Archiving and preservation (including storage and backup)	
Data storage (including backup): where? For how long?	Data is collected and backed up in UPM servers. It will be available from the contractual time of the project and extended with future studies.

Table 69. DS MAD Dataset Brain Games

Dataset name	DS3.BrainGames
Data identification	
Data set description	This dataset includes the results of the exercises for cognitive stimulation proposed in the DS Madrid. These exercises are provided from the sessions of the 12 games related to the categories indicated from a previous cognitive test that determines these categories: language, memory, calculation, logic, attention, visual-spatial and cognitive functions. For each type of game the specific results of that game will be provided and a score value with a function described to be used as a common field that allows studies to be carried out with all the datasets added in the same way as other common fields such as the time stamp of the exercise, the duration of the sessions or whether they were carried out successfully.
Source (i.e. which device?)	This dataset was collected through MAHA App and backend services.
Partners responsibilities	
Owner of the device	LifeSTech-UPM
Partner in charge of data collection (if different)	Tercera Edad Activa and LifeSTech-UPM
Partner in charge of data analysis (if different)	LifeSTech-UPM
Partner in charge of data storage (if different)	LifeSTech-UPM
Standards and metadata	

Info about metadata (Production and storage dates, places) and documentation?	Data collected on the dataset has been transformed to cope with JSON format and validated through ingestion tools form DS3 in order to ensure the uniqueness and conformity with the data model of the collected instances.
Standards, Format, Estimated volume of data	Data will be provided in csv format; Each data will be encompassed with each related metadata to provide the information corresponding to the type of data; that is: string, date (ISO-8601), Int64, float64, bool, etc. Instances available (31/07/2020): ~over 50k registries
Data exploitation and sharing	
Data exploitation (purpose/use of the data analysis)	This dataset provides brain games session results from collected data in Madrid DS. The exploitation of the data will be based on the production of academic studies in which it will be applied to test the hypotheses set out in the study protocol and to extend the information relating to this domain in the field of active ageing.
Data access policy / Dissemination level (Confidential, only for members of the Consortium and the Commission Services) / Public	The full dataset will be confidential and only the members of the DS and/or Consortium will have access on it. Furthermore, if the dataset or specific portions of it (e.g. metadata, statistics, etc.) are decided to become of widely open access, it will be uploaded to the ACTIVAGE open data platform. Of course, these data will be anonymized, so as not to have any potential ethical issues with their publication and dissemination.
Data sharing, re-use and distribution (How?)	The data sharing policy will be based on the specific licence established in D1.13. It will be based on a permissive base licence that allows the negotiation of sub-licences in the style of MIT-type licences, allowing the exploitation and level of access and specific use for each request for access to the data. In addition, public access will be given to the metadata describing the dataset to encourage its search, interoperability, preservation and dissemination, as well as the assignment of a DOI.
Embargo periods (if any)	In order to ensure data quality and to produce original and genuine studies Madrid DS embargo period will be set in 1 months from the time of publication (after concluding data collection). Data access will be fully controlled by Madrid DS policies.
Archiving and preservation (including storage and backup)	
Data storage (including backup): where? For how long?	Data is collected and backed up in UPM servers. It will be available from the contractual time of the project and extended with future studies.

Table 70. DS MAD Dataset Mindfulness

Dataset name	**DS3.Mindfulness**
Data identification	

Data set description	This dataset includes the results of the mindfulness sessions collected by the MAHA App. The information includes metadata of the session offered as well as the result of that session, i.e. whether the user successfully completed the session and, if so, an assessment of the session by the user.
Source (i.e. which device?)	This dataset was collected through MAHA App and backend services.
Partners responsibilities	
Owner of the device	LifeSTech-UPM
Partner in charge of data collection (if different)	Tercera Edad Activa and LifeSTech-UPM
Partner in charge of data analysis (if different)	LifeSTech-UPM
Partner in charge of data storage (if different)	LifeSTech-UPM
Standards and metadata	
Info about metadata (Production and storage dates, places) and documentation?	Data collected on the dataset has been transformed to cope with JSON format and validated through ingestion tools form DS3 in order to ensure the uniqueness and conformity with the data model of the collected instances.
Standards, Format, Estimated volume of data	Data will be provided in csv format; Each data will be encompassed with each related metadata to provide the information corresponding to the type of data; that is: string, date (ISO-8601), Int64, float64, bool, etc. Instances available (31/07/2020): ~over 700 registries
Data exploitation and sharing	
Data exploitation (purpose/use of the data analysis)	This dataset provides mindfulness session results from collected data in Madrid DS. The exploitation of the data will be based on the production of academic studies in which it will be applied to test the hypotheses set out in the study protocol and to extend the information relating to this domain in the field of active ageing.
Data access policy / Dissemination level (Confidential, only for members of the Consortium and the Commission Services) / Public	The full dataset will be confidential and only the members of the DS and/or Consortium will have access on it. Furthermore, if the dataset or specific portions of it (e.g. metadata, statistics, etc.) are decided to become of widely open access, it will be uploaded to the ACTIVAGE open data platform. Of course, these data will be anonymized, so as not to have any potential ethical issues with their publication and dissemination.

Data sharing, re-use and distribution (How?)	The data sharing policy will be based on the specific licence established in D1.13. It will be based on a permissive base licence that allows the negotiation of sub-licences in the style of MIT-type licences, allowing the exploitation and level of access and specific use for each request for access to the data. In addition, public access will be given to the metadata describing the dataset to encourage its search, interoperability, preservation and dissemination, as well as the assignment of a DOI.
Embargo periods (if any)	In order to ensure data quality and to produce original and genuine studies Madrid DS embargo period will be set in 1 months from the time of publication (after concluding data collection). Data access will be fully controlled by Madrid DS policies.
Archiving and preservation (including storage and backup)	
Data storage (including backup): where? For how long?	Data is collected and backed up in UPM servers. It will be available from the contractual time of the project and extended with future studies.

Table 71. DS MAD Dataset Coordination exercises

Dataset name	**DS3.Coordination_exercises**
Data identification	
Data set description	This dataset includes the results of the coordination exercises sessions collected by the MAHA App. The information includes metadata of the session offered as well as the result of that session, i.e. whether the user successfully completed the session. The sessions collected are divided in four categories: gait, lower-limbs, upper-limbs and sensory motor exercises (finger tapping). Generally, sessions are composed by information about the timestamp of realization and if the exercise was completed but in some cases, especially in the case of sensory motor sessions, additional information about the performance during the execution of the exercise is provided.
Source (i.e. which device?)	This dataset was collected through MAHA App and backend services.
Partners responsibilities	
Owner of the device	LifeSTech-UPM
Partner in charge of data collection (if different)	Tercera Edad Activa and LifeSTech-UPM
Partner in charge of data analysis (if different)	LifeSTech-UPM

Partner in charge of data storage (if different)	LifeSTech-UPM
Standards and metadata	
Info about metadata (Production and storage dates, places) and documentation?	Data collected on the dataset has been transformed to cope with JSON format and validated through ingestion tools form DS3 in order to ensure the uniqueness and conformity with the data model of the collected instances.
Standards, Format, Estimated volume of data	Data will be provided in csv format; Each data will be encompassed with each related metadata to provide the information corresponding to the type of data; that is: string, date (ISO-8601), Int64, float64, bool, etc. Instances available (31/07/2020): ~over 2k registries
Data exploitation and sharing	
Data exploitation (purpose/use of the data analysis)	This dataset provides coordination exercise session results from collected data in Madrid DS. The exploitation of the data will be based on the production of academic studies in which it will be applied to test the hypotheses set out in the study protocol and to extend the information relating to this domain in the field of active ageing.
Data access policy / Dissemination level (Confidential, only for members of the Consortium and the Commission Services) / Public	The full dataset will be confidential and only the members of the DS and/or Consortium will have access on it. Furthermore, if the dataset or specific portions of it (e.g. metadata, statistics, etc.) are decided to become of widely open access, it will be uploaded to the ACTIVAGE open data platform. Of course, these data will be anonymized, so as not to have any potential ethical issues with their publication and dissemination.
Data sharing, re-use and distribution (How?)	The data sharing policy will be based on the specific licence established in D1.13. It will be based on a permissive base licence that allows the negotiation of sub-licences in the style of MIT-type licences, allowing the exploitation and level of access and specific use for each request for access to the data. In addition, public access will be given to the metadata describing the dataset to encourage its search, interoperability, preservation and dissemination, as well as the assignment of a DOI.
Embargo periods (if any)	In order to ensure data quality and to produce original and genuine studies Madrid DS embargo period will be set in 1 months from the time of publication (after concluding data collection). Data access will be fully controlled by Madrid DS policies.
Archiving and preservation (including storage and backup)	
Data storage (including backup): where? For how long?	Data is collected and backed up in UPM servers. It will be available from the contractual time of the project and extended with future studies.

Table 72. DS MAD Dataset Locations

Dataset name	DS3.Locations
Data identification	
Data set description	This dataset is composed of instantaneous location instances obtained from the MAHA App application for the pseudo-real time monitoring of the users participating in the DS Madrid study. The data obtained in an asynchronous time frequency given the limitations for obtaining location information of the applications operating in the background on android devices. However, extensive information on user locations is needed to generate alerts and recognize user comfort regions and mobility areas over time while using the device.
Source (i.e. which device?)	This dataset was collected through MAHA App and backend services.
Partners responsibilities	
Owner of the device	LifeSTech-UPM
Partner in charge of data collection (if different)	Tercera Edad Activa and LifeSTech-UPM
Partner in charge of data analysis (if different)	LifeSTech-UPM
Partner in charge of data storage (if different)	LifeSTech-UPM
Standards and metadata	
Info about metadata (Production and storage dates, places) and documentation?	Data collected on the dataset has been transformed to cope with JSON format and validated through ingestion tools form DS3 in order to ensure the uniqueness and conformity with the data model of the collected instances.
Standards, Format, Estimated volume of data	Data will be provided in csv format; Each data will be encompassed with each related metadata to provide the information corresponding to the type of data; that is: string, date (ISO-8601), Int64, float64, bool, etc. Data is storage in GeoJSON format from spec. RFC 7946 Instances available (31/07/2020): ~over 850k registries
Data exploitation and sharing	
Data exploitation (purpose/use of the data analysis)	This dataset provides location positions as a result from collected data in Madrid DS. The exploitation of the data will be based on the production of academic studies in which it will be applied to test the hypotheses

	set out in the study protocol and to extend the information relating to this domain in the field of active ageing.
Data access policy / Dissemination level (Confidential, only for members of the Consortium and the Commission Services) / Public	The full dataset will be confidential and only the members of the DS and/or Consortium will have access on it. Furthermore, if the dataset or specific portions of it (e.g. metadata, statistics, etc.) are decided to become of widely open access, it will be uploaded to the ACTIVAGE open data platform. Of course, these data will be anonymized, so as not to have any potential ethical issues with their publication and dissemination.
Data sharing, re-use and distribution (How?)	The data sharing policy will be based on the specific licence established in D1.13. It will be based on a permissive base licence that allows the negotiation of sub-licences in the style of MIT-type licences, allowing the exploitation and level of access and specific use for each request for access to the data. In addition, public access will be given to the metadata describing the dataset to encourage its search, interoperability, preservation and dissemination, as well as the assignment of a DOI.
Embargo periods (if any)	In order to ensure data quality and to produce original and genuine studies Madrid DS embargo period will be set in 1 months from the time of publication (after concluding data collection). Data access will be fully controlled by Madrid DS policies.
Archiving and preservation (including storage and backup)	
Data storage (including backup): where? For how long?	Data is collected and backed up in UPM servers. It will be available from the contractual time of the project and extended with future studies.

Table 73. DS MAD Dataset Digital Phenotyping

Dataset name	**DS3.Digital Phenotyping**
Data identification	
Data set description	This dataset is composed of all the logged information of actions taken by the user of MAHA App from Madrid DS. It includes all the pressed buttons and actions performed during the interaction with the app menus which aims at providing insights on the use of mobile apps by target users and obtain statistics of the overall use of the app.
Source (i.e. which device?)	This dataset was collected through MAHA App and backend services.
Partners responsibilities	
Owner of the device	LifeSTech-UPM
Partner in charge of data collection (if different)	Tercera Edad Activa and LifeSTech-UPM

Partner in charge of data analysis (if different)	LifeSTech-UPM
Partner in charge of data storage (if different)	LifeSTech-UPM
Standards and metadata	
Info about metadata (Production and storage dates, places) and documentation?	Data collected on the dataset has been transformed to cope with JSON format and validated through ingestion tools form DS3 in order to ensure the uniqueness and conformity with the data model of the collected instances.
Standards, Format, Estimated volume of data	Data will be provided in csv format; Each data will be encompassed with each related metadata to provide the information corresponding to the type of data; that is: string (log) and date (ISO-8601). Instances available (31/07/2020): ~over 64k registries
Data exploitation and sharing	
Data exploitation (purpose/use of the data analysis)	This dataset provides detailed logs labels as a result from collected data in Madrid DS. The exploitation of the data will be based on the production of academic studies in which it will be applied to test the hypotheses set out in the study protocol and to extend the information relating to this domain in the field of active ageing.
Data access policy / Dissemination level (Confidential, only for members of the Consortium and the Commission Services) / Public	The full dataset will be confidential and only the members of the DS and/or Consortium will have access on it. Furthermore, if the dataset or specific portions of it (e.g. metadata, statistics, etc.) are decided to become of widely open access, it will be uploaded to the ACTIVAGE open data platform. Of course, these data will be anonymized, so as not to have any potential ethical issues with their publication and dissemination.
Data sharing, re-use and distribution (How?)	The data sharing policy will be based on the specific licence established in D1.13. It will be based on a permissive base licence that allows the negotiation of sub-licences in the style of MIT-type licences, allowing the exploitation and level of access and specific use for each request for access to the data. In addition, public access will be given to the metadata describing the dataset to encourage its search, interoperability, preservation and dissemination, as well as the assignment of a DOI.
Embargo periods (if any)	In order to ensure data quality and to produce original and genuine studies Madrid DS embargo period will be set in 1 months from the time of publication (after concluding data collection). Data access will be fully controlled by Madrid DS policies.
Archiving and preservation (including storage and backup)	

Data storage (including backup): where? For how long?	Data is collected and backed up in UPM servers. It will be available from the contractual time of the project and extended with future studies.

Table 74. DS MAD Dataset Social Isolation

Dataset name	**DS3.Social_Isolation**
Data identification	
Data set description	This dataset contains information about people at risk of social isolation and information extracted from the LOC devices used in the DS Valencia. From the information obtained, the dataset provides daily statistics on the duration of floor time, the hours the user goes to bed, the number of outings outside the home, the number of movements that indicate active mobility within the home as well as the time spent at home during the day.
Source (i.e. which device?)	This dataset was collected through MAHA App and backend services.
Partners responsibilities	
Owner of the device	LifeSTech-UPM
Partner in charge of data collection (if different)	Tercera Edad Activa and LifeSTech-UPM
Partner in charge of data analysis (if different)	LifeSTech-UPM
Partner in charge of data storage (if different)	LifeSTech-UPM
Standards and metadata	
Info about metadata (Production and storage dates, places) and documentation?	Data collected on the dataset has been transformed to cope with JSON format and validated through ingestion tools form DS3 in order to ensure the uniqueness and conformity with the data model of the collected instances.
Standards, Format, Estimated volume of data	Data will be provided in csv format; Each data will be encompassed with each related metadata to provide the information corresponding to the type of data; that is: string, date (ISO-8601), Int64 and float64. Instances available (31/07/2020): ~ registries
Data exploitation and sharing	
Data exploitation (purpose/use of the data analysis)	This dataset provides statistics of the data collected from LOCs devices in Madrid DS.

	The exploitation of the data will be based on the production of academic studies in which it will be applied to test the hypotheses set out in the study protocol and to extend the information relating to this domain in the field of active ageing.
Data access policy / Dissemination level (Confidential, only for members of the Consortium and the Commission Services) / Public	The full dataset will be confidential and only the members of the DS and/or Consortium will have access on it. Furthermore, if the dataset or specific portions of it (e.g. metadata, statistics, etc.) are decided to become of widely open access, it will be uploaded to the ACTIVAGE open data platform. Of course, these data will be anonymized, so as not to have any potential ethical issues with their publication and dissemination.
Data sharing, re-use and distribution (How?)	The data sharing policy will be based on the specific licence established in D1.13. It will be based on a permissive base licence that allows the negotiation of sub-licences in the style of MIT-type licences, allowing the exploitation and level of access and specific use for each request for access to the data. In addition, public access will be given to the metadata describing the dataset to encourage its search, interoperability, preservation and dissemination, as well as the assignment of a DOI.
Embargo periods (if any)	In order to ensure data quality and to produce original and genuine studies Madrid DS embargo period will be set in 1 months from the time of publication (after concluding data collection).
Archiving and preservation (including storage and backup)	
Data storage (including backup): where? For how long?	Data is collected and backed up in UPM servers. It will be available from the contractual time of the project and extended with future studies.

Table 75. DS MAD Dataset Evaluation

Dataset name	**DS3.Evaluation**
Data identification	
Data set description	This dataset contains the results of the evaluation questionnaires carried out in each phase of the Madrid DS study. Specifically, the dataset is composed of the results of the following tests: UTAUT, Eq5d3l, UCLA, carerqol7d and SPQ. Refer to each of the tests for more information.
Source (i.e. which device?)	This dataset was obtained from anamnesis of patients and caregivers from information collected through electronic record system software Redcap from Vanderbilt University.
Partners responsibilities	
Owner of the device	LifeSTech-UPM
Partner in charge of data collection (if different)	Tercera Edad Activa and LifeSTech-UPM

Partner in charge of data analysis (if different)	LifeSTech-UPM
Partner in charge of data storage (if different)	LifeSTech-UPM
Standards and metadata	
Info about metadata (Production and storage dates, places) and documentation?	All the questionnaires are provided with the relevant metadata regarding the questions and option choices as well as the score and procedure to obtained it/ or documentation.
Standards, Format, Estimated volume of data	All the questionnaires in use have been validated for clinical research as well as the data collection tool. Instances available (31/07/2020): ~more than 800 registries
Data exploitation and sharing	
Data exploitation (purpose/use of the data analysis)	This dataset provides results of the gathered information from evaluation questionnaires carried out in Madrid DS. The exploitation of the data will be based on the production of academic studies in which it will be applied to test the hypotheses set out in the study protocol and to extend the information relating to this domain in the field of active ageing.
Data access policy / Dissemination level (Confidential, only for members of the Consortium and the Commission Services) / Public	The full dataset will be confidential and only the members of the DS and/or Consortium will have access on it. Furthermore, if the dataset or specific portions of it (e.g. metadata, statistics, etc.) are decided to become of widely open access, it will be uploaded to the ACTIVAGE open data platform. Of course, these data will be anonymized, so as not to have any potential ethical issues with their publication and dissemination.
Data sharing, re-use and distribution (How?)	The data sharing policy will be based on the specific licence established in D1.13. It will be based on a permissive base licence that allows the negotiation of sub-licences in the style of MIT-type licences, allowing the exploitation and level of access and specific use for each request for access to the data. In addition, public access will be given to the metadata describing the dataset to encourage its search, interoperability, preservation and dissemination, as well as the assignment of a DOI.
Embargo periods (if any)	In order to ensure data quality and to produce original and genuine studies Madrid DS embargo period will be set in 1 months from the time of publication (after concluding data collection). Data access will be fully controlled by Madrid DS policies.
Archiving and preservation (including storage and backup)	

Data storage (including backup): where? For how long?	Data is collected and backed up in UPM servers. It will be available from the contractual time of the project and extended with future studies.

5.3.6.2 Continuation strategy

DS MAD will continue with the Pilot and MAHA community. Some of our 1000 pilot users, from the beginning, have shown interest to continue with the health and active aging activities provided by us through different use cases and we have created all the conditions so that they can continue. It is also our aim to continue the enlargement of the MAHA community; in which we consider that the traditional ageing identity has to change to a new vision enriched by the vision that older adults provide relational goods, and that our communities need this goods for their sustainability.

5.3.6.3 Replication strategy

DS MAD will replicate at the level of a neighbourhood, with three levels of action:

1. Home Sweet Home: the deployment of solutions to strengthen the in-house environment of the elderly through three main objectives 1) Monitoring of the Activities of Daily Living (ADL), basic and instrumental, for the support of informal caregivers and for the follow-up and self-management of formal caregivers (RUC1); 2) Detection of specific behaviours or situations that require immediate attention (RUC4); and 3) increase safety and comfort at home.
2. Health and Silver Pathways: the deployment of solutions to support, promote and strengthen the confidence of older adults to leave home; as well as the activities they carry out on their way to their destination.
3. Meet and Stay in Contact: the deployment of solutions to strengthen the promotion of activities for social interaction in order to counteract the social isolation, cognitive deterioration and sedentary lifestyle of older adults, and a new AHA-IoT service portfolio.

5.3.6.4 Scaling-up strategy

We have considered three lines of actions, all of them considering COVID-19 new situation and following important lessons learned.

- Creating safe environments indoor and outdoor.
- Promoting home care and delay institutionalization.
- Taking the ride of the new awareness of the importance of IoT domain.
- Enhancing self-care.

We will continue with our RUCs 1, 5, 6, 7 but we are going to add RUC4, RUC8 and RUC9. We are going to add new adapted TECHNOLOGIES like the solution *HOW ARE YOU?* (¿Cómo estás?) or the solution *#LAZOTEA*, together with the MAHA dashboard. At the same time, some new devices like smartwatch will be introduced. Finally, we will have new users collaborating with us.

5.3.7 Sustainability findings

As a direct consequence of the analysis of the results of the demonstration, expansion and growth phases of the project, DS MAS will keep operational once the project is finished, guaranteeing the objectives and positive impacts tested and validated through the experiment. In order to preserve the value of the AHA-IoT ecosystem, a new approach is being implemented where sustainability is guaranteed through the creation of a Permanent Pilot Plant in the friendly neighborhoods of Madrid, that will be empowered by the services and experiences of all validated DSs during the ACTIVAGE project execution.

In this sense, DS MAD drives its sustainability from the perspective of the quadruple helix; taking advantage of common infrastructures and economies of scale to strengthen relations with industry and social actors. This open innovation model allows DS MAD to face the new challenges that companies and societies undertake in creating new healthcare strategies.

This perspective in conjunction with the Relational Goods, where older people are providers of critical social goods for the development of society, foster teamwork, collaboration and the exchange of ideas in the DS MAD. This cooperation enhances an ecosystem which guarantees a sustainability strategy focused on the generation of value for the elderly, as well as for all the parties involved in the Madrid ecosystem: academia, public administration, companies and citizens in general.

Likewise, we can highlight the importance of the proposed model, which has evolved iteratively until it allows us to arrive at an innovation that finds a field defined by three vertices: the neighbourhood as a geographical meeting point, the new role of the elderly as providers of relational goods and the new concept in service provision. It is in this new field that *MAHA neighbourhood* sustainability expands through new technologies and adding users to enhance the results and innovations obtained throughout the development of DS MAD.DS MAD is heavily invested in the development and integration of both brand-new and widely contrasted technologies and collecting the produced data. There is also a huge component of engaging different stakeholders in the effort of running the pilot. In this context AIOTES has been the driver for integrating solutions, filling in the missing standards for a true interoperable solution ecosystem. AIOTES is however limited to its' design parameters, and in our continuous improvement of technologies, being limited to IoT supported in the cloud, without proper solutions for mobile, edge computing, Smart City, Robotics, Smart Transportation. All these paradigms could be a risk for dropping AIOTES in the future and represent future challenges that must be faced. AIOTES needs to continue improving, by simplifying most operations (such as alignment development and management). It needs to make its services and documentation better organized and more accessible. It needs to project the image of a full interoperability platform, which includes legacy services, for the service ecosystem to really take hold.

We have identified potential services to be managed by ACTIVAGE.org. The first set are local entities to whom activities such as questionnaire collection, installation of technology, and training (both of end users and professionals) could be outsourced. The are other services which the association could offer, outside the local ecosystem, such as a technology newsletter (to keep up with the technological trends), and data analysis expertise (hiring international experts on data analysis, and/or AHA services to produce reports over the collected data). In this respect, the no less important contribution to the generation of Open Data should be noted.

Open data repositories are web-based interfaces designed to make it easier to find re-usable information. These repositories will be exploited through ACTIVAGE.org establishing an open data policy to favour the public supply of the data generated will facilitate the co-creation and search for new exploitation strategies. The data sets that will be continuously recorded will be automatically dumped on request by adapting and curing the content based on demand. The metadata of the sets offered in addition to public ones will follow the standard data scheme DataCite. This format not only facilitates the generation of a Digital Object Identifier (DOI) that favours the easy citation of the datasets and guarantees that access to them remains perdurable. It also allows for great interoperability with multiple formats, including recently released results from other EU projects, such as the EINFRA family of e-Infrastructure (Exploiting results from THOR EU project - Grant agreement ID: 654039) and the European Open Science Cloud (EOSC) by exploiting results from FREYA EU Project - Grant agreement ID: 777523 where DataCite schema is being established.

All in all, the combination of all the strategies presented in the local exploitation plan will seek to guarantee sustainability and the inclusion of actors that will ensure the establishment of innovative solutions in search of the benefit of society in the quadruple helix framework.

5.4 Conclusion

This chapter presents how the Madrid DS has built an entire ecosystem around the older adults in Madrid and the use of IoT technology, with the aim to prove that Smart living environments based on IoT technologies can contribute to and have beneficial effects in quality of life in terms of self-perceived QoL, physical status perception and social engagement contributing to achieve with a successful aging objective thought the promotion of active and healthy aging interventions in people over 65 years old.

In the entire process of the experiment, one of the main factors that have characterized the Madrid DS has been the engagement strategy developed to involve users and keep them active using IoT solutions for active and healthy aging. In this sense, this engagement continues after experiment period, monitoring and providing interventions and follow up to the users that willing to maintain the technology. This engagement strategy is flexible and adaptable so it covers the needs of the Madrid DS, and has been useful to face the problems, barriers and other circumstances, during the experiment duration. As example of this, it is the impact of the COVID-19 pandemic, with especially harsh consequences for the elderly population of the Madrid region.

In this context without precedents and despite the restrictions caused by this crisis, the adaptability of the DS strategy has enabled the adaptation of the solutions, follow-up and interventions offered in the Madrid DS to the restrictions, while overcoming the limitation of person-to-person encounters. During COVID-19 crisis, the MAHA solutions have been used as core enablers, taking advantage of the deployed technology to continue offering the DS services remotely. As example of this adaptation and the strong impact on the elderly users' daily activities was the change in one of the solutions, called Diviértete, in which different activities were offered to motivate users to do outdoor activities. Well, with the COVID-19 crisis, all these activities outside the home were exchanged for virtual activities and events that users could follow from their homes with the tablet provided by the Madrid DS.

Thanks to these engagement efforts, a total of 1029 users were enrolled, evaluated and analysed, including 100 informal careers, initially not defined, The qualitative and quantitative results obtained, have validated the usefulness of the proposed technology to maintain the QoL of the participants, while have the potentiality to adapt easily the proposed interventions to the very variable aging variables, conditions and needs.

From the perspective of the quadruple helix, an ideal environment for Madrid DS' innovation has been consolidated, making it possible to take advantage of common infrastructures and economies of scale to strengthen, from the perspective of the quadruple helix, relationships with industry, service providers, caregivers, NGOs and city councils in the regional environment, promoting the offer of services and innovation in the field of active and healthy aging in Madrid. Likewise, the importance of the sustainability proposed model is highlighted where the innovation of the Madrid DS, based on the combination of services and specific technologies for each user, allows a personalized response promoting the expansion of services without thereby losing the particularities of each need. This sustainability strategy will be energized for its expansion from ACTIVAGE.org.

6 DS 4 RER final report

6.1 DS Experiment report

6.1.1 User engagement report

Table 76. DS RER total user recruited

RUC	Elderly	Informal caregiver	Formal caregiver	Other stakeholder
UC1/2/5/7 Experimental group	27	*27*		
UC1/2/7 Control group	28	28		
TOTAL	55	55		

Table 77. DS RER total number of facilities confirmed

RUC	Private homes	Personal environments	Shared room in senior facility	Healthcare/Daycare facility	Other spaces
1/2/7	27				
5	15				
TOTAL	27				

6.1.2 IoT infrastructure deployment

Table 78.DS RER Final total number installations completed at individual facilities

RUC	Private homes	Personal environments	Shared room in senior facility	Healthcare/ Daycare facility	Other spaces
Environmental sensor RUC 1/2/5/7	101				
Pill dispenser RUC5	15				
Router 1/2/5/7	27				
TOTAL	143				

Table 79. DS RER Devices per categories installed

RUC	Gateways	Environment sensors	Wearables	Health / Alarm devices	Communication devices	User interface devices
1/2/5/7	27 router					
1/2/5/7		101				
5				15		
TOTAL						

Percentage of installations completed over total targeted in DS RER is 92% considering the sept 2019 target.

The original plan was to install the services in 100 apartments, with full sensor kit or partial according to feasibility, acceptance, and opportunity. The target was reformulated in two occasions, reflecting the low availability and involvement of the GPs, despite the commitment of the higher level of the management of LHA PR and the meticulous dedication to the involvement of general practitioners as described in previous reports. The target set at sept 2019 was of a total of 30 elderly and 30 caregivers.

All final users were involved in all RUC considered in DS RER:

6.1.3 Experiment running report

6.1.3.1 Users drops out

Table 80. DS RER Drop-offs and main reasons for dropping

Reasons for drop-offs	Number of drop-offs	
	Control	**Experimental**
Death	2	1
Mistrust		5
Health issues		2
unknown		1
TOTAL	11	

	Female	Male	TOTAL
Control	1	1	2
Experimental	3	6	9

Table 81. DS RER Details reason for dropping-off

id	gender	cohort	Date of entering	Date of termination	Reason for termination	Reasons for termination details
User	Female	Control	17/05/2018	13/03/2019	death	DECEASED

005						
User 008	Male	Control	05/09/2018	04/05/2020	death	deceased (COVID19)
User 011	Male	Control	27/10/2018	07/11/2018	mistrust	During IoT installation he had doubts about the feeling of being spied on and did not want to continue
User 025	Male	Exp	03/04/2019	22/08/2019	death	Deceased
User 041	Male	Exp	20/06/2019	28/06/2019	health	after user's acceptance to participate at ACTIVAGE project, a few days later he had health problems and he was moved out of the house to another facility incompatible with the installation of IoT
User 053	Male	Exp	24/07/2019	30/07/2019	Health	Due to the worsening of the user's health problems, it was not possible to proceed with the IoT installation at home
User 017	Female	Exp	22/01/2019	31/01/2019	mistrust	During IoT installation caregiver's user was worried about the presence of IoT sensors in the home of elderly relatives who might bring them stress due of the lack of understanding of technologies
User 028	Male	Exp	15/04/2019	22/04/2019	mistrust	During IoT installation he had doubts about feasibility and usefulness of ACTIVAGE project and did not want to continue
User 034	Female	Exp	16/06/2019	26/06/2019	mistrust	During IoT installation caregiver's user was worried about the presence of IoT sensors in the home of elderly relatives who might bring them stress due of the lack of understanding of technologies
User 050	Female	Exp	15/07/2019	19/07/2019	mistrust	after acceptance to participate at ACTIVAGE project, a few days later User informed us that no longer wanted to participate in the project because Caregiver did not allow the installation of IoT sensors in the house
User 048	Male	Exp	15/07/2019	18/07/2019	unknown	User informed us by phone that no longer wanted to participate in the project not explaining why

Table 82. DS RER Users in operation by 30th of June

RUC	Elderly	Informal caregiver	Formal caregiver	Other stakeholder
UC1/2/5/7 Experimental group	19	19		
UC1/2/7 Control group	25	25		
TOTAL	**44**	**44**		

All users were equipped with a number of sensing devices from 3 to 6 according to the acceptance and technical feasibility of deployment. Once installed, the environmental sensors are active 24/7 and transparent to users and collect measurements without a direct intervention of the user. Pill dispenser have been installed when the user was willing to change his habits in the routine of assumption of drugs. Users were using the smart pill dispenser according to the therapy, usually received the reminder 2 or three times per day.

In some case the user asked for the possibility to keep the sensors. In particular the smart pill dispenser, that found in particular the interest of the caregivers. It was not possible to proceed.

Table 83. DS RER Short Portable Mental State Questionary (SPMSQ) results

SPMSQ	EXPERIMENTAL			CONTROL				
step	n	Mena	SD	n	Mean	SE	*Test*	p-value
Baseline	19	8,53	2,1	26	8,50	1,2	***t = -0.0542***	**0,5215**
Intermediate	35	8,09	2,5	30	8,70	1,5	***t = 1.1903***	**0,1192**
Final	19	8,26	2,3	26	7,00	1,6	***t = -2.1718***	**0,9823**

The result of the Short Portable Mental State Questionary (SPMSQ) highlight that the attention of the users has been stable for all the period of the experiment. This shows that the results can be considered trustworthy, since there has not been significative reduction of cognitive performance.

6.1.3.2 Operational effectiveness

Table 84. DS RER Nr of technical/ operational issues reported (per RUC).

RUC	Number of issues	Description of main issues experienced
5	8	Smart pill dispenser had a problem in Wi-Fi management and needed an update of the firmware that was not feasible during COVID emergency. In two cases the devices were substituted. By end June 2020 6 pill dispenser were not functioning. H&S, device vendor, will update all 60 devices after summer 2020,
1/2/5/7	2,2	Average number of down longer than 48h per environmental device in the whole period of experimentation. Main reason is battery depletion. Toilette sensor had a sensibly higher rate of battery consumption. MTBF 186 h MTTR 63,2 h

In the first period of the experimentation, while installing the solution in the first 5-6 apartments, deployment suffered from immaturity of HW and SW.

Installers with wide set of skill were required to face the upcoming unexpected issue that arouse. Between them:

- Difficulties in connecting device to Wi-Fi
- Unexpected behaviour of device. Non documented feedback information from sensors leds
- Poor Wi-Fi connection due to locations of the rooms
- Special requests by elderly

The actions taken to overcome these issues allowed to reduce the number of people involved in the single installation, reduce the time spent in users' apartment and reduce the number of reworks.

Actions included provide installers with software to control connectivity, enhanced environmental device, training material with detailed procedure and lesson learnt, prepare backup installation kits.

No installation has been delayed due to any issue.

In some cases, chair sensor could not be installed because the chair/sofa itself did not allow to set the sensing cushion.

6.1.3.3 Use case exchange report

The mobility is considered an important indicator of the health status after a stroke event. The monitoring of the daily step was of great interest for the health professional and it was intended to increase the level of knowledge of the status of the end users.

It was also very interesting to test the usage of a complex but friendly device as the Samsung smartwatch on elderly people with chronic conditions.

We needed to amend the protocol submitted to ethical committee to include the new UC, including DS LEE service. The procedure can be long and it was concluded in February 2020.

We aimed at importing one service

DSLEE_SBSRV_C_1: Step count for alert to physical changes

Why: Enhance ADL monitoring with detail on person mobility.

But the effort planned for integration with AIOTES, version 1.5, was depleted by the complexity of the procedures. The Lepida's team involved installed the suite, but a full functional stage was not reached. This increased the delays, definitively complicated by the COVID emergency, as Lepida was deeply involved by the regional health system in the crisis management. This determined the impossibility to proceed with full import of DS LEE service.

DS RER received some Samsung smartwatches from DS LEE. Only a test of installation in the DS LEE portal was possible.

We didn't distribute any smartwatch and smartphone (intended to be used only as a gateway) due to coronavirus emergency.

In addiction we report that some users were highly interested in the device , the smartwatch, and willing to test them. Others were scared about the idea as not digitally literate, nor used to wear a watch.

During the configuration of the test user, we noticed that there were a number of privacy policies to accept while installing the apps, sometime only in english language. That could have been a major issue while deploying to Italian elderlies.

6.2 Local evaluation report

DS RER activities all along the project have been firmly driven by a scientific study protocol, that detailed some aspects of the evaluation strategies described in project documents. The following sections will report the planned endpoints and KPIs. Evaluation data collected and planned KPIs go beyond the ones needed for the definition of the endpoints, covering needs coming from the technical stakeholders, and the ones from the normalization of evaluation between DS required by WP6.

6.2.1 Goal of local evaluation: primary and secondary endpoints

The project aims to provide personalized services at home supported by IoT technologies addressed to elder people with neurological disease mainly over 65: the main goal of the pilot is reduce the re-hospitalization rate and the time needed for regaining autonomy, increase the quality of life for elder adults and their carers and decrease the risk of social exclusion. These elements are considered some of the key drivers of quality and cost of ageing well and care providing. Therefore, expected benefits with impacts to these drivers are directly impacting costs, quality, time and revenue of care givers.

Impact and replicability of the project

The pilot outcomes have impacts to users and their relatives, in the form of enhanced social inclusion and increase of their quality of Life. Moreover, the project has two other important objectives:

1. increase the cost efficiency and improve the health outcome offered by the Italian Public Health System;
2. enable the conditions to provide additional services to older people and therefore create a marketplace for new additional care/assistance providers.

Primary Endpoint

Reduction of re-hospitalization.

The data related from Parma's province in the year 2016 record a number of hospitalisation for stroke equal to 692 and of rehospitalization following the first one, equal to 231. In the evaluation of the type of re-hospitalization the raw rate calculated as the number of hospitalisation following the first one / number assisted with first hospitalisation is equal to 33,38%: the objective of the project is relative decrease of 50% (i.e., from 30% to 15%)of the re-hospitalization's rate[15]

Secondary Endpoint

Maintenance/improvement of motor resources, improvement of acts essential to maintaining relationships and communication in life, in family life and in the social context.

Intends therefore:

- to reach a more active share of the process of assistance from the users in a rate of 25% valuate in comparison to the basal data.
- to reach an increase of the ability of relationship in a rate of 40% in comparison to the basal values.

Furthermore, it will be recorded direct costs of hospitalization of patients in the two arms, measured through costs due to hospitalization days and rehabilitation days

6.2.2 Local KPI collected

Evidence on the benefit of the proposed solutions for active and independent living and quality of life and for cost saving in public expenditures, they will be measured according to the following KPIs:

Table 85. DS RER Local KPIs

Sustainability		
Reduction of re-hospitalisation rate	Administrative Data: Hospital Discharge Data (SDO), Home Care (ADI), Severe Acquired Disability (GRADA)	50% relative decrease (i.e., from 30% to 15%)
Reducing frequent visits to the Emergency Department	Administrative Data: Emergency Admission Data (PS)	30,00%

15 Figures updates at year 2019: The data related from Parma's province in the year 2019 record a number of hospitalizations for stroke equal to 762 and of rehospitalization following the first one, equal to 154. In the evaluation of the type of re-hospitalization the raw rate calculated as the number of hospitalization following the first one / number assisted with first hospitalization is equal to 20%: the objective of the project is relative decrease of 50% (i.e., from 20% to 10%) of the re-hospitalization's rate

Reduction of hospital admission and days spent in hospital	Administrative Data: Hospital Discharge Data (SDO)	15%
Users' relatives: decrease in days off work	CarerQol-7D Informal Care Questionnaire (still under discussion)	after +5 years: 25% 2 days per months
Monitoring and reducing consumption of assistive devices for post-stroke patients (observation from the beginning of the pilot)	Administrative Data: Assistive Device	
Innovation and Growth		
Creation of a marketplace for apps addressing ageing well need and older people requirements	Record date of marketplace creation / count number of apps available	target date / target number of apps
enable new services linked to IoT and increase the number of services provided by social assistance cooperatives	User Experience Questionnaire	Up to 30%
Increasing the size of the spin-off ICUBO: 50% new employees	Verify new employee contracts	
Impact on QoL		
Reducing adverse events related to comorbidities	Data comparison through SOLE network and EHR (Emilia Romagna eHealth infrastructure	35% reduction
More active participation in the care process	Social Interaction (Kane Scale)	25% increase
Improvement physical well-being	Barthel Scale, Activity of Daily Living Questionnaire (ADL); Instrumental Activities of Daily Living Scale (IADL)	15%

On the recommendation of the European coordination group of ACTIVAGE, in order to assess the impact of services based on AHA-IoT making the different projects developed in the various DS to be comparable, it has identified the following KPIs classified in the categories QoL and Sustainability whose measurement is based on internationally validated scales such as UT-AUT, EQ-5D-3L, UCLA Loneliness scale version 3:

Sustainability			
KPI	**Sub Global KPI**	**Data source**	**Target**
Service acceptance and user satisfaction	• Level of acceptance by end users • Level of acceptance by informal caregivers • Level of acceptance by professional caregivers	UT-AUT	>20%

IoT impact Self-Perception	• Level of acceptance by end users	questionnaire on IoT impact Self-Perception	
Impact on QoL			
KPI	**Sub Global KPI**	**Data source**	**Target**
QoL	• Improved QoL for end users	EQ-5D-3L	>10%
Social isolation		UCLA Loneliness scale version 3	33<x<39

As regards the "IoT impact Self-Perception questionnaire", it should be noted that it was developed by the central coordination of ACTIVAGE, and that it was created with the aim of knowing the potential of new IoT technologies used to improve the quality of life, involving all participants in all the DS of ACTIVAGE development as a single cohort. This questionnaire will be validated, following an appropriate validation methodology, during the project duration, comparing the results generated with the results provided by the standard scales above.

6.2.3 Local evaluation protocol

Rationale study

Even considering the mortality (30 days and 6 months), about 5.000 persons who had a stroke adverse event each year survive and need care assistance. Obviously, the above figure is related to just one year thus the percentage of the total population who had a stroke is higher and in sole Province of Parma (where the pilot is located) is near to 10.000 persons.

The proposed pilot project was aimed at people over 65 years of age and aimed at providing better results for people with CVD pathologies living at home, maximizing the value of technologies that allow better communication between the user and caregivers (both formal and informal). The offered technologies, which included remote health monitoring, tele-assistance, telemedicine/teleconsultation and applications, integrated services such as electronic health records and communication between health and social care staff.

The pilot technology targeted a wide area of potential users with the aim of supporting independent living and ageing in a broad acceptance. Nevertheless, in order to allow for analytic assessment of outcomes and impact, and given the necessarily limited number of people involved, the profile of the pilot population has been restricted to a more homogeneous class, and more specifically to people recovering from a stroke event and still suffering from stroke after-effects, even if it does not strictly require institutionalization, i.e. people with a medium severity disability index who use aids to support motor activity in their daily life, it is quite a relevant population (in Emilia Romagna there are 7.380 stroke adverse events every year) and can provide an adequate benchmarking for the targeted technology: stroke recovery, in fact, is a life-long process that involves the recovery of autonomy or support in the frequency of daily activities, the continuous monitoring of health conditions, the effective connection with health services. In addition, support for psychological well-being, social interaction and the support network around the primary-end user is of the utmost importance. In this respect, most of the specific needs addressed by the pilot are representative of a much wider area of interest. Therefore, a narrower focus of the pilot allowed the implementation of more rigorous results assessment techniques, without limiting too much the generality of the approach. Within a user-centred approach, the pilot addressed the needs of the primary end users described above, as well as formal and informal care givers involved in social and health support networks around the primary end user itself.

To describe the use cases, we can refer to the guidelines described in the report "Interoperability process recommendation for EIP-AHA and for standardization" [...] published by the European Innovation Partnership on Active and Healthy Ageing and in the report "AAL use cases and integration profiles" [...] of the Active Assisted Living Association.

The pilot is aligned with a new organization model who is taking place in Emilia Romagna and in particular in LHA Parma: this new organization is called "Home of Health" (alias "Case Della salute") and the new model is focused on the "case management" to provide high level services to the citizen increasing the prevention's activities.

In this context new tools such as EHR (Fascicolo Sanitario Elettronico) and SOLE record (Cartella SOLE) are inserted to support respectively the citizen and the General Practitioner in the treatment process.

Statistical considerations and analysis plan

Sample size determination

As of the determination of the re-hospitalization rate, the actual re-hospitalization rate evaluated in 2016 for Parma province* (30% of patients with stroke) will be assumed as a reference. Considered a relative decrease of 50% (from 30% to 15%) of the primary end-point, the expected power for a size of 200 patients (100 per arm) is 0.77, with an alpha=0.05 (one-tailed Pearson Chi-square test)

Statistical methods

For the valuation of primary end point it will use the Pearson Chi-Square test .

Qualitative variables will be compared using Pearson'schi-square or Fisher's exact test and reported as frequency(%).

Quantitative variables will be compared using the non-parametric Mann–Whitneyor Kruskal-Wallis tests and reported as mean±standard deviation.

Direct costs will be compared using independent samples t-test and reported as mean ±standard deviation.

Descriptive analysis of randomized groups will be based on the following features:

- Gender (female/male)
- Age classTime from stroke event at randomization time
- hypertension (presence/absence at the moment of randomisation)
- diabetes (presence/absence at the moment of randomisation)
- atrial fibrillation(presence/absence at the moment of randomisation)

Furthermore, for the evaluation of secondary end point it will use the following indicators :

As for the Barthel ADL and IADL statistical values will be measured on frequency of users who will maintain the numeric values chosen the inclusion.

Statistical values for KANE and SPMSQ will be considered a statistical point lower compared with baseline values.

The statistic method is used to measure is Kaplan-Meier.

6.2.4 Analysis of results

6.2.4.1 Local KPI results:

Sustainability

Reduction of re-hospitalisation rate	Administrative Data: Hospital Discharge Data (SDO), Home Care (ADI)[16], Severe Acquired Disability (GRADA)[17]	50% relative decrease (in respect with 33,2% of re hospitalized in 2016 and 20% in 2019)

Table 86. DS RER Re-hospitalizations stroke related

Re-hospitalizations stroke related				
Group	**Enrolled**	***Re-hospitalizations***	**% Re-hospitalization**	
EXP	27	0	0%	***Pearson chi2(1) = 0.9821 Pr = 0.322***
Ctrl	28	1	4%	
	55	***1***	**2%**	

Primary endpoint Target achieved

Reducing frequent visits to the Emergency Department	Administrative Data: Emergency Admission Data (PS)	30,00%

Table 87. DS RER HR admissions

HR admissions					
Group	**enrolled**	***HR admissions***	**# patients**	**% pat with access**	
Exp	27	*8*	*4*	15%	***Pearson chi2(1) = 0.8912 Pr = 0.345***
Contr	28	*10*	*7*	25%	
	55	***18***	***11***	**20%**	

Target achieved

Reduction of hospital admission and days spent in hospital	Administrative Data: Hospital Discharge Data (SDO)	15%

Table 88. DS RER Hospitalizations days

Hospitalization days							
Group	**Obs**	**Mean**	**Std. Err.**	**Std. Dev.**	**[95% Conf.**	**Interval]**	
Exp	27	1,46	0,72	3,76	-0,02	2,95	

16 ADI indicators have not been considered as the clinical condition have been stable and no specific home care assistance were not necessary

17 GRADA has not been considered as DS RER ACTIVAGE population is not rated with GRADA, that rate severe cases, out of inclusion criteria

Cont	28	1,62	0,77	4,10	0,03	3,21	*t = 0.5726* *Pr(T > t) = 0.284*
combined	55	1,54	0,53	3,90	0,49	2,60	
diff		***0,15***	***1,06***		***-1,97***	***2,28***	

The reduction in terms of hospitalization days is 10%. ***Target NOT achieved***.

Users' relatives: decrease in days off work	CarerQol-7D Informal Care Questionnaire	after +5 years: 25% 2 days per months

Table 89. DS RER CarerQoL results

CARERQoL	EXPERIMENTAL			CONTROL				
step	**n**	**Mean**	**SD**	**n**	**Mean**	**SD**	***Test***	**p-value**
Baseline	19	9,16	2,0	26	9,42	1,8	***t=0.4630***	**0,3229**
Intermediate	21	11,81	4,33	23	10,61	2,4	***t=-1.1500***	**0,8717**
Final	16	9,63	1,9	-	-	-		

We choose to consider the results of carerQoL as indicator of the general wellbeing of the carer.

We can notice that after an initial increase in the overall score, it lowered down in the final round of submission of the questionnaire, probably due to overlapping Coronavirus emergency.

The final submission has been possible only for experimental group. We can notice that during the normal flow of events, considering the evolution from Baseline to intermediate, we have a much better increase of the score for the experimental group in comparison with the control one.

Monitoring and reducing consumption of assistive devices for post-stroke patients (observation from the beginning of the pilot)	Administrative Data: Assistive Device	

KPI dropped.

Monitoring have been maintained identical from the beginning to the end of the observation period

Innovation and Growth

Table 90. DS RER Innovation & Growth results

Number of Open Source components made available	Count publications on open source platforms like GitHub etc.	at least 5	2 BAM[18] UniPR: https://github.com/niccolomora/ActivageUniPRPublic TeleVisit: https://marketplace.activage.iti.gr/market/app/106/

18 Behavioural Analysis Module

Creation of a marketplace for apps addressing ageing well need and older people requirements	Record date of marketplace creation / count number of apps available	target date / target number of apps	1 APP TeleVisit: https://marketplace.activage.iti.gr/market/app/106/

<table>
<tr>
<td>enable new services linked to IoT and increase the number of services provided by social assistance cooperatives</td>
<td>User Experience Questionnaire</td>
<td>Up to 30%</td>
<td>
See 0 Overall results of innovation and growth KPIs are positive, considering that part of the infrastructure, namely the regional eHR (Fascicolo Sanitario Elettronico) that includes GUI for citizens and professionals, shared as open source
Impact on QoL
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eHealt</td></tr>
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Table 91. DS RER Cost of care results
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<tr><th colspan="3"></th></tr>
<tr><th>Group</th><th>Enrolled</th><th>Hospitalizations</th></tr>
<tr><td>EXP</td><td>27</td><td>8</td></tr>
<tr><td>Contr</td><td>28</td><td>14</td></tr>
</table>
The clear reduction in costs and the reduction in hospitalization and access to HR reflects a clear reduction in the adverse events linked to this chronic pathology as well as other pathologies.
<table>
<tr><td>More active participation in the care process</td><td>S</td></tr>
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Table 92. DS RER Kane questionnaire results
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<tr><th>KANE</th><th colspan="2">EXPERIMEN</th></tr>
<tr><th>step</th><th>n</th><th>Mean</th></tr>
<tr><td>Baseline</td><td>19</td><td>37,47</td></tr>
<tr><td>Intermediate</td><td>34</td><td>33,18</td></tr>
<tr><td>Final</td><td>19</td><td>32,63</td></tr>
</table>
Kane results repost a worsening of the social activities and relationship, therefore the Target is not achieved. Nonetheless, we
</td>
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consider that the COVID emergency had a huge impact on social activities and relationship for the observed persons. And therefore, we do not consider the results from Kane questionnaire reliable. Though we can notice that the reduction between the experimental group (13%) is in considerably lower than the one in control group (-30%)

Improvement physical well-being	Bar Que of D

Table 93. DS RER Barthel questionnaire results

BARTHEL	EXPERIMENTAL	
step	n	Mean
Baseline	19	67,89
Intermediate	19	64,24
Final	19	63,16
		-7%

Variation are not relevant enough to report any variance in the motor activities

Table 94. DS RER IADL questionnaire results

iADL	EXPERIMEN	
step	n	Mean
Baseline	19	4,63
Intermediate	33	3,61
Final	19	3,37
		-27%

Table 95. DS RER ADL questionnaire results

ADL	EXPERIMENT	
step	n	Mean
Baseline	19	4,84

Intermediate	35	4,23	1,6
Final	19	3,32	1,6
		-32%	

In both iADL and ADL we notice a significant deterioration

In both groups there is a risk factor regarding both everyday activities and daily life functions. Intending with risk factor the fact that doctors must take note that there is some issue.

Target not achieved

6.2.4.2 Global KPI results

Sustainability	
KPI	**Sub Global K**
Service acceptance and user satisfaction	• Level of ac • Level of ac caregivers • Level of ac caregivers

The UT-AUT questionnaire have been submitted to elderly end users only. Following, the results:

Table 96. DS RER UT-AUT questionnaire results

Mean	SD	EE
4,15	0,40	Baseline
3,99	0,58	Intermediate
4,50	0,76	Final
4,19	**0,59**	**TOT**

Mean	SD	SI
4,14	0,54	Baseline
4,07	0,64	Intermediate
4,33	0,50	Final
4,17	**0,56**	**TOT**

Mean	SD	SE
4,00	0,71	Baseline
3,61	0,61	Intermediate
4,75	0,50	Final
3,95	**0,73**	**TOT**

AX	n	Mean	SD
Baseline	20	1,43	1,40
Intermediate	23	1,05	1,11
Final	17	0,30	0,95
TOT	**60**	**0,90**	**1,18**

BI	n	Mean
Baseline	20	3,99
Intermediate	23	4,62
Final	17	4,45
TOT	**60**	**4,36**

Considering the 7 dimensions of the UTAUT questionnaire, here following the overall results in terms of final value of the score and variation from the first submission

Table 97. DS RER UT-AUT summary of results

	Final score
ınce Expectancy	4,5
ɔectancy	4,6
towards using technology	4,3
luence	4,8
ıg Conditions	4,7
r self-efficacy	4,2
r anxiety	4,7
ral intention	4,4

In this result we can highlight a good impression on the technology of the services, in particular the result in reduction on anxiety in the use of technology. The target has been achieved in three dimensions, Social Influence, Facilitating Conditions and Computer anxiety .

Sustainability	
KPI	**Sub Global KPI**
IoT impact Self-Perception	Level of acceptar

Table 98. DS RER Global questionnaire results

	n	Mean	S
ːline	19	49,05	
·mediate	25	52,84	

Final	17	59,53	9,6
Tot	57	53,84	10,5

Increment of 21%

Even the target was not detailed, we consider this increase of 21% a success.

Impact on QoL	
QoL	Improved QoL for

Table 99. DS RER EQ visual analogue scale (EQ VAS)

	n	Mean	S
line	19	39,05	
rmediate	22	40,32	
l	17	67,65	
	59	**47,24**	

Target achieved.

Impact on QoL	
Social isolation	

Table 100. DS RER UCLA scores

	n	Mean	S
line	19	42,68	
rmediate	24	42,79	
l	17	46,06	
	60	**43,68**	

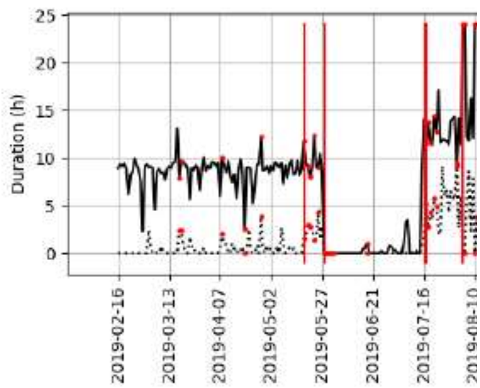
Target not achieved. Increment of social interaction by 8% of UCLA score.

6.2.4.3 Additional Indicators

Number of measurements collected:

- Raw: 6.395.876
- Elaborated: 1.511.799

Results of data analysis:

			Data analysis was able to predict 75% hospitalization sessions, 8 to 21 days in advance. And 67% alerts were confirmed to be semantically meaningful, e.g. the system raised an alert eight days before a hospitalization of one of the subjects and provided insights into the subsequent recovery phase at home. Further, reduced social interaction could be observed during the COVID-19 lock-down period across the cohort.  Figure 59. DS RER Point anomalies (red dots) and long-term changes (red lines) detected by the Isolation Forest User Experience Questionnaire paragraph below
Increasing the size of the spin-off ICUBO: 50% new employees	Verify new employee contracts	Since the Activage project was proposed, in 2016, the situation has evolved, with University spin-off policies having changed. As a result, a **new company has been funded by some of I-Cubo shareholders**. The new company has then been actively involved in the project, as a subcontractor. Launching of the new company was successful, with new shareholders being involved, a significant increase in the overall turnover and (despite the COVID crisis) a promising outlook.	

Overall results of innovation and growth KPIs are positive, considering that part of the infrastructure, namely the regional eHR (Fascicolo Sanitario Elettronico) that includes GUI for citizens and professionals, shared as open source

Impact on QoL

Reducing adverse events related to comorbidities	Data comparison through SOLE network and EHR (Emilia Romagna eHealth infrastructure	35% reduction

Table 91. DS RER Cost of care results

COSTs					
Group	Enrolled	*Hospitalizations*	Regional budget (total)	Regional Budget (mean)	
EXP	27	*8*	38.882,59 €	*4.860,32 €*	***t = 0.5231*** ***Pr(T > t) = 0.3015***
Contr	28	*14*	74.661,49 €	*5.332,96 €*	

The clear reduction in costs and the reduction in hospitalization and access to HR reflects a clear reduction in the adverse events linked to this chronic pathology as well as other pathologies.

More active participation in the care process	Social Interaction (Kane Scale)	25% increase

Table 92. DS RER Kane questionnaire results

KANE	EXPERIMENTAL			CONTROL				
step	n	Mean	SD	n	Mean	SD	*Test*	p-value
Baseline	19	37,47	13,9	26	35,62	9,3	***t=-0.5369***	**0,7029**
Intermediate	34	33,18	10,8	30	37,97	10,5	***t=-2.6085***	**0,9938**
Final	19	32,63	11,4	26	24,96	8,3	***t=1.7941***	**0,0388**

Kane results repost a worsening of the social activities and relationship, therefore the **Target is not achieved**. Nonetheless, we consider that the COVID emergency had a huge impact on social activities and relationship for the observed persons. And therefore, we do not consider the results from Kane questionnaire reliable. Though we can notice that the reduction between the experimental group (13%) is in considerably lower than the one in control group (-30%)

Improvement physical well-being	Barthel Scale, Activity of Daily Living Questionnaire (ADL); Instrumental Activities of Daily Living Scale (IADL)	15%

Table 93. DS RER Barthel questionnaire results

BARTHEL	EXPERIMENTAL			CONTROL				
step	n	Mean	SD	n	Mean	SD	*Test*	p-value
Baseline	19	67,89	5,6	26	69,04	5,3	***t=0.6982***	**0,2444**
Intermediate	19	64,24	17,9	26	76,61	17,43	***t=2.7853***	**0,0036**
Final	19	63,16	20,6	26	66,58	16,9	***t=0.6038***	**0,2746**
		-7%			-4%			

Variation are not relevant enough to report any variance in the motor activities

Table 94. DS RER IADL questionnaire results

iADL	EXPERIMENTAL			CONTROL				
step	n	Mean	SD	n	Mean	SD	*Test*	p-value
Baseline	19	4,63	1,5	26	5,85	1,4	***t=2.9176***	**0,0028**
Intermediate	33	3,61	2,1	28	4,94	2,3	***t=2.4058***	**0,0096**
Final	19	3,37	2,1	26	3,54	2,2	***t=0.2607***	**0,3978**
		-27%			-39%			

Table 95. DS RER ADL questionnaire results

ADL	EXPERIMENTAL			CONTROL				
step	n	Mean	SD	n	Mean	SD	*Test*	p-value
Baseline	19	4,84	0,8	26	5,15	0,9	***t = 1.1990***	**0,1185**
Intermediate	35	4,23	1,6	30	4,97	1,4	***t = 1.9153***	**0,0300**
Final	19	3,32	1,6	26	3,50	1,6	***t = 0.3772***	**0,3540**
		-32%			-32%			

In both iADL and ADL we notice a significant deterioration

In both groups there is a risk factor regarding both everyday activities and daily life functions. Intending with risk factor the fact that doctors must take note that there is some issue.

Target not achieved

6.2.4.4 Global KPI results

Sustainability			
KPI	**Sub Global KPI**	**Data source**	**Target**
Service acceptance and user satisfaction	• Level of acceptance by end users • Level of acceptance by informal caregivers • Level of acceptance by professional caregivers	UT-AUT	>20%

The UT-AUT questionnaire have been submitted to elderly end users only. Following, the results:

Table 96. DS RER UT-AUT questionnaire results

PE	**n**	**Mean**	**SD**
Baseline	20	4,15	0,40
Intermediate	23	3,99	0,58
Final	17	4,50	0,76
TOT	**60**	**4,19**	**0,59**

EE	**n**	**Mean**	**SD**
Baseline	20	4,18	0,69
Intermediate	23	4,33	0,55
Final	17	4,63	0,52
TOT	**60**	**4,38**	**0,58**

AT	**n**	**Mean**	**SD**
Baseline	20	4,14	0,54

SI	**n**	**Mean**	**SD**
Baseline	20	3,98	0,07

Intermediate	23	4,07	0,64
Final	17	4,33	0,50
TOT	**60**	**4,17**	**0,56**

Intermediate	23	4,13	0,76
Final	17	4,83	0,41
TOT	**60**	**4,23**	**0,63**

FC	**n**	**Mean**	**SD**
Baseline	20	4,00	0,71
Intermediate	23	3,61	0,61
Final	17	4,75	0,50
TOT	**60**	**3,95**	**0,73**

SE	**n**	**Mean**	**SD**
Baseline	20	4,03	0,78
Intermediate	23	4,18	0,64
Final	17	4,20	1,03
TOT	**60**	**4,14**	**0,79**

AX	**n**	**Mean**	**SD**
Baseline	20	1,43	1,40
Intermediate	23	1,05	1,11
Final	17	0,30	0,95
TOT	**60**	**0,90**	**1,18**

BI	**n**	**Mean**	**SD**
Baseline	20	3,99	1,45
Intermediate	23	4,62	0,62
Final	17	4,45	0,79
TOT	**60**	**4,36**	**1,03**

Considering the 7 dimensions of the UTAUT[19] questionnaire, here following the overall results in terms of final value of the score and variation from the first submission

Table 97. DS RER UT-AUT summary of results

		Final score	Variation from
PE	Performance Expectancy	4,50	8%
EE	Effort Expectancy	4,63	11%
AT	Attitude towards using technology	4,33	5%
SI	Social Influence	4,83	22%
FC	Facilitating Conditions	4,75	19%
SE	Computer self-efficacy	4,20	4%
AX	Computer anxiety[20]	4,70	32%
BI	behavioural intention	4,45	11%

In this result we can highlight a good impression on the technology of the services, in particular the result in reduction on anxiety in the use of technology. The target has been achieved in three dimensions, Social Influence, Facilitating Conditions and Computer anxiety .

19 Performance Expectancy PE The degree to which an individual believes that using the system will help him or her to attain gains in job performance.
Effort Expectancy EE The degree of ease associated with the use of the system.
Attitude towards using technology AT An individual's overall affective reaction to using a system
Social Influence SI The degree to which an individual perceives that important others believe he or she should use the new system.
Facilitating Conditions FC The degree to which an individual believes that an organizational and technical infrastructure exists to support use of the system.
Computer self-efficacy SE Judgment of one's ability to use a technology to accomplish a particular job or task.
Computer anxiety AX Evoking anxious or emotional reactions when it comes to performing a behaviour
Behavioural Intention

20 Scale from 5 to 0 , 0 best result, normalized to 0 to 5 like other dimensions)

Sustainability			
KPI	**Sub Global KPI**	**Data source**	**Target**
IoT impact Self-Perception	Level of acceptance by end users	questionnaire on IoT impact Self-Perception	

Table 98. DS RER Global questionnaire results

	n	Mean	SD
Baseline	19	49,05	11,3
Intermediate	25	52,84	8,2
Final	17	59,53	9,6
Tot	**57**	**53,84**	**10,5**

Increment of 21%

Even the target was not detailed, we consider this increase of 21% a success.

Impact on QoL			
QoL	Improved QoL for end users	EQ-5D-3L	>10%

Table 99. DS RER EQ visual analogue scale (EQ VAS)

VAS	n	Mean	SD
Baseline	19	39,05	26,4
Intermediate	22	40,32	26,0
Final	17	67,65	13,5
Tot	**59**	**47,24**	**26,4**

Target achieved.

Impact on QoL			
Social isolation		UCLA Loneliness scale version 3	33<x<39

Table 100. DS RER UCLA scores

	n	Mean	SD
Baseline	19	42,68	7,8
Intermediate	24	42,79	7,9
Final	17	46,06	8,3
Tot	**60**	**43,68**	**8,0**

Target not achieved. Increment of social interaction by 8% of UCLA score.

6.2.4.5 Additional Indicators

Number of measurements collected:

- Raw: 6.395.876

- Elaborated: 1.511.799

Results of data analysis:

Data analysis was able to predict 75% hospitalization sessions, 8 to 21 days in advance. And 67% alerts were confirmed to be semantically meaningful, e.g. the system raised an alert eight days before a hospitalization of one of the subjects and provided insights into the subsequent recovery phase at home. Further, reduced social interaction could be observed during the COVID-19 lock-down period across the cohort.

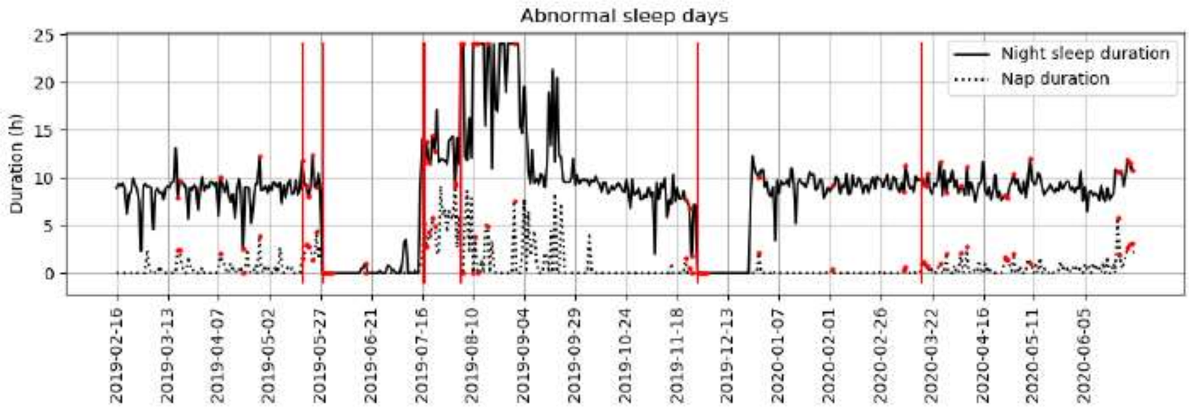


Figure 59. DS RER Point anomalies (red dots) and long-term changes (red lines) detected by the Isolation Forest

6.2.4.6 User Experience Questionnaire results

All users of the experimental group were questioned in May 2020 on their experience in the use of the services during ACTIVAGE experimentation. 19 answers have been collected to the UEQ questionnaire[21]

As the creator of the questionnaire explains the scales of the questionnaire cover a comprehensive impression of user experience. Both classical usability aspects (efficiency, perspicuity, dependability) and user experience aspects (originality, stimulation) are measured.

This tool allows us to have a point of view of the elderly on our solutions on the following aspects:

- Attractiveness: Overall impression of the product. Do users like or dislike it?
- Perspicuity: Is it easy to get familiar with the product and to learn how to use it?
- Efficiency: Can users solve their tasks without unnecessary effort? Does it react fast?
- Dependability Does the user feel in control of the interaction? Is it secure and predictable?
- Stimulation: Is it exciting and motivating to use the product? Is it fun to use?
- Novelty: Is the design of the product creative? Does it catch the interest of users?

Here following the results:

21 https://www.ueq-online.org/

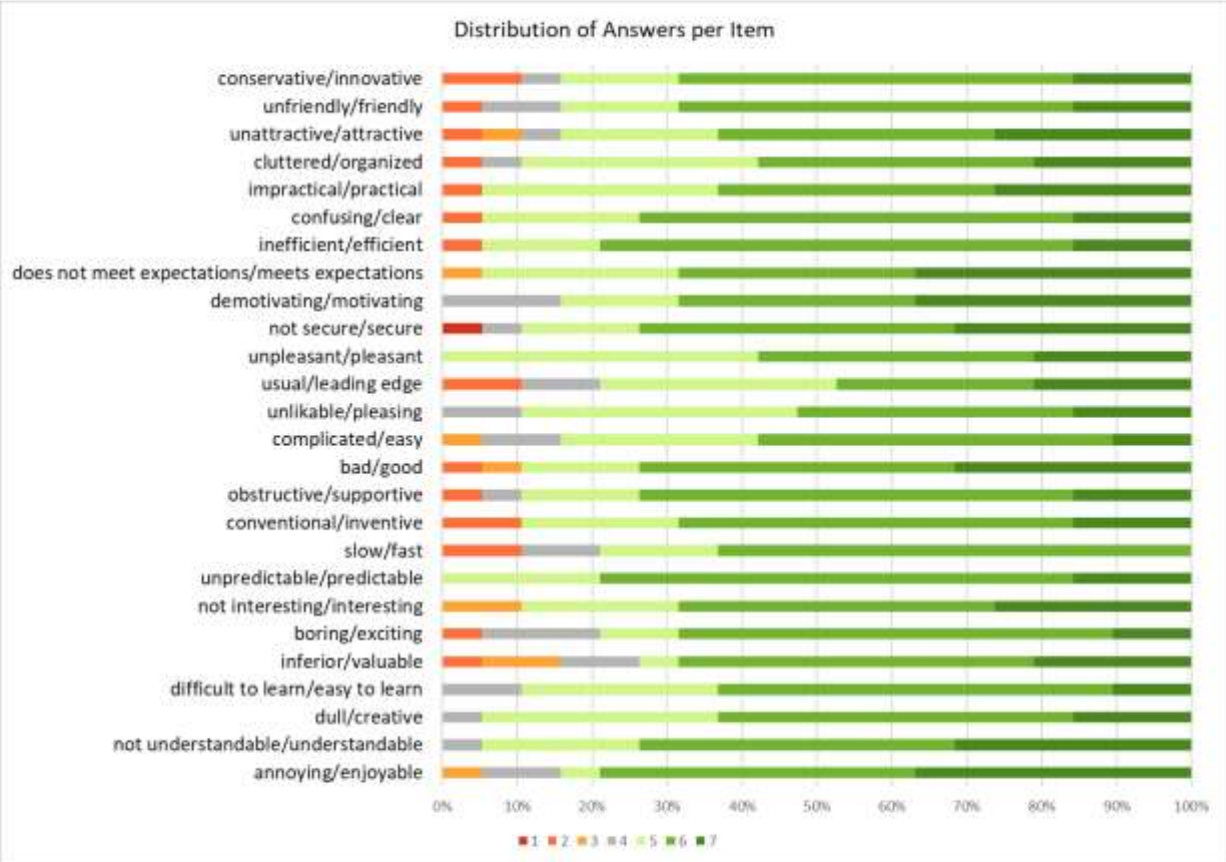


Figure 60. DS RER UEQ Distribution of answers per item

Aggregating the result of the above-mentioned aspects we obtain the data reported in Table 101

Table 101. DS RER UEQ Scales

UEQ Scales (Mean and Variance)		
Attractiveness	1,711	0,88
Perspicuity	1,711	0,41
Efficiency	1,579	0,58
Dependability	1,842	0,70
Stimulation	1,632	1,29
Novelty	1,500	0,72

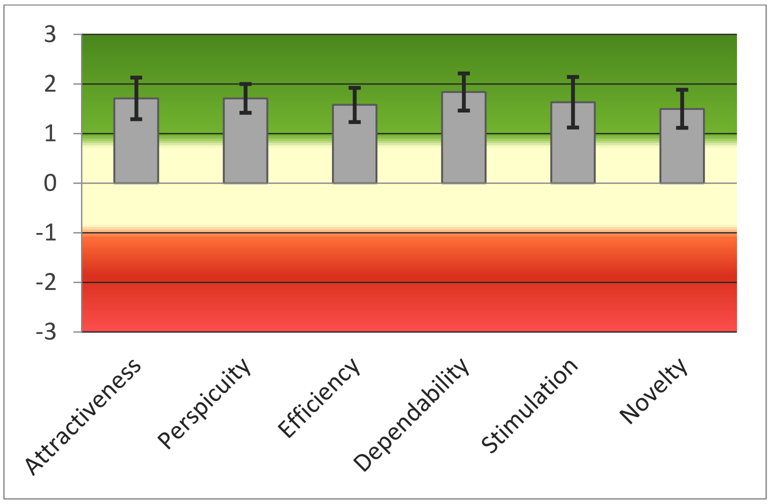


Figure 61. DS RER UEQ Scales

The KPI results are good in every dimension, as we could consider “extremely unlikely to observe values above +2 or below -2.” [22]

Novelty and Efficiency as the area where to concentrate future efforts.

Considering subset of users:

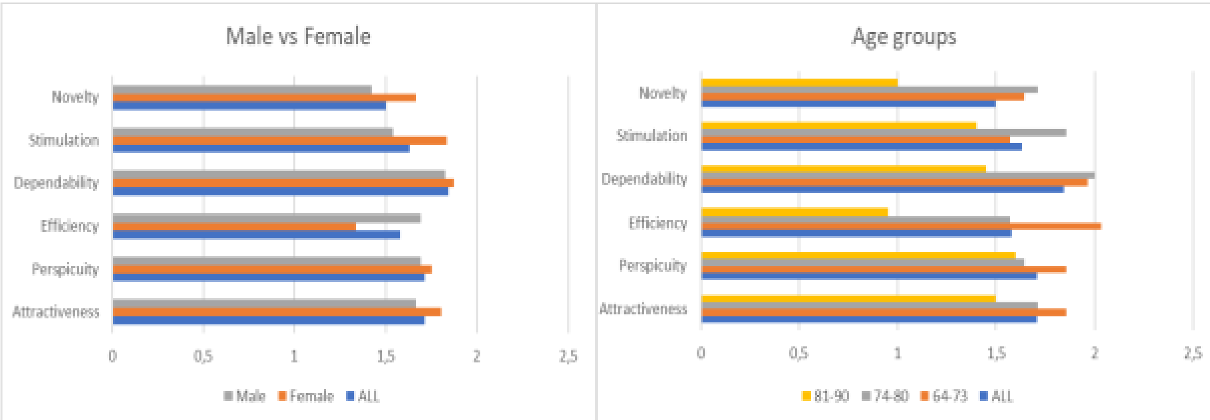


Figure 62. DS RER UEQ Users and Age view

22 Values between -0.8and 0.8 represent a more or less neutral evaluation of the corresponding scale, values > 0,8 represent a positive evaluation and values < -0,8 represent a negative evaluation.
The range of the scales is between -3 (horribly bad) and +3 (extremely good). But in real applications, in general, only values in a restricted range will be observed. It is due to the calculation of means over a range of different persons with different opinions and answer tendencies (for example the avoidance of extreme answer categories) extremely unlikely to observe values above +2 or below -2.
Thus, even a quite good value of +1.5 for a scale looks from the purely visual standpoint on a scale range of -3 to +3 not as positive as it really is. For this reason this sheet contains two variants for the figure that depicts the scale means. Use the figure with the reduced scale -2 to +2 if you communicate the results to persons that have not much knowledge on the interpretation of this type of data and in situations where you don't want to explain in detail how building mean values and answer tendencies influence the observed data. (https://www.ueq-online.org/Material/Handbook.pdf - User Experience Questionnaire Handbook All you need to know to apply the UEQ successfully in your projects Author: Rd. Martin Schrepp Version 8)

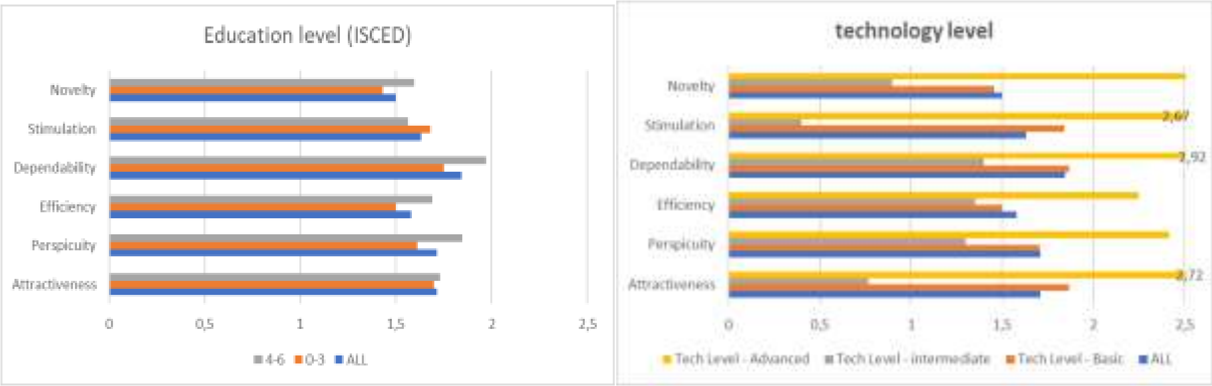


Figure 63. DS RER UEQ Education and Technology level view

As expected, people with higher education and advanced technology awareness tends to have a better and easier approach to digital services

6.2.5 Conclusions

A) PERSONAL DATA PART

The Experimental and Control Groups are overlapping by age and gender

Some differences:

1) The experimental group has a higher level of schooling and so for the level of knowledge
2) technology. However, the Control Group has 93% basic knowledge.
3) The experimental group lives mainly in urban areas.
4) The majority of both of them are in a non-working pension scheme

In conclusion the 2 groups (experimental control) are in the statistical condition to be able to be compared

B) DATA to evaluate the PRIMARY OBJECTIVE

1) comparison between the data of the re-hospitalisation in the experimental group and in the control group: data show a better reduction of re-hospitalization in the experimental group
2) comparison with regional data (SDO) related to the re-hospitalization in the Local Health Authorities of Parma: also in this case the data are better for both groups in the comparison with data extracted from provincial hospitals for the year 2019

C) DATA for the achievement of secondary objectives

1) Access to HR
    a. The percentage of users who went to the HR is lower in the Experimental Group while the number of accesses is identical for the 2 groups
2) The number of days spent in hospital is lower in the Experimental Group and the average cost of hospitalisation is therefore lower
3) The maintenance of functional motor conditions remains substantially unchanged (Barthel) and therefore without major variations, while the functionality of users in daily life activities (iADL, ADL) appears significantly worsened. This appears to be a crisis factor that the formal care giver had to bear in mind.

D) Data related to the scores of the questionnaires for the 2 groups (Experimental and Control)

1) Questionnaires aimed at analysing clinical, cognitive and relationship functions.
2) It is significant that the attention and therefore the compliance of the users remained intact throughout the trial (whose condition was among the factors of inclusion). At the same time, the basic technological level in the experimental group made it possible to check and support the meaning of the IoT of the protocol, also facilitating support.
3) The use of the sensors did not change the relationships both within the family and towards the outside world in any way, but rather facilitated their adaptation.
4) The important result is that the use of sensors has significantly reduced the use of territorial services, and rehabilitation services that have been replaced by video-visits with physiotherapist.
5) In consideration of this, we have been able to verify that the users of the two groups have accepted the technology services in their apartment. In particular, we would like to point out the importance of the dispenser pill which, in addition to monitoring the evolution of the clinical picture, has represented for the users and even more so for the care giver a possibility to increase the pharmacological compliance and not to interrupt pharmacological therapies, which in chronicity is of decisive importance.
6) We have also confirmed that, separately, the users and care givers considered the use of IoTs to be significant. The evaluation of the formal care giver, the GPs, has also been positive because it has increased the use of the tools that the control body has put in place, such as the regional eHR, the SOLE network and the web based regional GP folder software.

6.3 Local sustainability plan

6.3.1 Product/Service Definition

DS RER implemented services for the citizen older than 64, of Parma province and that suffered from a stroke event. The three services are listed in the following sections

- **Physiotherapist videovisit**

  A socio-health operator in the older adult apartment connect with a professional clinician or therapist with audio and video, using a dedicated client-server Windows application. The service is used by an operator that facilitates exercises of AFA, Adapted Physical Activity, monitored remotely by the physiotherapist

- **Abnormal ADL situations monitoring (sleep, movement, social, toilet, therapy adherence)**

  The system collect measurement, from environmental sensors (pressure: bed, chair; contact: door; presence: PIR; distance: toilette), from use of smart pill dispenser. Easily scalable to any sensor that send via Wi-Fi a measurement (value, type, timestamp).

  The service produces elaboration of the measurements to provide more useful measurements (e.g. bed sensor --> number of hours slept, number of awakening)

  All measurements are accessible via eHR by citizens and Regional Health professionals

  System could detect variation in normal behaviour for each sensed ADL activity and highlight the abnormality.

- **drugs consumption monitoring**

The older adult uses a smart pill dispenser. Case Manager configure the therapy on a third-party web tool. Activage collects information regarding the adherence to therapy (pills taken, delayed, not taken)

6.3.1.1 Product Lean canvas

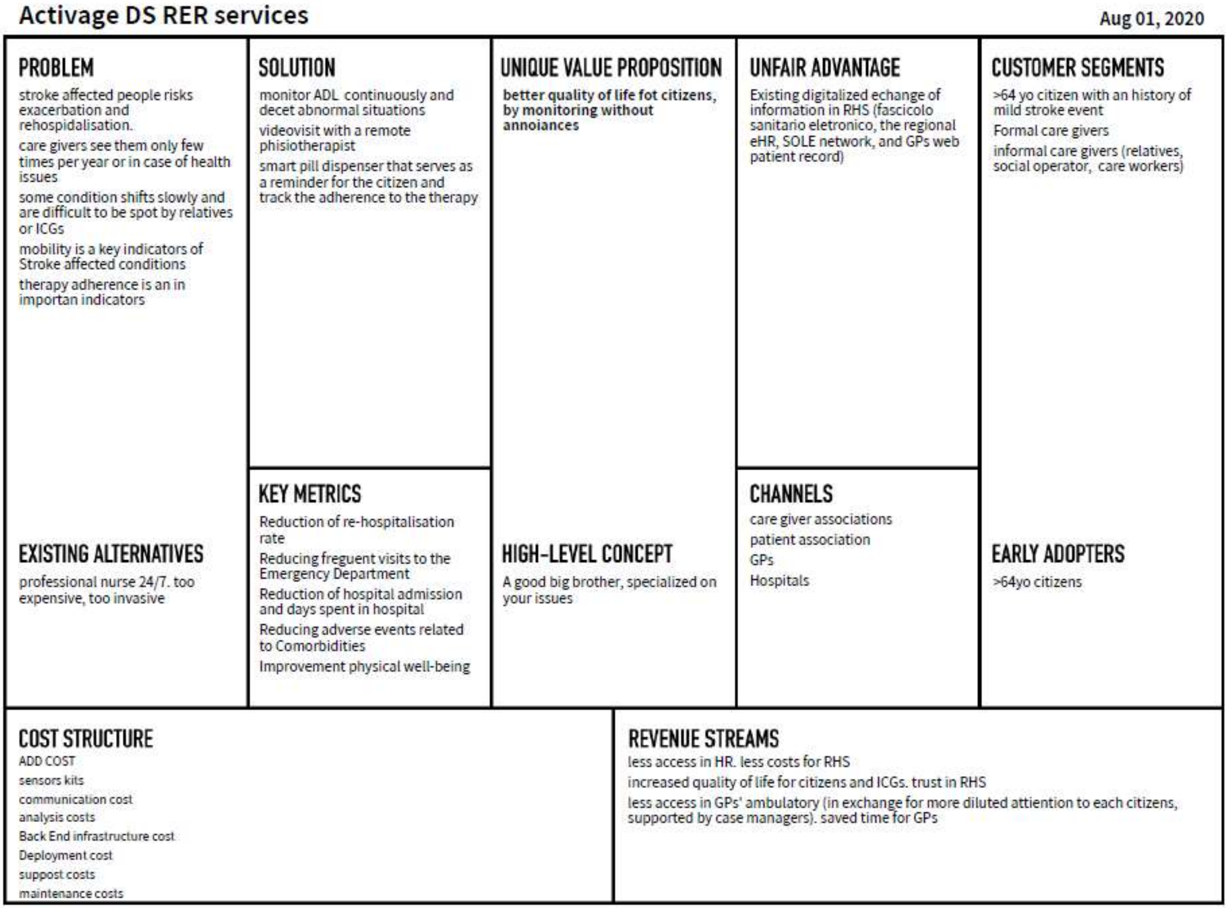


Figure 64. DS RER lean canvas

6.3.2 Market Analysis

Ds RER activities in ACTIVAGE project are centered in a peculiar market. Main partners are Local Health Authority of Parma a public administration of the regional health system, and Lepida scpa, the in-house company of the region Emilia Romagna for the innovation in ICT.

The service developed in collaboration with the other partners, aimed at enhancing the public care service to target customers, the citizens, under the umbrella of the universal health care.

This premise is important to understand the analysis of the following sections that highlights the potentials benefit (economic and social) of the solutions for the RHS and the citizens

6.3.2.1 Market characterization

Regarding the assumptions with the DS RER, Region Emilia Romagna decided to provide a commitment in the ACTIVAGE Project for innovating the network of services for better care of people with chronic diseases. Indeed, that was of particular interest for local health policies which have the aim to incorporate technological solutions in the provisions of services.

- The Local Health Authority of Parma has the highest number of Houses of Health (Case della Salute) and primary care units aggregation of General Practitioners in the Region and this kind of organizations would support the further implementation of the use cases developed during ACTIVAGE in the DS RER.
- The choice of the stroke as a clinical pathology to which technological innovations would be applied, is linked to the fact that among the elderly it is the most important cause for disability, thus, home monitoring becomes crucial to avoid clinical deterioration and re-hospitalisation. At the same time, the solution implemented in the DS RER would be extended to other chronic diseases as chronic respiratory diseases, diabetes, chronic heart diseases. .
- LEPIDA is the main operational instrument as regards implementation of the Regional ICT Plan that defines the ensures and optimizes the delivery of ICT services, develops cloud infrastructure, implements and manages innovative solutions for the modernization of healthcare paths to improve the relationship between citizens and the Regional Health Service in accordance with the provisions of the European, National and Regional Digital Agendas.

In the last decade the Emilia-Romagna Region participated to several projects on Telemedicine, focusing on specific conditions and targeting population with limited access to services. From 2016, according to a Regional Decision, a comprehensive programme has been adopted to ensure equity and appropriateness of access to all citizens with chronic conditions living in remote areas, in close cooperation with the Community Health Centres.

The assets developed by ACTIVAGE are in line with the regulatory and strategic framework of the Emilia Romagna Region. The Social and Health Plan of the Emilia-Romagna Region 2017-2019 had identified three strategic objectives to respond to the challenges of the current demographic transition and societal changes: fight against exclusion, the identification of the local district as the strategic hub of integration of policies and services, the identification of new tools to guarantee proximity and integration. The Plan identified 39 actions targeting 5 transversal areas (proximity and domiciliation, reduction of inequalities and promotion of health, autonomy of people, participation and empowerment, qualification and efficiency of services) and new methods of local planning and regional development. Emilia-Romagna integrates social protection and health care in a unique planning instrument.

From these assumptions there would be the willingness of the Local Health Authority of Parma together with the Region to continue the participation in the Activage activities to promote its applicability in the context of its structures (Health Houses and Primary Care Units). The ambition for the future is to consolidate the collaboration between the organisations (public authorities, private organisations, user associations and social cooperatives) that have been worked in the DS RER to scale up the provided solutions and promote policies and tools to support citizens in need of care and their caregivers.

Extract from Protocol

Rationale Study

“In Emilia Romagna there are 7380 new stroke adverse event each year.”

Even considering the mortality (30 days and 6 months), about 5.000 persons who had a stroke adverse event each year survive and need care assistance. Obviously, the above figure is related to just one year thus the percentage of the total population who had a stroke is higher and in sole Province of Parma (where the pilot is located) is near to 10.000 persons.

The proposed pilot in ACTIVAGE is addressed to greater than or equal 65 years old persons and aims to deliver better outcomes for people with CVD pathologies living at home by maximizing the value of technologies that enable better communication between the user and the caregivers (both formal and informal). The offered technologies, which will include remote health monitoring, telecare, telemedicine/teleconsultation and apps, will complement services such as electronic health records and communication between health and social care staff.

6.3.3 Competition/sector Analysis

6.3.3.1 Competition profile analysis

Main competitors are IoT solution available on the market.

Currently we do not have notion of any on the shelf solution for such services that can be integrated as required with regional infrastructure.

Nevertheless, the decision maker could be attracted to stand alone solution for simplicity of management, overall, in terms of legal and organizational aspect

6.3.3.2 SWOT analysis

Table 102. DS RER SWOT analysis

STRENGTHS	WEAKNESSES
Natively integrated with regional infrastructure (Fascicolo sanitario elettronico) Users, professional and not, are already familiar to the user interfaces Sensors produced by a project partners Evaluate the risk factors that may lead to a re-hospitalisation. To better organise home care. To allow a continuous control and contact of the formal and informal care-giver.	Wi-Fi sensors are not common in the market Involvement of GPs Target users want to be followed constantly with human interactions. IT knowledge and the use of IT tools is not yet widespread, both as culture and as practice.
OPPORTUNITIES	**TREATHS**
Continuous monitoring of patient in chronic conditions Enhancement of Patient – doctor relationship COVID19 and other emergencies increased sensibly the need for telemonitoring Drive the market to the production of solutions adapted to the needs of people affected by chronic diseases	New Market product that could be easier to manage and take on legal and security responsibilities Difficulties for users and operators to adapt to technological development. Resistance in the public health institution to the adoption of innovative solution that imply high initial costs, organizational changes and legal responsibility related to privacy

6.3.4 Value proposition and Targeted Customers

Value Proposition Canvas

Value map

Gain creators

Feeling of being cared: Target Users gain trust in RHS by knowing that they are constantly cared

Videovisit allow to receive professional consultancy without moving from their premises

Smart pill dispenser was found very useful by some of the target users.

Pain relievers

Transparent to user: target user are poorly digitally literates, the less use or technology the better.

ICG gain peace of mind in caring them.

Being monitored continuously reassure on the positive evolvement of the condition

Product & Services

Physiotherapists videovisit: A socio-health operator in the older adult apartment connect with a professional clinician or therapist with audio and video, using a dedicated client-server Windows application. The service is used by an operator that facilitates exercises of AFA, Adapted Physical Activity, monitored remotely by the physiotherapist

Abnormal ADL situations monitoring for professionals (sleep, movement, social, toilet, therapy adherence):The system collect measurement, from environmental sensors (pressure: bed, chair; contact: door; presence: PIR; distance: toilette), from use of smart pill dispenser. Easily scalable to any sensor that send via Wi-Fi a measurement (value, type, timestamp).

The service produces elaboration of the measurements to provide more useful measurements (e.g. bed sensor --> number of hours slept, number of awakening)

FIT

Customer profile

Gains

More care.

Professional consultancies

Pains

Decrease of physical conditions

Lack of peers network to share problems

Decrease of psychological conditions

Customer Job(s)

Support research

Increase Qu (target user and ICG)

Increase of physical conditions

Increase of psychological conditions

	All measurements are accessible via eHR by citizens and Regional Health professionals System could detect variation in normal behaviour for each sensed ADL activity and highlight the abnormality. Drugs consumption monitoring: The older adult uses a smart pill dispenser. Case Manager configure the therapy on a third party web tool. Activage collects information regarding the adherence to therapy (pills taken, delayed, not taken)			

6.3.5 Strategy for local sustainability

6.3.5.1 Open Data strategy

Table 103. DS RER Dataset questionnaire answers

Dataset name	DS4.1.Questionnaire answers
Data identification	
Data set description	Questionnaire answer have been collected online by operators via web using on Lepida's instantiation of limesurvey. Almost 1000 single questionnaire answer of 11 different questionnaire submitted to asses along the project both experimental and control group are stored
Source (i.e. which device?)	limesurvey online questionnaire
Partners responsibilities	
Owner of the device	Lepida scpa
Partner in charge of data collection (if different)	AuroraDomus and LHA PR operators interviewed the users and reported the result online
Partner in charge of data analysis (if different)	LHA PR, LEP, IBM
Partner in charge of data storage (if different)	Lepida
Standards and metadata	
Info about metadata (Production and storage dates, places) and documentation?	*The metadata still need to be detailed for public availability*
Standards, Format, Estimated volume of data	*The metadata still need to be detailed for public availability* . *Around 1000 questionnaires submitted. Less than 1Mb*
Data exploitation and sharing	
Data exploitation (purpose/use of the data analysis)	Internal evaluation of DS RER results.

Data access policy / Dissemination level (Confidential, only for members of the Consortium and the Commission Services) / Public	*Taking into account the monitoring times envisaged by the Project (24-month observation), personal data will be kept for a period of time not exceeding that necessary to achieve the purposes. After that period the data anonymized can be used freely from privacy limitations*
Data sharing, re-use and distribution (How?)	*The use of anonymized data will be decided within the scope of activage.org by data owner , LHA PR*
Embargo periods (if any)	*None*
Archiving and preservation (including storage and backup)	
Data storage (including backup): where? For how long?	*Data is owned by LHA PR, stored by Lepida on behalf of Region Emilia Romagna on regional secured servers.* *According to privacy policy, pseudo anonymized data are stored for a period of time that allow the analysis of it for the purpose of the project. After that period, deanonymization keys will be deleted and data can be used free of law limitations*

Table 104. DS RER Dataset measurements

Dataset name	**DS4.2.Measurements**
Data identification	
Data set description	*Raw measurement coming from environmental sensors placed at elderly user premises, and other measurement elaborated by data analysts.* *Raw measurements come from the following sensors:* - *Entrance door* - *Presence in a room* - *Presence on the bed* - *Presence on a chair/sofa* - *Use of WC* - Smart pill dispenser 28 other elaborated types of measurement have been designed by data analyst and stored in the system.
Source (i.e. which device?)	Raw data are sent from the devices. Elaborated data comes from analysis module, IBM cloud
Partners responsibilities	
Owner of the device	*Data owner is LHA PR*

Partner in charge of data collection (if different)	*Lepida is data processor and manages the system that receive and organize data, and deanonymize when displayed to the users*
Partner in charge of data analysis (if different)	*IBM, CNR, UniPR*
Partner in charge of data storage (if different)	*Lepida*
Standards and metadata	
Info about metadata (Production and storage dates, places) and documentation?	Data are categorized and described. Not documented yet for public availability
Standards, Format, Estimated volume of data	*The metadata still need to be detailed for public availability*
Data exploitation and sharing	
Data exploitation (purpose/use of the data analysis)	Internal evaluation of DS RER results.
Data access policy / Dissemination level (Confidential, only for members of the Consortium and the Commission Services) / Public	*Taking into account the monitoring times envisaged by the Project (24-month observation), personal data will be kept for a period of time not exceeding that necessary to achieve the purposes. After that period the data anonymized can be used freely from privacy limitations*
Data sharing, re-use and distribution (How?)	*The use of anonymized data will be decided within the scope of activage.org by data owner , LHA PR*
Embargo periods (if any)	*None*
Archiving and preservation (including storage and backup)	
Data storage (including backup): where? For how long?	*Data is owned by LHA PR, stored by Lepida on behalf of Region Emilia Romagna on regional secured servers.* *According to privacy policy, pseudo anonymized data are stored for a period of time that allow the analysis of it for the purpose of the project. After that period, deanonymization keys will be deleted and data can be used free of law limitations*

6.3.5.2 Continuation strategy

The deployed users meaning the patients at home for DS RER have been included in a detailed protocol approved by the Ethical Committee which has been defined the timing for their use. On the contrary, the medical doctors and specialists and other health professionals involved in the DS can still use the tools developed by ACTIVAGE and their integration with the Personal Electronic Health Record with the aim to recruit new patients and explore new use case for the monitoring of additional pathologies than the stroke. The emergency linked to the COVID-19 has pointed out that the digital tools can support in different activities but above all the monitoring at home of people in need of care. Thus, the innovation brought by the ACTIVAGE project is representing a verified field of knowledge to be further exploited by the LHA PR and the technical partners as the regional boards for emergency and crisis have been asking ideas for delivering services to support citizens and healthcare professionals in the Emilia-Romagna Region. Lastly, the participation of Lepida since the foundation of ACTIVAGE.org, will allow to contribute to the exploitation and expansion of the ACTIVAGE approach.

The Telco technology will play a central role in the success of the new approach promoting by ACTIVAGE. Through the qualified network of partners involved in the ACTIVAGE it is possible to create an ecosystem with the right skills and competences offering different elements as

- Data accessibility everywhere, from anywhere at anytime
- Enforcing remote patients monitoring at home
- Effective communication with caregiver and patients through digital tools

In particular WINDTRE is in the position to exploit the emerging opportunities using the outcome of the project and services already on the market. As Telco WINDTRE has the following targets: to guarantee (i) the effective communication with caregiver and patients through smart terminals; (ii) the possibility to improve the solution for real-time applications (like images and video transfer thanks to low latency); last but not least (iii) the support for effective and enriched analysis of patients thanks to vital parameters collected by remote monitoring systems.

Besides, according to the WINDTRE vision the ACTIVAGE's contributions refer other aspects: the solution offered by ACTIVAGE allows to guarantee access to care in a neutral way, both in urban and rural areas, for men and women regardless of other ethical factors, if any.

ACTIVAGE establish an ecosystem of digital responsibility in which the institutions define clear and shared rules for using digital services above all as far as regards the health sector: citizens are able to use the digital services in a secure and knowledgeable manner. ACTIVAGE offers a clear example of how the digital evolution can be transformed into an enabling factor for the creation of a more fair, secure, and sustainable smart communities. The completely connected world in which we are about to live will be potentially capable of reconciling the protection of natural resources with the improvement of quality of life. From smart homes to smart cities and smart grids, from the walls of the home to the city streets, the future is going to become part of every aspect of our lives, with enormous impacts in terms of health care and the protection of the global ecological balance. The solutions, some of which are already available, are numerous. ACTIVAGE tries to incorporate the improvement of quality of life offering the possibility to interpersonal connection; the value of this aspect is enormous and remains largely untapped. Last but not least, ACTIVAGE offers the opportunity to use the new method to cooperate and improve the acquisition of the new knowledge.

6.3.5.3 Replication strategy

Lepida, as coordinator of the DS RER, has got the mission to be the operational instrument of the Emilia-Romagna Region to plan, design and develop services to boost the digital transformation in the different public sectors. Therefore, based on this fact, the Emilia Romagna Government, as proposed by its ICT Committee and coherently with the pluriannual Plan for the ICT Development of the Regional Health Service, establishes the annual operational plan of activities to be realised by Lepida. This plan is related to the projects and services to be promoted and realised at regional level with the involvement of all regional healthcare organisations, namely Local Health Authorities. The infrastructures of Lepida (broadband networks, datacentres, IT services) can be used by all Lepida's members. In this context Lepida is promoting the replication of the ACTIVAGE solutions among the other members mainly to the activation of services based on the results of the ACTIVAGE experimentation. ACTIVAGE.org would support Lepida in this mission, as it will provide the opportunity to the Lepida's member LHAs, municipalities, public organisations for the provision of services to citizens) to contribute to the effective adoption of the proposed IoT certified solutions.

6.3.5.4 Scaling-up strategy

Lepida has positioned the ACTIVAGE project within the Digital Health Division that directs all the procedures for the implementation of the ICT services in the healthcare sector. The division has been working in the regional ICT boards that meet periodically over the years to make known the potentialities of ACTIVAGE and consolidate the results obtained to date in terms of technologies used and protection of privacy and security of the systems. Very recently contacts have been taken with the energy manager of the Municipality of Parma who is the local coordinator of the RUGGEDISED project. They are trying to integrate project solutions that can contribute to the digital transformation through the smart city concept. They are developing within the end of the year 2020 a masterplan with strategic actions to be implemented.

7 DS 5 GRC final report

7.1 DS Experiment report

The Greek pilot has been deployed in the Region of Attica through the participation of the Municipality of Metamorfosis (MM), it continues in the region of Central Greece by the "Digital Community of Central Greece S.A" - (DCCG /CitiesNet) participation, and then concludes in the Region of Central Macedonia through the involvement of the Municipality of Pilea-Hortiatis municipality (MPH).

7.1.1 User engagement report

Table 105: DS GRC Total users recruited per category

RUC	Municipality	Elderly	Informal caregiver	Formal caregiver	Other stakeholder
RUC 1	DCCG	114	93	6	
RUC 2	DCCG	44	0	5	10
RUC 1	MPH	109	77	2	
RUC 1	MM	83	67	1	
RUC 9	Mobility Scenario	518			
TOTAL		**868**	**237**	**14**	**10**

Table 106: DS GRC Total number of facilities confirmed

RUC	Municipality	Private homes	Personal environments	Shared room in senior facility	Healthcare/Daycare facility	Other spaces
RUC 1	DCCG	114				
RUC 2	DCCG	44			3	
RUC 1	MPH	109				
RUC 1	MM	83				
RUC 9	Mobility Scenario		518			2
TOTAL		**350**	**518**			**2**

7.1.2 IoT infrastructure deployment

Table 107: DS GRC distribution of installation per type of environment

RUC	Municipality	Private homes	Personal environments	Shared room in senior facility	Healthcare/Daycare facility	Other spaces
RUC 1	DCCG	114				
RUC 2	DCCG	27			3	
RUC 1	MPH	88				
RUC 1	MM	83				
RUC 9	Mobility Scenario		518			2
TOTAL		**312**	**518**		**3**	**2**

In RUC 1 all facilities were private homes. In each home 4 motion sensors, 1 door sensor, 1 raspberry and 1 panic button were installed

In RUC 9 the solution was provided in the personal environment of the users and 2 smart city installations (Bluetooth detectors in road, Cosmo shopping mall)

Table 108: DS GRC devices installed per category

RUC		Gateways	Environment sensors	Wearables	Health / Alarm devices	Communication devices	User interface devices
RUC 1	DCCG	114	570		114		
RUC 2	DCCG	30	0	0	30	30	3
RUC 1	MPH	88	440		88		
RUC 1	MM	83	415		83		
RUC 9	Mobility Scenario	1				1	518
TOTAL		**316**	**1425**		**315**	**31**	**521**

7.1.3 Experiment running report

7.1.3.1 Users participation

Table 109: DS GRC number and reasons of drop-offs.

Reasons for drop-offs	Number of drop-offs
Mostly due to health decline that lead to early hospitalization or even mortality	DCCG UC1 & UC3: there were 11 drop offs
1 patient due to privacy concerns, 1 patient due to anxiety related to device	DCCG UC2: 3 drop-offs

measurements and 1 patients due to network issues	
	Mobility Scenario: there were no drop-offs
	MPH had 7 drop offs. 4 of them left due to mortality and the 3 decided to leave the programme.
3 passed away, 2 no internet access anymore, 1 moved to another place, 1 not satisfied	7 drop offs in MM
TOTAL	28 totals drop-offs

Table 110: DS GRC number of users in operation by 30th of June.

RUC	Municipality	Elderly	Informal caregiver	Formal caregiver	Other stakeholder
RUC 1	DCCG	0			
RUC 2	DCCG	44		5	10
RUC 1	MPH	0			
RUC 1	MM	0			
RUC 9	Mobility Scenario	518			
TOTAL		**562**		**5**	**10**

DCCG UC1 & UC3 the un-instalment of all 114 facilities has been completed. There are currently 0 active users.

MPH has uninstalled all 88 facilities. There are currently 0 active users.

MM has uninstalled all 83 facilities. There are currently 0 active users.

7.1.3.2 Operational effectiveness

Table 111: DS GRC technical incidences received

RUC	Number of issues	Description of main issues experienced
RUC 1	DCCG	**Average response time to end-user requests/ inquiries (in hours)**: For DCCG UC1 & UC3 the health personnel appointed to monitor the smart houses was able to address any user request (e.g a panic button alert) almost immediately during office hours. **Effectiveness in incidents management (% of issues solved)**: For DCCG UC1 & UC3 most alerts were adequately addressed (95%).
RUC 2	DCCG	Only in one case network issues were reported
RUC 1	MPH	The alert of the panic button was immediately sending an email to the health professional who responded during the day (12

		hours) immediately by calling the elderly or his/her caregiver. When the mail was received at night the response was in the morning hours.
RUC 1	MM	The alert of the panic button was immediately sending an email to the health professional and relative.
RUC 9	Mobility Scenario	0
TOTAL		

7.1.3.3 Use case exchange report

Regarding the Use Case exchange scenario, in Central Greece the existing Use Case on IoT enabled Integrated Care for patients with Type 2 Diabetes Mellitus with comorbidities was expanded with the Use Case from Galicia Pilot site. The new Use Case includes a Clinical Decision Support System (CDSS) for an IoT telemonitor platform of patients with Hypertension. An example of the described scenario, the measurements taken an the assessment evaluation can be shown in Figure 65.

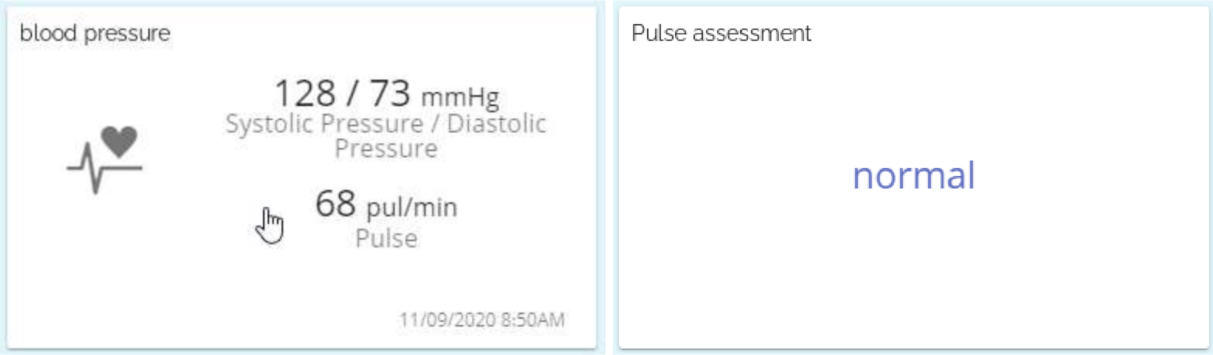
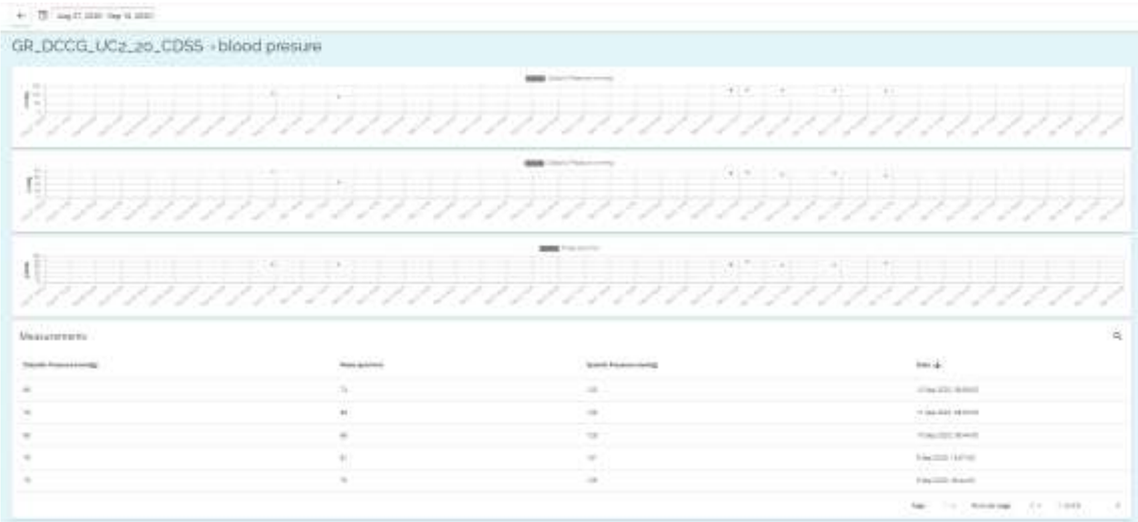


Figure 65. DS GRC UC exchange scenario. (Left: the measurement taken. Right: assessment evaluation.

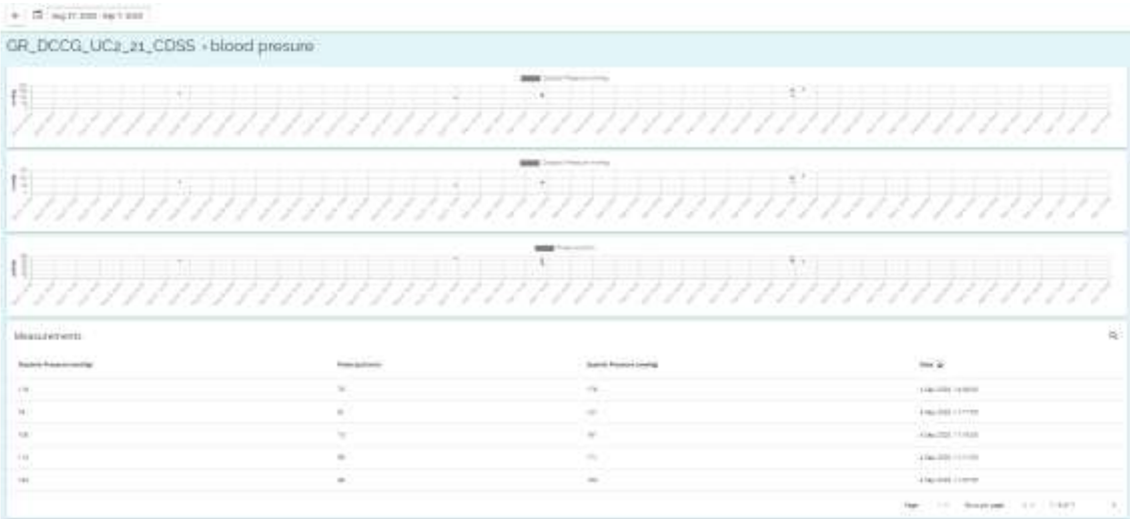
It is worth noting that the Use Case exchange scenario had to deal with certain challenges related to the COVID19 pandemic lockdown. Due to the strict measurements taken, the pilot of the UC exchange had to be postponed and the time left for a testing and evaluation of the new use case leveraging semantic translation provided by AIOTES was limited. Therefore, only a proof of concept study was conducted with 3 volunteer patients towards the end of summer 2020. The patients received a tele-BP device for testing, along with a raspberry Pi kit for connection with CERTH's ACTIVAGE platform. Finally, patients' acceptance scale was administered at the end of the Proof of Concept study.

Sample measurements, specifically blood pressure details (systolic pressure, diastolic pressure and pulse), taken from the 3 patients are presented in the screenshots of the ACTIVAGE platform below:

User 1:



User 2:



User 3:

Figure 66. DS GRC UC exchange scenario – sample measurements

Finally, the results for the UTAUT questionnaire are presented in Figure 67.

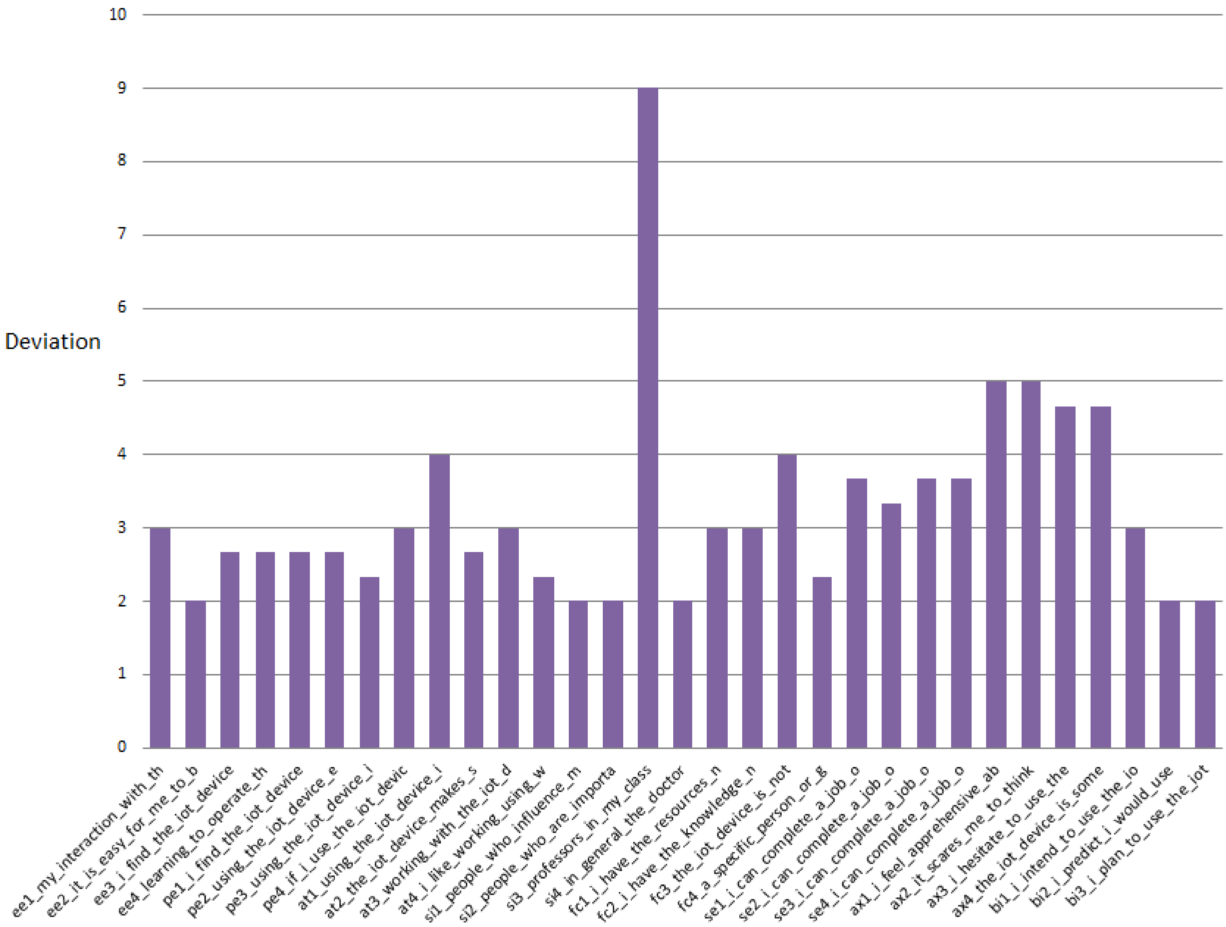


Figure 67. DS GRC Results of UTAUT questionnaire (X axis – questions, Y-axis – deviation).

7.1.3.4 Open Calls report

Regarding the new service supported by the Open Calls technical solutions, the wearable and the application MUVONE was selected https://www.muvone.com/en/

Figure 68. DS GRC Open Call selected application

Muvone is a wearable device specifically designed to help prevent osteoporosis.

Its small size and attractive design make it a friendly complement to take care of the elderly users' health intelligently, by delaying the onset of osteoporosis symptoms.

Muvone allows the daily checking of the physical activity in order to reach targets that are sufficient to help strengthen bones or how much sunlight a user needs to absorb enough vitamin D. In addition, the app provides recommendations so that the user can have diet rich in foods that can help prevent osteoporosis.

The technical and organizational aspects of the Muvone application integration had to deal with certain challenges. The software menu was not available in the Greek language and the diet recommendations did not include the Greek foods. In addition, the sunlight exposure measurements service was not available.

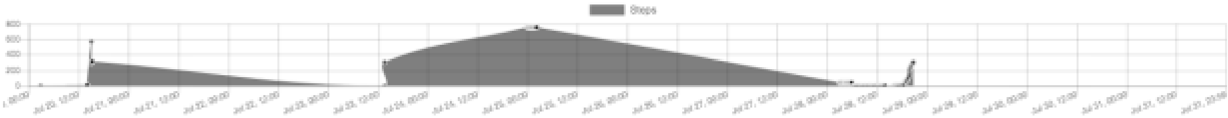
Moreover, in a more technical point of view, in order to connect with the AIoTES ecosystem, integration between the MUVONE's Cloud and a FIWARE-Based platform had to be achieved. Once the MUVONE's Cloud was connected to the FIWARE platform, semantical and syntactical translation needed to be carried out in order to transform from the FIWARE ontology to the AHA ontology, so any other platform compatible with the AHA ontology would be able to retrieve the data and transform it to its own ontology. This had been done with the upstream alignment developed by Secmotic and available in the repository of ACTIVAGE.

Furthermore, due to the COVID19 pandemic lockdown, the time left for a pilot testing of the new platform was limited. Therefore, only a proof of concept study was conducted with 4 patients towards the end of summer 2020. The patients received a Muvone device, along with a raspberry Pi kit for connection with CERTH's ACTIVAGE platform, at home for a period of about a month and the IoT platform recorded all available measurements (steps, impacts, movement (acceleration on X, Y, Z axis)). Also, a Health-Related Quality of the Life scale was administered at the base line and the end of the proof of concept study. A patients' acceptance scale was administered at the end of the proof of concept study.

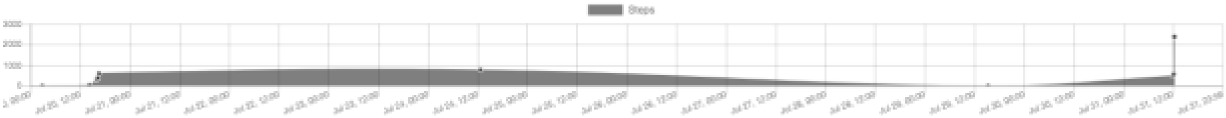
A sample of the measurements related to the users' activity (e.g. daily steps counting) of the 4 volunteers' patients is presented in the screenshots of the ACTIVAGE platform below:

User 1:

User 2:



User 3:



User 4:

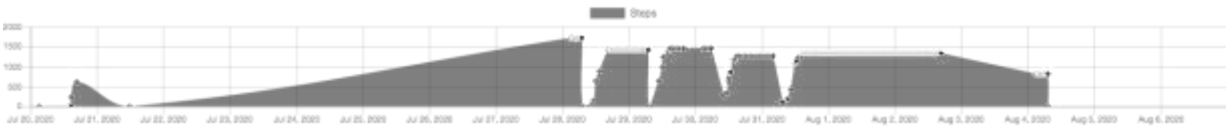


Figure 69. DS GRC Open call application user data examples

The results for the EQ5D questionnaire are presented in Figure 70.

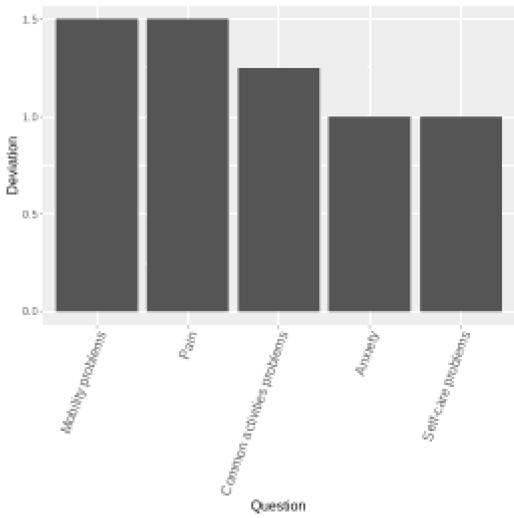


Figure 70. DS GRC – Open call - Results of EQ5D3L questionnaire (X axis – questions, Y-axis – deviation)

Finally, the results for the UTAUT questionnaire are presented in Figure 71.

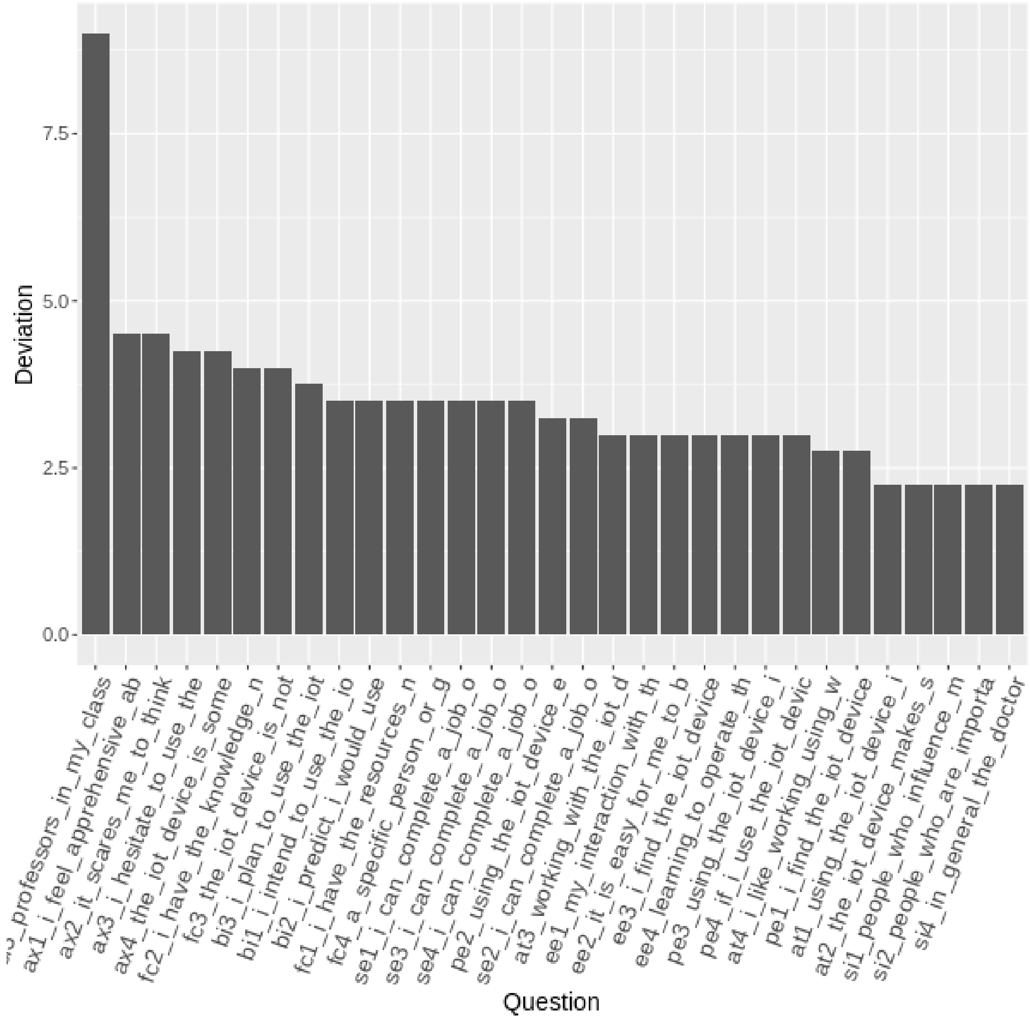


Figure 71. DS GRC – Open call results of UTAUT questionnaire (X axis – questions, Y-axis – deviation)

7.2 Local evaluation report

7.2.1 Goal of local evaluation: primary and secondary endpoints

The evaluation has been a continuous and systematic process, focused on the collected aspects of both the self-perception and quality of life of the older adult, and it has served to verify the achievements in terms of the proposed objectives.

The information collected from the different questionnaires has been reported monthly to WP6 and WP9. Moreover, the above-mentioned information has been uploaded to the ACTIVAGE information collection tool developed by the UPM (DS evaluation LSP dashboard).

7.2.2 Local KPI collected

7.2.2.1 Mobility scenario

For the purpose of the Mobility Scenario pilot the ACTIVAGE Safe Mobility Platform has been developed to provide older drivers with information both before and after their trips. Through the ACTIVAGE Safe Mobility Platform the following services are provided to the users:

- Trips Dashboard
- Personal Trips
- Traffic
- Routing

The use of the provided services aims to improve the mobility conditions of the older drivers in terms of comfort, safety and awareness towards sustainable urban mobility. The aforementioned factors are set as Key Performance Indicators.

In order to achieve this overall objective, the following specific objectives have been identified:

- **Impact on Comfort**

  Increased comfort of daily travel of drivers citizens through the provision of IoT-enabled info mobility services (baseline, intermediate, final evaluation).

- **Impact on Safety**

  Increased travel safety of older drivers (baseline, intermediate, final evaluation).

- **Impact on Awareness**

  Increased awareness towards sustainable urban mobility of older citizens (baseline, intermediate, final evaluation).

- **Impact on QoL**

  Improve the quality of life of the users (baseline, intermediate, final evaluation).

7.2.2.2 Smart Home scenario

Regarding the SmartHome scenario, which covers UC1 and UC3, the ACTIVAGE Monitoring Platform has been developed to provide healthcare providers and caregivers information about elderly living alone. This information includes behavioral and health-related monitoring by using data collected through the deployment of IoT sensor related to the physical activities of elderly people inside their homes. The data collected are fully anonymized and they are visually accessible only to the authorized healthcare provider and or caregivers of each user. Through the ACTIVAGE monitoring platform the following services are provided to the users:

Monitoring of movement inside the main rooms of the house

Monitoring of door status, which is used to determine whether the user has left the house and together with the movement status can be used as a warning of no movement.

Panic Button service, which is activated whenever the installed panic button is pressed.

Notification service, which is enabled whenever a certain “alarming” condition occurs. In that frame, a set of rules have been created, based on the behavioral habits of each specific user. The outcome of this service generates a platform notification, e-mail and in certain cases an SMS which is send to the authorized healthcare provider in case of the occurrence of an alarming behavior.

Visual Analysis and detection of abnormalities of the behavior of each user extracted from the data collected from the installed IoT devices included in the SmartHome scenario.

In order to achieve this overall objective, the following specific objectives have been identified:

- **Impact on QoL**

  Improve the quality of life of the older persons (baseline, intermediate, final evaluation).

  Assist the older persons in performing activities of daily living.

  Assist the caregivers in taking care of their relatives, with less effort.

  Increase the confidence of the older persons towards their abilities and the use of technology.

- **Impact on Awareness**

  Increase the awareness of the older persons about technologies that can help them in their everyday life.

7.2.3 Local evaluation protocol

7.2.3.1 Mobility scenario

The local evaluation protocol regarding DS-GRE Mobility Scenario is as follows:

When an older driver registers the ACTIVAGE Safe Mobility Platform, the following data is collected:

- Demographic data
- Quality of Life Questionnaire (EQ-5D-3L - baseline)
- Self Perception Questionnaire (SQP - baseline)
- Mobility related Questionnaire (baseline)

During the intermediate evaluation of the Mobility Scenario the following data is collected:

- Quality of Life Questionnaire (EQ-5D-3L – intermediate)
- Self Perception Questionnaire (SQP - intermediate)
- Mobility related Questionnaire (intermediate)

At the end of the pilot, the final evaluation is carried out:

- Quality of Life Questionnaire (EQ-5D-3L - final)
- Self Perception Questionnaire (SQP - final)
- Mobility related Questionnaire (final)

7.2.3.2 Smart Home scenario

The local evaluation protocol regarding the DS-GRE Smart Home scenario is as follows:

When an older person registers in the ACTIVAGE Smart Home Platform, the following data is collected:

- Demographic data

- Katz Index of Independence in Activities of Daily Living (ADL - baseline)
- Instrumental Activities of Daily Living scale (IADL - baseline)
- Falls Efficacy Scale – International (FES-I - baseline)
- Quality of Life Questionnaire (EQ-5D-3L – baseline)
- Carer Quality of Life (answered by caregivers) (CarerQoL - baseline)
- Self Perception Questionnaire (SQP – baseline)
- UCLA loneliness scale (UCLA – baseline)

During the intermediate evaluation of the Smart Home scenario, the following data is collected:

- Katz Index of Independence in Activities of Daily Living (ADL - intermediate)
- Instrumental Activities of Daily Living scale (IADL - intermediate)
- Quality of Life Questionnaire (EQ-5D-3L – intermediate)
- Carer Quality of Life (answered by caregivers) (CarerQoL - intermediate)
- Self Perception Questionnaire (SQP – intermediate)
- UCLA loneliness scale (UCLA – intermediate)
- Unified Theory of Acceptance and Use of Technology (UTAUT - intermediate)

At the end of the pilot, the final evaluation is carried out:

- Katz Index of Independence in Activities of Daily Living (ADL - final)
- Instrumental Activities of Daily Living scale (IADL - final)
- Falls Efficacy Scale – International (FES-I - final)
- Quality of Life Questionnaire (EQ-5D-3L – final)
- Carer Quality of Life (answered by caregivers) (CarerQoL - final)
- Self Perception Questionnaire (SQP – final)
- UCLA loneliness scale (UCLA – final)
- Unified Theory of Acceptance and Use of Technology (UTAUT - final)

7.2.3.3 Integrated Care scenario

The IoT Telehealth service was at home and it aims to monitor vital parameters of the person.

In terms of interaction, this LUC requires the standard intervention of the elderly user, since after the measurement of the vital parameter, e.g. BP, glucose, all the data related to its behaviour is collected in a transparent way by the IoT infrastructure deployed in the home. Then the information is analysed in the background and a set of results is produced. These results can be seen by the health professionals. The aim of the care plan was a coordinated IoT supported care service for elderly patients with Type 2 Diabetes Mellitus and comorbidities (e.g. Hypertension)

The system in some specific situations could inform the user about a certain trend that can improve his/her health status.

In order to evaluate the service and unmasked, pragmatic RCT study was designed. The intervention group was the elderly patients that received the IoT home service, while the control group included the standard care service. The follow up of the study per patient was set on 6 months.

The inclusion criteria were defined based on the patient characteristics of Group1, of the "Treatment of Diabetes in Older Adults: An Endocrine Society* Clinical Practice Guideline – 2019". (Figure 72)

Overall Health Category		Group 1: Good Health	Group 2: Intermediate Health	Group 3: Poor Health
Patient characteristics		No comorbidities **or** 1-2 non-diabetes chronic illnesses* **and** No ADL€ impairments and ≤1 IADL impairment	3 or more non-diabetes chronic illnesses* **and/or** Any one of the following: mild cognitive impairment or early dementia; ≥2 IADL impairments	Any **one** of the following: End-stage medical condition(s)**; Moderate to severe dementia; ≥2 ADL impairments; Residence in a long-term nursing facility
		Reasonable glucose target ranges and HbA1c by group — Shared decision-making: individualized goal may be lower or higher		
Use of drugs that may cause hypoglycemia (e.g., insulin, sulfonylurea, glinides)	No	Fasting: 90-130 mg/dL Bedtime: 90-150 mg/dL <7.5%	Fasting: 90-150 mg/dL Bedtime: 100-180 mg/dL <8%	Fasting: 100-180 mg/dL Bedtime: 110-200 mg/dL <8.5%¥
	Yes£	Fasting: 90-150 mg/dL Bedtime: 100-180 mg/dL ≥7.0 and <7.5%	Fasting: 100-150 mg/dL Bedtime: 150-180 mg/dL ≥7.5 and <8.0%	Fasting: 100-180 mg/dL Bedtime: 150-250 mg/dL ≥8.0 and <8.5%¥

Note: While glucose targets are highlighted for each group in this framework, overall health categories can also be considered for other treatment goals such as blood pressure and dyslipidemia. See Appendix A on "How to use the conceptual framework."

* Coexisting chronic illnesses may include osteoarthritis, hypertension, chronic kidney disease stages 1-3, or stroke, among others.

**One or more chronic illnesses with limited treatments and reduced life expectancy. These include metastatic cancer, oxygen-dependent lung disease, end-stage kidney disease requiring dialysis, and advanced heart failure.

£ As long as achievable without clinically significant hypoglycemia; otherwise, higher glucose targets may be appropriate. Note also that the lower HbA1c boundary was included as data suggesting increased hypoglycemia and mortality risk at lower HbA1c levels are strongest in the setting of insulin use. However, the lower boundary should not reduce vigilance for detailed hypoglycemia assessment.

¥ HbA1c of 8.5% correlates with an average glucose level of approximately 200 mg/dL. Higher targets than this may result in glycosuria, dehydration, hyperglycemic crisis and poor wound healing.

€ ADLs include bathing, dressing, eating, toileting, and transferring, and IADLs include preparing meals, shopping, managing money, using the telephone, and managing medications.

Includes data from Cigolle CT, Kabeto MU, Lee PG, Blaum CS. Clinical complexity and mortality in middle-aged and older adults with diabetes. J Gerontol A Biol Sci Med Sci 2012; 67(12):1313-1320 (39); and from Kirkman MS, Jones Briscoe V, Clark N, et al. Diabetes in older adults. Diabetes Care 2012; 35(12): 2650-2664 (40).

Abbreviations: IADL, instrumental activity of daily living; ADL, activity of daily living; SU, sulfonylurea.

Figure 72: DS GRC - Conceptual Framework for Considering Overall Health and Patient Values in Determining Clinical Targets in Adults Aged 65 years and Older

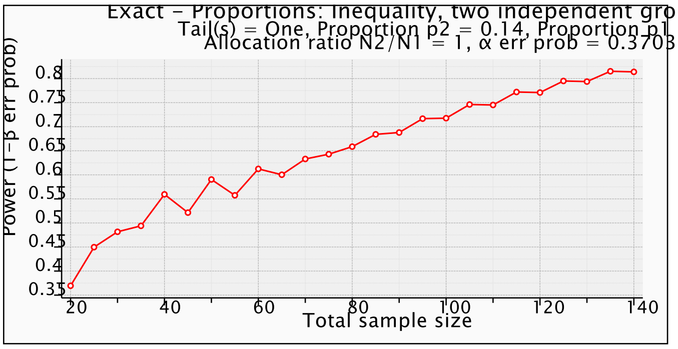


Figure 73: DS GRC – RUC 2 Power Analysis for sample size

Goal of local evaluation: primary and secondary endpoints

Primary outcome

The primary outcome was the effect of the effect on the HbA1c of the patients (local KPI). The target was the reduction of the HbA1c from over 7.5 to 7. HbA1c was measured at the beginning

The sample calculation of the study (Figure 73) was calculated based on study: The Lim, S., Kang, S. M., Shin, H., Lee, H. J., Yoon, J. W., Yu, S. H., … Jang, H. C. (2011). Improved glycemic control without hypoglycemia in elderly diabetic patients using the ubiquitous healthcare service, a new medical information system. *Diabetes Care*, *34*(2), 308–313. https://doi.org/10.2337/dc10-1447

For a superiority trial design, the sample was calculated to 130 patients (65 per group, power 80%)

Secondary outcomes

Health Related Quality of Life -HRQOL (based on EQ-5D scale ,version validated in Greek) (Global KPI).

Local KPIs

Disease specific HRQOL (PAID scale validated in Greek)

Patients Acceptance/Satisfaction with the IoT telehealth service (SUTAQ scale of WSD trial n UK)

Cost Utility Analysis (CUA) of the IoT telehealth Service. A piggy-back trial design was used for the economic analysis, which was embedded in a clinical trial. Additional economic cost and outcome data were collected and analyzed, but the trial itself was designed according to clinical issues.

7.2.4 Analysis of results

7.2.4.1 Mobility scenario

Through the Mobility related Questionnaires information related to the following KPIs collected by the registered users of the ACTIVAGE Safe Mobility Platform.

- Increased comfort of daily travel of older citizens through the provision of IoT-enabled info mobility services
- Increased travel safety of older citizens
- Increased awareness towards sustainable urban mobility of older citizens

In data:

- 518 sociodemographic data have been collected from older drivers.
- 518 Quality of Life questionnaires have been carried out through the global questionnaire defined in ACTIVAGE (ACTIVAGE Global Questionnaire) to older drivers.
- 518 Quality of Life (QOL) questionnaires (EQ-5D-3L) have been collected from older drivers.
- 1554 Mobility related Questionnaires have been collected from older drivers.

The evaluation of the KPIs in the Mobility Scenario demonstrates the benefits of the ACTIVAGE Safe Mobility Platform, in terms of comfort, safety, awareness and quality of life. The results of the Mobility Scenario KPIs have shown that ACTIVAGE has improved the perceived comfort and safety, the awareness regarding sustainable urban mobility and the quality of life. The results regarding the perceived comfort of the older drivers before the use of the ACTIVAGE Safe Mobility Platform and during the use of the ACTIVAGE Safe Mobility Platform depicts below.

Figure 74: DS GRC – RUC 9 results for comfort of older drivers

Moreover, the results regarding the perceived safety of the older drivers before the use of the ACTIVAGE Safe Mobility Platform and during the use of the ACTIVAGE Safe Mobility Platform shows below.

Figure 75: DS GRC – RUC 9 results for safety of older drivers

In addition, the results regarding the awareness towards sustainable urban mobility of older citizens before the use of the ACTIVAGE Safe Mobility Platform and during the use of the ACTIVAGE Safe Mobility Platform represents below.

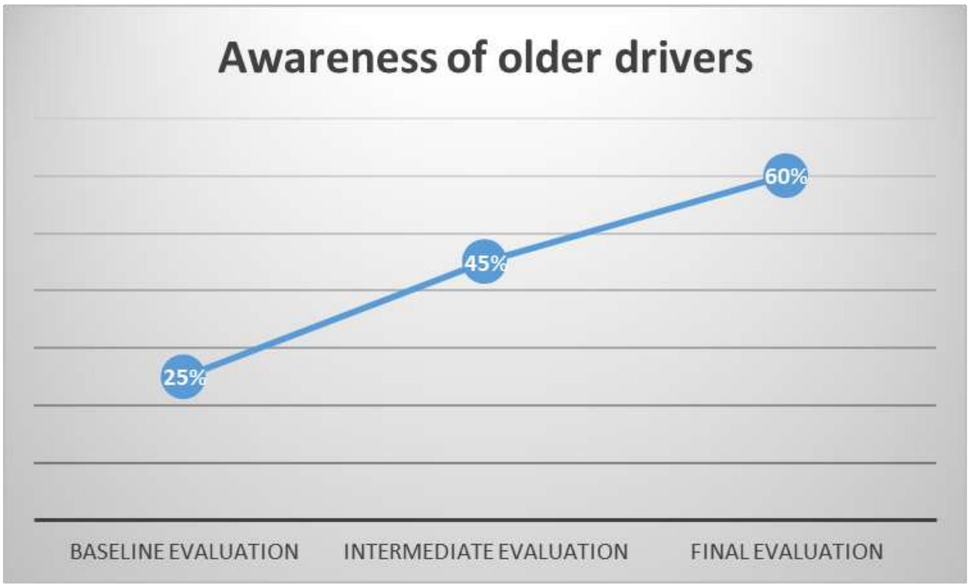


Figure 76: DS GRC – RUC 9 results for awareness of older drivers

Finally, the increase of the quality of life of older drivers before the use of the ACTIVAGE Safe Mobility Platform and during the use of the ACTIVAGE Safe Mobility Platform shows below.

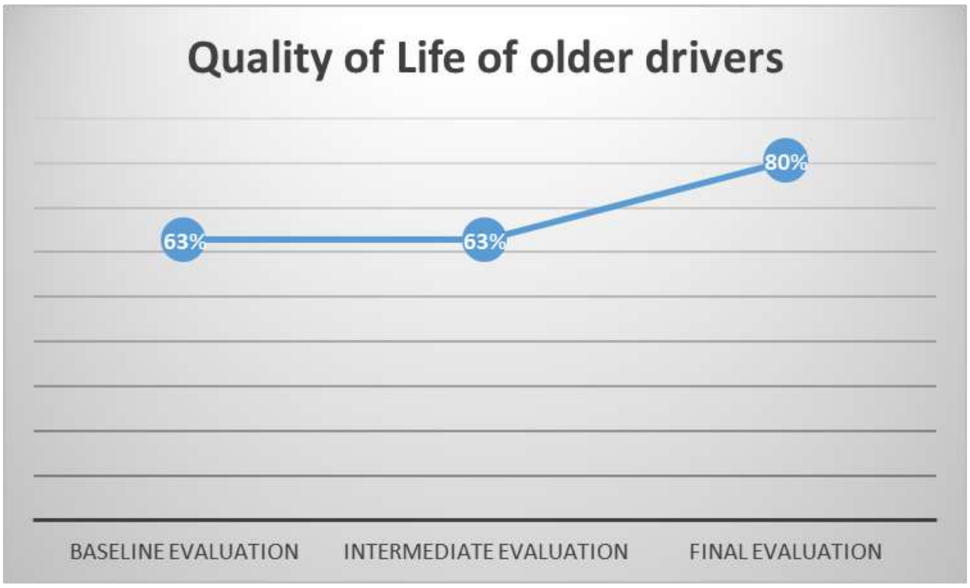


Figure 77: DS GRC – RUC 9 results for quality of life of older drivers

During the execution of the pilot, there were no dropouts.

7.2.4.2 Smart Home scenario

User participation

At first, we look at some characteristics of the users that participated in the studies. In total, 432 users (houses) participated in the Greek DS, across the following municipalities:

- Municipality of Pylaia/Hortiatis
- Municipality of Metamorfosi
- The Digital Cities of Central Greece (DCCG) cluster, which consists of the following municipalities:
    - Trikala
    - Karditsa
    - Larissa
    - Veroia
    - Katerini
    - Grevena

The distribution of users across the municipalities can be seen in Figure 78. Most of the houses were located in the municipalities of Pylaia/Hortiatis and Metamorfosi, although collectively, the municipalities of DCCG contain a similar number of users.

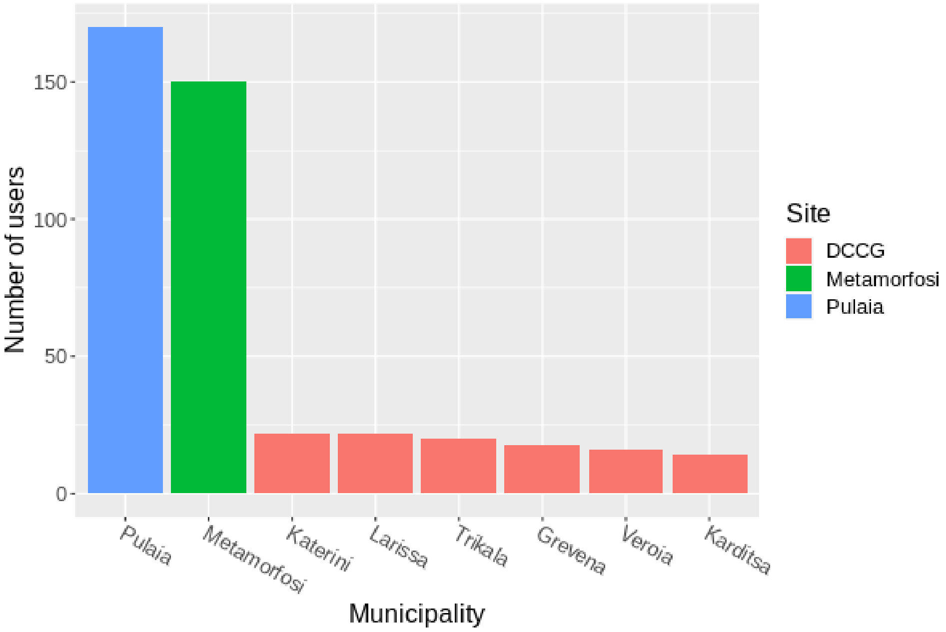


Figure 78: DS GRC Number of users per municipality.

The geographical distribution of the users in the municipalities can be seen in Figure 79. The participating municipalities cover a large part of northern and central Greece.

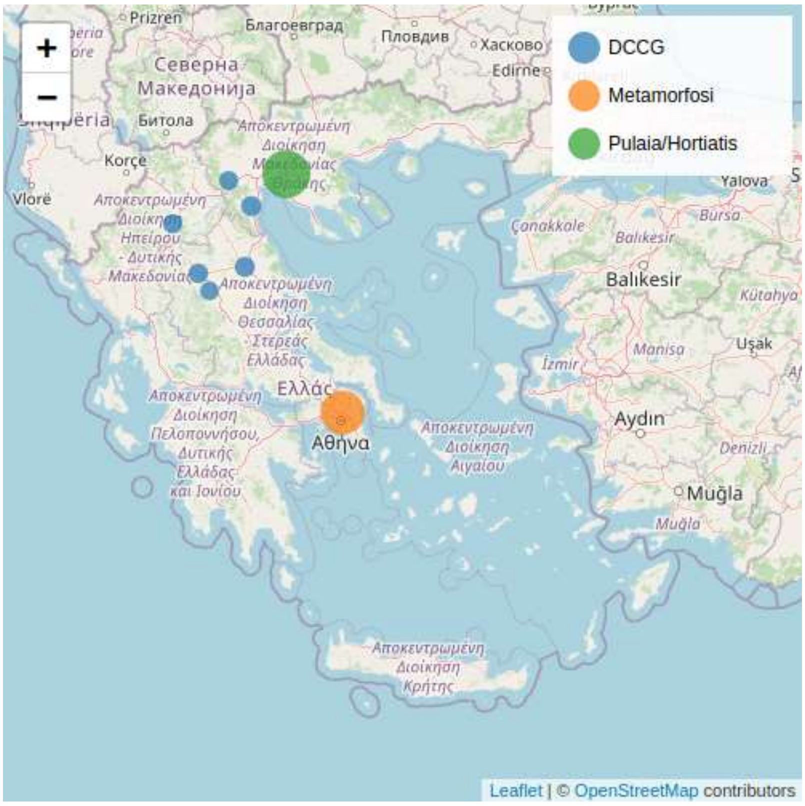


Figure 79: DS GRC Geographical distribution of users across the municipalities.

Not all users continued participating until the end of the pilots. About 8% of the involved users terminated participation after the midterm evaluation, as shown in Figure 80. The reasons for early termination included death, technical problems (such as connection issues that hindered further participation), dissatisfaction by the users (e.g. being annoyed by the presence of sensors), change of residence, and hospitalization. The number of users terminating participation due to the above reasons can be seen in Figure 81.

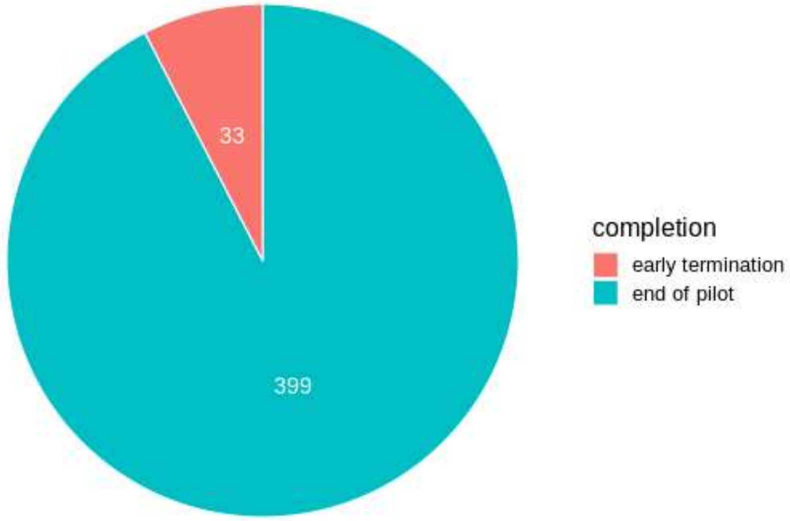


Figure 80: DS GRC Proportion of early terminating users.

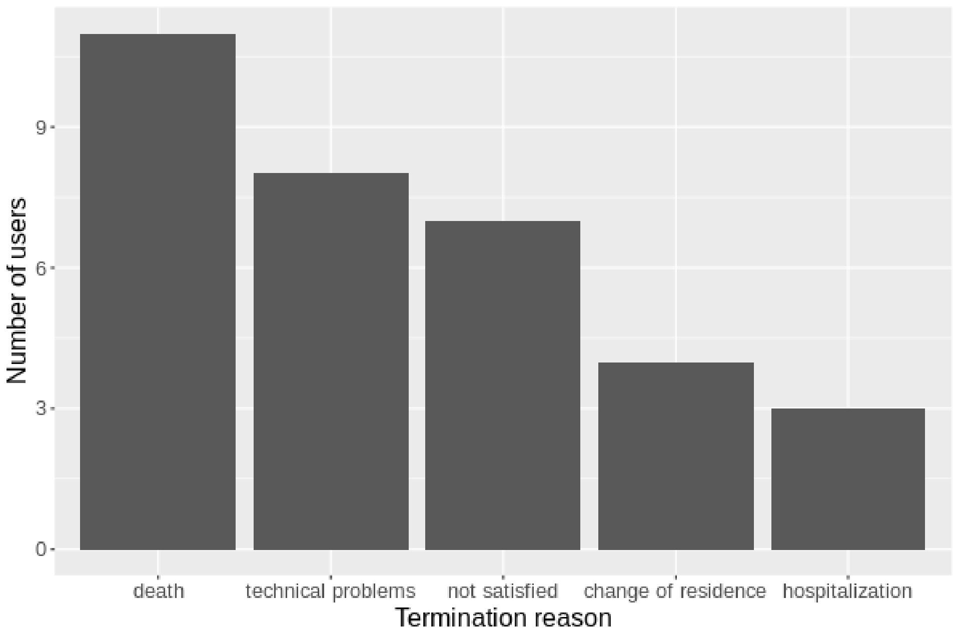


Figure 81: DS GRC Reasons for early termination of user participation.

It has to be highlighted that due to the advanced age of most of the users most of the drop outs had to do with the fact that their health declined, thus some of them had to be hospitalized or move in with their children, whereas some of them died due to chronic health issues.

User characteristics

The age distribution of the participating users can be seen in Figure 82. The average age was about 71 years old. Most participating users were between 40 and 98 years old, with the central 90% percentile ranging between 47 and 90 years old. The DCCG users were slightly older on average, with a mean of 79 years old and a 90% percentile between 66 and 90 years old.

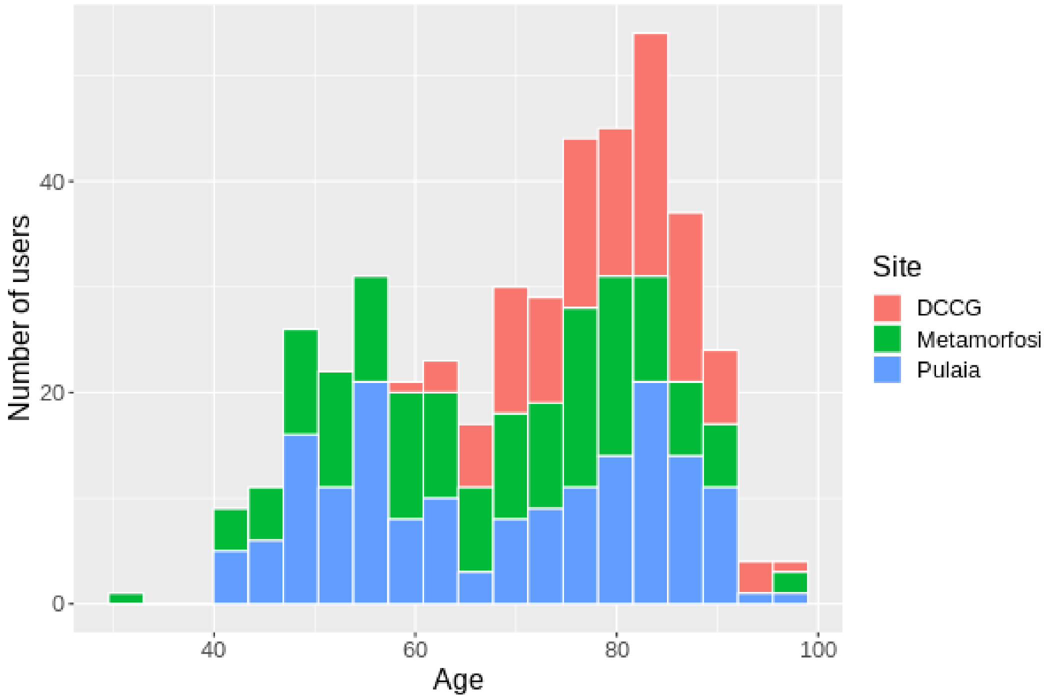


Figure 82: DS GRC Age distribution of users in the participating municipalities.

The gender distribution of the users per municipality can be seen in Figure 83. In total, 250 women and 182 men participated, although the ratio of women over men varied across the municipalities.

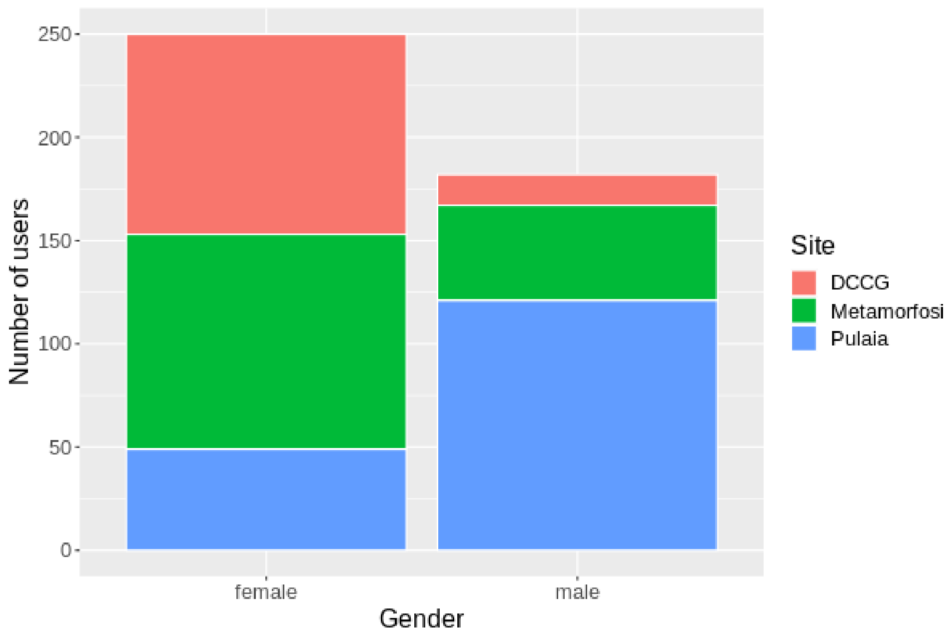


Figure 83: DS GRC Gender distribution per municipality.

Most users had a rather basic experience with technology, with only a few having a more advanced experience, as can be seen in Figure 84.

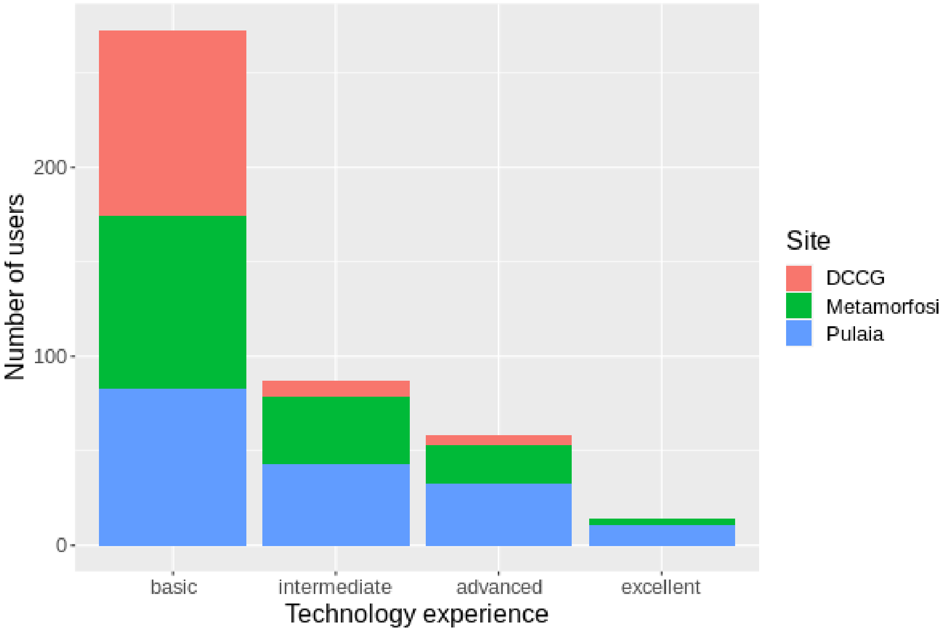


Figure 84: DS GRC Technology experience levels across participating users.

Comparison across evaluation phases

The evaluation took place in three phases:

- the baseline phase, at the start of the pilot, before the usage of the ACTIVAGE system;
- the intermediate phase, at the middle of the pilot;
- the final phase, at the end of the pilot.

A number of questionnaires were provided to the users at the above phases, to evaluate the system's usability, usefulness and impact on the lives of the individual users.

With regard to the impact of the system to the lives of the individuals, the following indices have been used:

- The Katz Index of Independence in Activities of Daily Living (ADL)
- The Instrumental Activities of Daily Living scale (IADL)
- The Falls Efficacy Scale – International (FES-I)

The ADL and IADL scores measure the independence of a person from other while performing activities of daily living. The scores result from summing the answers to relevant questionnaires, with a maximum of 6 and 8 for ADL and IADL, respectively. The larger the score, the more independent the user is in performing activities. Small values show that the user depends a lot in help from caregivers.

The FES-I score measure the self-estimated risk of fall during various activities. It is also the sum of the answers to several related questions, with a maximum total value of 28. Large values of the score mean that the user has increased risk or fear of falling.

The average values of the ADL, IADL and FES-I scores across all users at the three phases of the pilot are shown in Figure 85, Figure 86 and Figure 87, respectively. The FES-I value was only measured at the baseline and final phases, so there is no value for the intermediate phase.

The IADL and FES-I scores showed a slight increase and a decrease, respectively, during the pilot, suggesting a possible positive impact of the use of the ACTIVAGE system in the performance of activities of daily living and perception of danger of falls, respectively. The ADL score did not show much variation during the pilot, with even a very slight decrease at the final phase, suggesting no impact as measured by the ADL score.

This was an expected outcome because ADL measures changes that have to do with major declines in individuals' ability to take care of themselves, thus it was more or less expected not to show major differences among the different phases. Regarding IADL and FES-I results they may indicate that many users felt more confident and secure via the ACTIVAGE service in relation to their everyday activities and the fact that they could reach for help via the panic button.

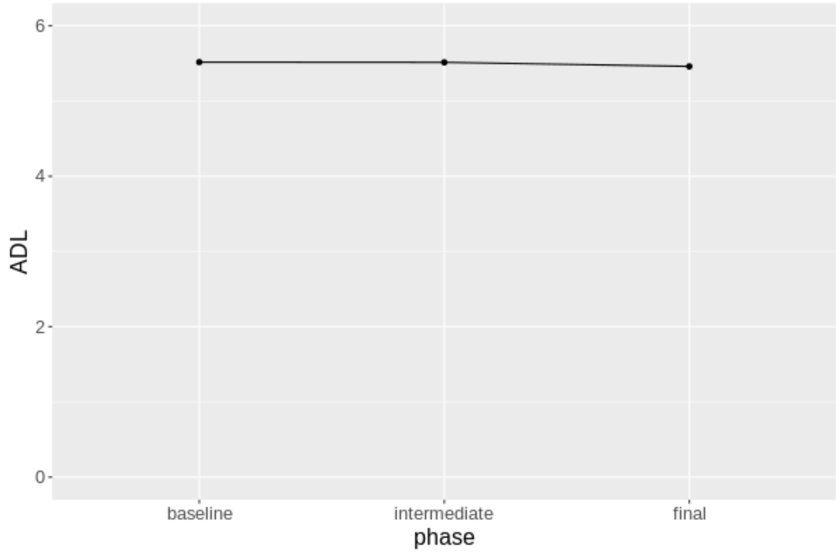


Figure 85: DS GRC Average value of ADL at the different phases of the pilot.

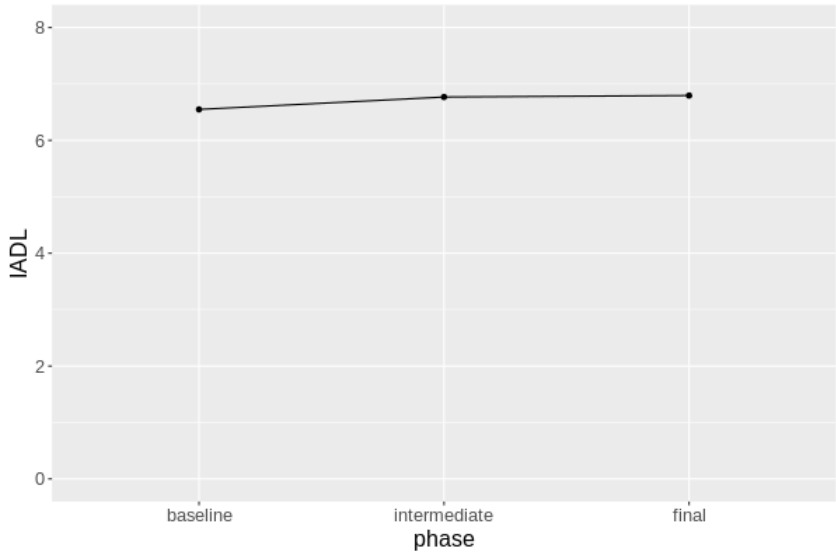


Figure 86: DS GRC Average value of IADL at the different phases of the pilot.

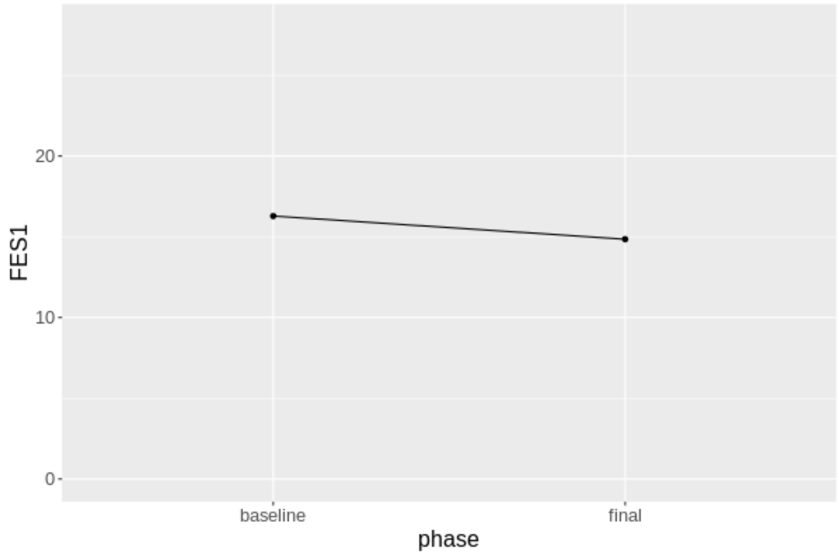


Figure 87: Average value of FES-I at the different phases of the pilot.

To measure the statistical significance of the detected changes above, we have performed a Student's t-test for each of the ADL, IADL and FES-I scores, for comparing the mean values of the scores between the baseline and the final phases. In each test, the null hypothesis was that the mean value does not change across phases, while the alternative hypothesis that the mean value was higher (for the ADL and IADL scores) or smaller (for the FES-I score) at the final phase, compared to the baseline phase. The results of the t-tests are shown below.

Table 112: DS GRC result of t-test for smart home scenario

Score	Alternative hypothesis	p-value
ADL	The mean value is larger at the final phase compared to the baseline phase.	0.749
IADL	The mean value is larger at the final phase compared to the baseline phase.	**0.038**
FES-I	The mean value is smaller at the final phase compared to the baseline phase.	**0.007**

Of the three scores studied, the IADL and FES-I scores showed a statistically significant amount of change between the baseline and the final phases ($p < 0.05$). This suggests a positive impact of the ACTIVAGE system to the users' performance of activities of daily living and their perception of risk of falling. At the final phase, after the use of the ACTIVAGE system, the users felt that they could perform activities better and with a lower risk of falling compared to the baseline phase, before the system had been used.

However, no statistically significant outcome has been acquired for the ADL score. The very high p-value for this score is expected, since the observed slight change is in the opposite direction than the alternative hypothesis (i.e. a smaller ADL value is observed at the final phase, compared to the baseline). Considering the opposite alternative hypothesis for this case, i.e. that the mean ADL value at the final phase is smaller than at the baseline phase still results in a large p-value ($p = 0.251$), meaning that we can neither deduce that the ADL score drops during the pilot. The results for ADL suggest that a larger amount of data would be necessary to reach a statistically significant result, for the observed effect size.

A cross-phase comparison has also been performed for each of the quality of living-related questionnaires answered by the users. The following questionnaires were administered to the users:

- EQ5D3L
- CarerQoL (answered by the caregivers)
- SPQ
- UCLA
- UTAUT

For each of the questionnaires, at each phase, the average value of the answers to each question was computed, and then the deviation of each average between the final and baseline phase was computed (when an intermediate phase was also available, the deviation was defined as the mean of the final and intermediate phases minus the baseline phase). The deviation may be positive or negative for each question, but the questions have either positive or negative affect, depending on the questionnaire. Thus, a positive deviation in one questionnaire may show a positive progress for the user, while a in another questionnaire a negative progress. For this reason, the bars in the charts to follow are coloured based on whether the impact to the user was positive (blue bars) or negative (red bars).

A comparison of the EQ5D3L questionnaire is shown in Figure 88. We can see that, on one hand, the users deteriorated in terms of anxiety or self-care, while they had positive progress regarding common activities, mobility and pain.

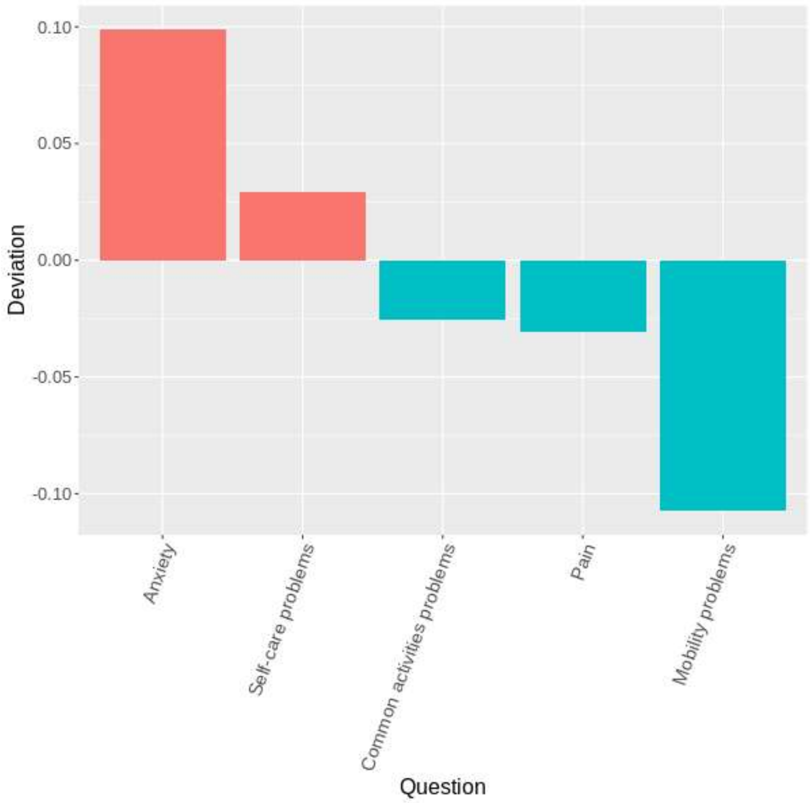


Figure 88: DS GRC Deviations of average scores in the EQ5D3L questions compared to the baseline in smart home scenario.

A similar comparison of the results of the CarerQoL questionnaire across the three phases of the pilot is shown in Figure 89. As it is inferred from this analysis caregivers felt more supported in taking care of the elderly due to the ACTIVAGE service, showing an increase in care satisfaction altogether. Overall, the impact was positive for most questions.

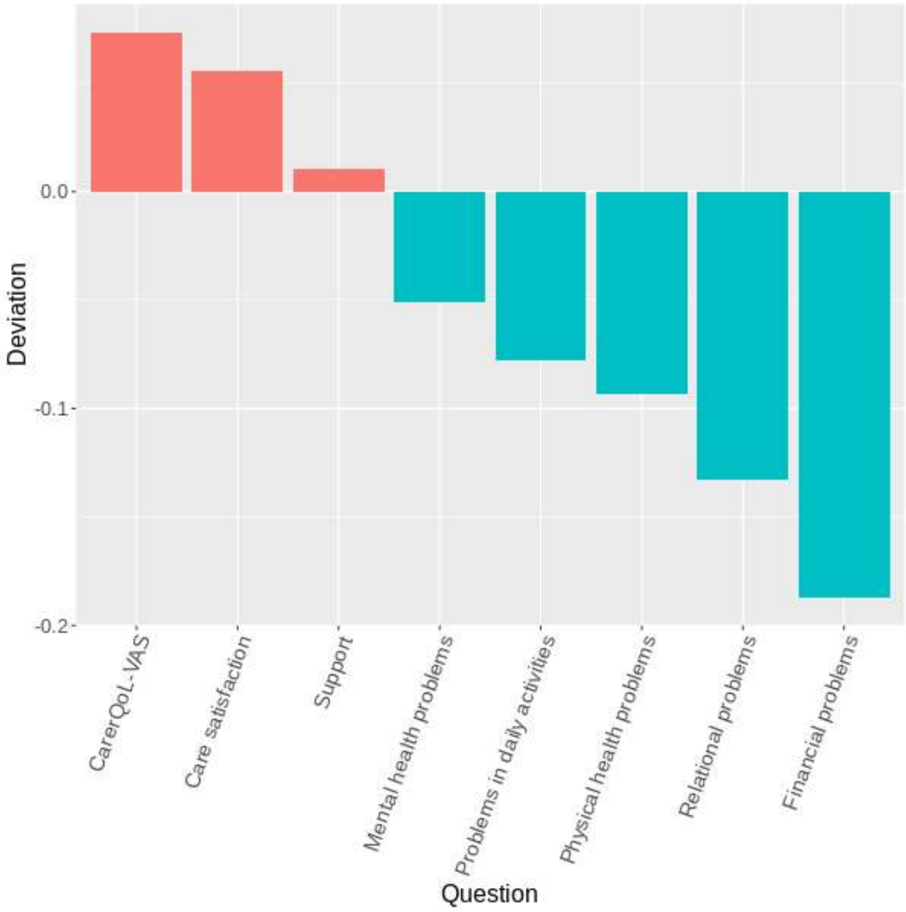


Figure 89: DS GRC Deviations of average scores in the CarerQoL questions compared to the baseline for smart home scenario.

The corresponding diagram for the SQP questionnaire is shown in Figure 90. We can see that the impact was positive for all questions, showing that the user self-perception of quality of life and use of technology was more positive at the end.

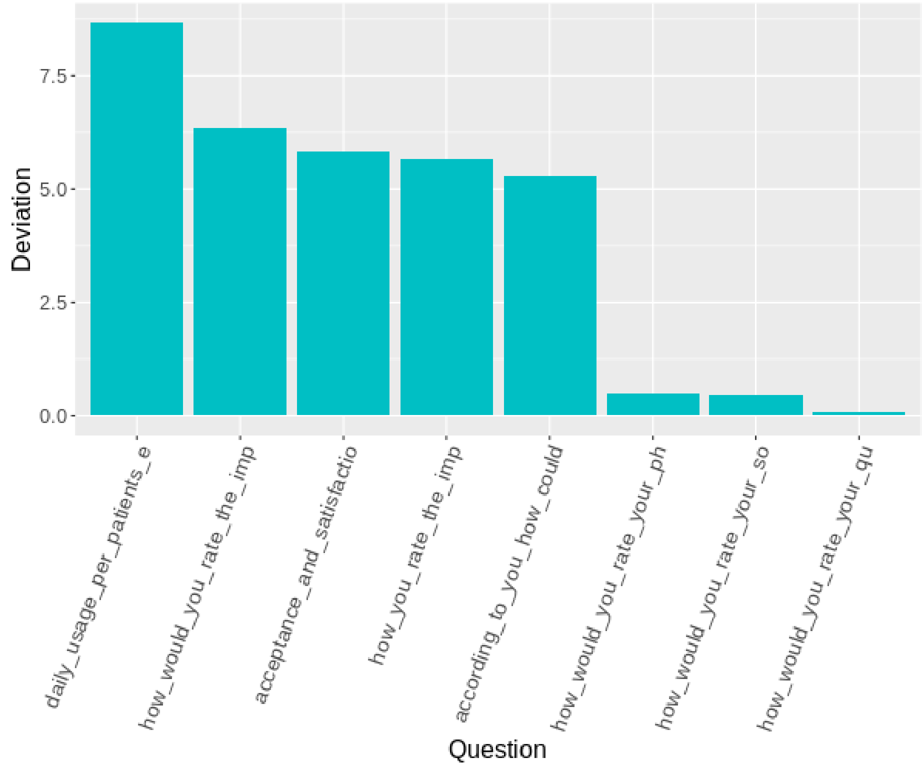


Figure 90: DS GRC Deviations of average scores in the SPQ questions compared to the baseline in smart home scenario.

The results for the UCLA questionnaire are shown in Figure 91. Here, the impact seems to be negative for most of the questions, indicating that the users felt lonelier after the use of the system.

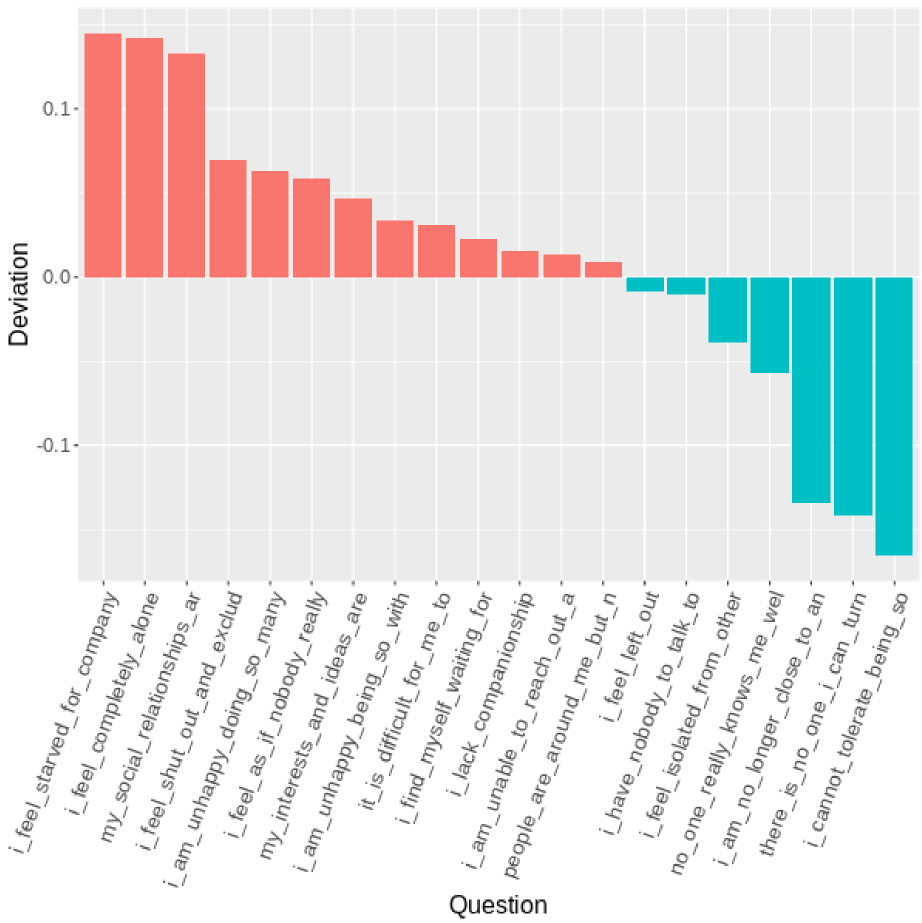


Figure 91: DS GRC Deviations of average scores in the UCLA questions compared to the baseline for smart home scenario.

Finally, the results for the UTAUT questionnaire are presented in Figure 92. Most of the answers were more positive at the end than at the beginning of the pilot, although for those questions that were more negative, the effect was much larger. At the end of the pilot, the users felt less fear in using the introduced technologies, although they express interest for the effectiveness improvement of the provided system.

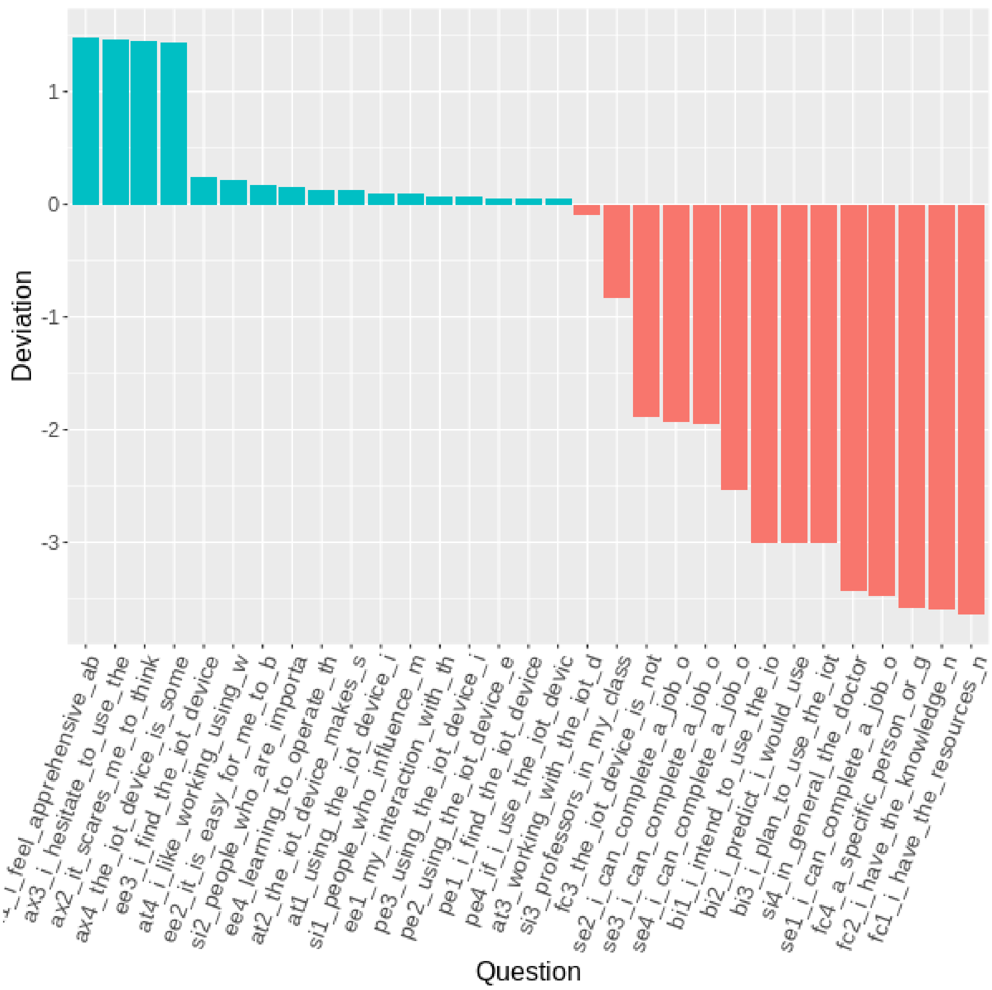


Figure 92: DS GRC Deviations of average scores in the UTAUT questions compared to the baseline.

7.2.4.3 Integrated Care scenario

Analysis of results

Due to the delay in the public procurement of the equipment and the lock down due to the COVID19 pandemic, the recruitment of the patients did not reach the target (24 patients in the control group and 19 in the intervention group). The clinical study is considered underpowered and therefore a conclusion regarding the primary outcome cannot be reached, as far as the superiority trial design is concerned. Ancillary analysis regarding the noninferiority trial design could be considered, however.

In Table 113, the demographics of the patients recruited are presented. No statistically significant differences in all cases, therefore the randomization of the study is considered successful.

Table 113: DS GRC – RUC 2 Demographics *(no statistically significant differences in all cases)*

		Group				
		Control		Case		
		Count	Column N %	Count	Column N %	p-values
	Elementary	20	83,3%	10	52,6%	0,081*

Educational level of the elderly	High school	3	12,5%	7	36,8%	
	Higher education	1	4,2%	2	10,5%	
Previous experience with Technology of the elderly	Basic	21	87,5%	15	78,9%	0,385*
	Intermediate	2	8,3%	2	10,5%	
	Advanced	1	4,2%	0	0,0%	
	Excellent	0	0,0%	2	10,5%	
Sex	Male	16	66,7%	10	52,6%	0,350**
	Female	8	33,3%	9	47,4%	
Live alone at home	Yes	1	4,2%	2	10,5%	0,575*
	No	23	95,8%	17	89,5%	
Assossiated relatives	Yes	23	95,8%	17	89,5%	0,575*
	No	1	4,2%	2	10,5%	
Children	Yes	1	4,2%	4	21,1%	0,153*
	No	23	95,8%	15	78,9%	
Spouse/ Partner	Yes	14	58,3%	12	63,2%	0,748**
	No	10	41,7%	7	36,8%	
Other type ICG	Yes	0	0,0%	0	0,0%	-
	No	24	100,0%	19	100,0%	

*Fisher's exact test, **Pearson Chi Square test

Group Statistics

	Group	N	Mean	Std. Deviation	Std. Error Mean	P value
Age	Control	24	71,88	4,656	,950	0,769
	Case	19	71,32	7,674	1,761	

1 Primary outcome

HbA1c: Statistically significant differences only at the intermediate measurement, where lower levels are observed for the group of cases.

Table 114: DS GRC – RUC 2 primary outcome results

Group Statistics

	Group	N	Mean	Std. Deviation	Std. Error Mean	p-value
HbA1c at baseline	Control	22	7,873	,7923	,1689	0,361*
	Case	20	7,655	,7280	,1628	
HbA1c intermediate	Control	13	7,585	,7267	,2015	0,026*
	Case	13	7,031	,4250	,1179	
HbA1c final	Control	7	7,129	,2928	,1107	0,321*
	Case	11	6,882	,5879	,1773	

*Independent Samples T test

2 Secondary outcomes

Health Related Quality of Life -HRQOL (based on EQ-5D scale, version validated in Greek) **(Global KPI).**

EQ 5D: no statistically significant differences in all cases

Table 115: DS GRC – RUC 2 secondary outcomes results

		Group				
		Control		Case		
		Count	Column N %	Count	Column N %	p- value
EQ5D Mobility	No problems	11	45,8%	6	31,6%	0,492*
	Some problems	8	33,3%	10	52,6%	
	Extreme problems	5	20,8%	3	15,8%	
EQ5D Self-care	No problems	14	58,3%	10	52,6%	0,643*
	Some problems	10	41,7%	8	42,1%	
	Extreme problems	0	0,0%	1	5,3%	
EQ5D Activity	No problems	15	62,5%	11	57,9%	1,000*
	Some problems	7	29,2%	6	31,6%	
	Extreme problems	2	8,3%	2	10,5%	
EQ5D Pain	No problems	17	70,8%	12	63,2%	0,594**
	Some problems	7	29,2%	7	36,8%	
	Extreme problems	0	0,0%	0	0,0%	
EQ5D Anxiety	No problems	7	29,2%	5	26,3%	0,904**
	Some problems	11	45,8%	10	52,6%	
	Extreme problems	6	25,0%	4	21,1%	

*Fisher's exact test, **Pearson Chi Square test

Group Statistics

	Group	N	Mean	Std. Deviation	Std. Error Mean	p- value
EQ5D VAS	Control	24	85,21	8,403	1,715	0,648*
	Case	19	86,32	7,040	1,615	

*Independent Samples T test

3 Local KPIs

Disease specific HRQOL (PAID scale validated in Greek)

PAID: no statistically significant differences in all cases

Table 116: DS GRC – RUC 2 PAID Group Statistics

	Group	N	Mean	Std. Deviation	Std. Error Mean	p- value
PAID START	Control	23	16,9022	12,43660	2,59321	0,275*
	Case	20	21,4375	14,35153	3,20910	

*Independent Samples T test

	Group	N	Mean	Std. Deviation	Std. Error Mean	p- value
PAID end	Control	16	15,0000	8,70823	2,17706	0,053
	Case	11	26,8182	17,06938	5,14661	

*Independent Samples T test

Patients Acceptance/Satisfaction with the IoT telehealth service (SUTAQ scale of WSD trial in UK)

SUTAQ scale scores (administration at the end of the follow up of the patients in the IoT Telehealth study).

Table 117: DS GRC – RUC 2 SUTAQ Descriptive Statistics

	N	Minimum	Maximum	Mean	Std. Deviation
enhanced care	11	3,40	5,80	4,6182	,78207
increased accessibility	11	3,25	5,25	4,1591	,68258
privacy & discomfort scale	11	1,00	2,25	1,4545	,41560
care personnel concerns	11	1,33	3,00	1,8788	,50050
kit as substitution	11	2,33	5,00	3,4242	,90788
satisfaction	11	5,00	6,00	5,5758	,36790

Researchers under the leadership of Professor Stanton Newman at University College of London have developed a patient acceptability questionnaire, called Service User Technology Acceptability Questionnaire or SUTAQ. This is based on a literature review and testing in qualitative studies. The questionnaire is used in WSD pilots including about 3000 patients. The questionnaire can be self-completed by the patients. The wording of the questions does not include "NHS-terms" and any references to NHS and similar, and thus can be used in other countries.

The wording of the 22 items (statements) in the Likert scale questionnaire are both positive and negative, and this reduces the risk of bias. The topics include questions on:

- Enhanced care (based on item: 17, 15, 10, 11, 13)
- Increased accessibility (based on item: 1, 3, 4, 19)
- Privacy and discomfort scale (based on item: 5, 2, 8, 12)
- Care personnel concerns (based on item: 9, 21, 20)
- Kit as substitution (based on item: 18, 22, 16)
- Satisfaction (based on item: 7, 6, 14)

The development of the WSD patient acceptability questionnaire, the content and the results from the first test of validity of the questionnaire are described in Hirani et al. (2012) entitled "Quantifying beliefs Regarding Telehealth: Development of the SUTAQ - Service User Technology Acceptability Questionnaire"

The score options include scores, from 1 to 6, reflecting more or less agreement with the item statements, respectively.

Based on the score, the patients agree that IoT telehealth provides Enhanced care and Increased accessibility, and they did not report Privacy and discomfort or Care personnel concerns. The IoT platform seems to be considered as an extra service, that cannot substitute the standard care and the patient's overall Satisfaction from the IoT platform service was high.

Cost Utility Analysis (CUA) of the IoT telehealth Service.

A piggy-back Health Technology Assessment (HTA) trial design was used for the economic analysis, which was embedded in a clinical trial. Additional economic cost and outcome data were collected and analyzed, but the trial itself was designed according to clinical issues. The CUA was performed based on the **MAFEIP tool** https://www.mafeip.eu/the-tool (Boehler, C. E., De Graaf, G., Steuten, L., Yang, Y., & Abadie, F. (2015). Development of a web-based tool for the assessment of health and economic outcomes of the European Innovation Partnership on Active and Healthy Ageing (EIP on AHA). *BMC medical informatics and decision making*, *15*(3), 1-10.)

The **HTA perspective used was based on the Health System, and not Societal**, **healthcare costs** represent the costs for both the intervention and standard care (control group) in *baseline* and *disease/impairment* states. These costs are defined per person. Healthcare costs refer to resource use within the healthcare system, excluding the cost for the intervention itself (which should be indicated under intervention costs above). In this regard, note that, if an intervention is not aimed at all patients but, for instance, only at those in the *disease/impairment* state, the intervention costs should be inputted as a healthcare cost in its corresponding state. **Societal costs** represent a wider resource use perspective which includes healthcare costs, but also other costs outside the healthcare sector (e.g. out-of-pocket payments and travel costs for patients, productivity losses).

Model input

The parameters required are divided into four sections: (1) model analysis, (2) costs associated with health states and intervention costs, (3) transition probabilities for moving between states with and without the intervention, and (4) utilities (also called quality of life weights) that are associated with each state. They are presented in Table 2.

Defining the health states and the transition probabilities

The 3-states Markov model considers a *baseline* state, which represents the general health status of the target population, a *disease/impairment* state, which reflects the health status of people who experience the condition of interest (the condition that the intervention aims to prevent, relieve or cure), and the *dead* state.

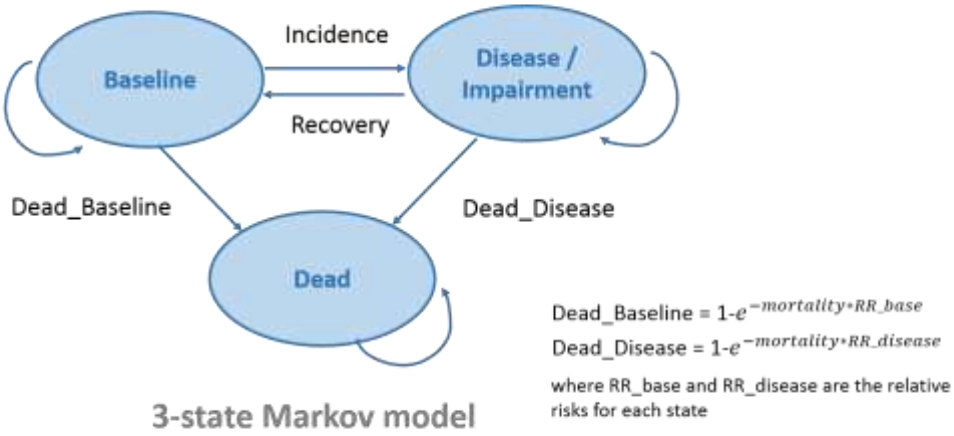


Figure 93: DS GRC – RUC 2 – CUA Markov model

Our study with 65+ years old T2DM patients had a follow-up period of 6 months, so we have reviewed to the literature for the probabilities of the MARKOV Model (3 cycles), from the baseline stage to the next stage with complications or the dead state.

According to the following paper with 65+ years old T2DM patients and follow up for 10 years vs control of general population, (Bethel, M. A., Sloan, F. A., Belsky, D., & Feinglos, M. N. (2007). Longitudinal incidence and prevalence of adverse outcomes of diabetes mellitus in elderly patients. *Archives of Internal Medicine*, *167*(9), 921–927. https://doi.org/10.1001/archinte.167.9.921) the following model calculations were made:

1. The incidence of the transition probability to the stage with complications from the baseline, is 535/1000 for T2DM patients in the first year and increases every year.
2. Regarding the mortality RR, there are no specific data from the T2DM patient's registry in Greece.
   According to the respective paper, the RR is 9,2/11.8=0.77, So I guess this is the RR I should use for Relative risk of mortality in disease/impairment state
   (Based on the paper: "Medicare beneficiaries in the DM group had excess mortality of 9.2% by 2004 relative to control group 2 (P↨.001) and 11.8% relative to control group 1 (P↨.001).")
3. Considering that the study did not include an intervention, the relative risks for the intervention and control group for people in the baseline are identical (both 1).
   The relative risk of mortality in the respective study for baseline state is 1, considering that they took a random selection of people that do not have DM and shows the number of deaths after the first year (and subsequent years). Calculating the relative risk in mortality in disease state, we see that after the first year 2.861 out of 33.772 people died (which is 0.08 %), while in the matched control group there were only 1483 deaths (0.044 %). This is a factor 1.8 (0.08/0.044) more in the disease state than "normal"

Computing the costs
Healthcare costs were considered:

<u>One-off and annual recurrent costs Intervention costs</u>

Cost items to be considered for the intervention include a) one-off intervention cost and b) total intervention cost per person per year. One-off intervention costs represent the total cost per patient incurred only at the implementation point, thus, total cost incurred only once (the cost of a telemonitoring device).

The total intervention cost per person per year represents the annual recurrent cost incurred for delivering the intervention and consists of two components: First, variable costs of the intervention that are incurred for each individual and each year (e.g., software license of the programme used, maintenance of the service, etc.). Second, the share of annual fixed costs per patient currently treated or targeted by the intervention represents, for instance, the annual cost of the infrastructure used for all patients divided by the number of patients currently treated or targeted by the intervention.

Standard care costs

The total annual cost per patient for managing diabetes in Greece was estimated at C 7,111 and was, statistically significantly, higher for patients with inadequate glycemic control (Hba1c > 7%) versus patients with adequate control (Hba1c =7%) (C 7,783 versus C 6,366, resp.; ?? = 0.017). Migdalis, I., Rombopoulos, G., Hatzikou, M., Manes, C., Kypraios, N., & Tentolouris, N. (2015). (The Cost of Managing Type 2 Diabetes Mellitus in Greece: A Retrospective Analysis of 10-Year Patient Level Data "The HERCULES Study." *International Journal of Endocrinology*, *2015*, 1–7. https://doi.org/10.1155/2015/520759)

Utility

To estimate the impact of the intervention in terms of health outcomes, utility weights associated with *baseline* and *disease/impairment* states is provided here. Following the common practice, the tool identifies measures of preference-based Health Related Quality of Life (HRQoL) and life expectancy as preferred categories of health outcome on intervention level. The EQ-5D questionnaire is recommended for calculating utility since the conceptual basis of the EQ-5D is the holistic view of health (i.e. not only including the medical aspect, but also physical, emotional and social functioning of the patient)

The HRQoL as expressed through a quality-of-life weight (utility) represents a particular health outcome. The utility measures summarize both positive and negative effects of an intervention into one value between 0 (indicating death) and 1 (which is equal to perfect health condition) so that the higher the value, the higher the quality-of-life associated with that health outcome.

The HRQoL scores for the Deteriorated state of the model was based on the paper: Yfantopoulos, I., Katopodis, P., Rombopoulos, G., Yallouridis, A., Chantzaras, A., Kossiva, E., & Varounis, C. (2016). The Influence of Glycemic Control in the Quality of Life of Type 2 Diabetes Mellitus Patients in Greece-the Hypo2 Study. *Value in Health*, *19*(7), A679. https://doi.org/10.1016/j.jval.2016.09.1913

Table 118. DS GRC – RUC 2 Input data used to populate the MAFEIP model

	Control Group	Intervention Group
Transition Probabilities		
Incidence	53.5	53.5
Recovery	0	0
Relative Risk		
Baseline State	1.8	1.8
Deteriorated State	0.77	0.77
One-off cost per patient (Intervention)	0	365
Recurring cost per patient/year (intervention)	0	91.8
Healthcare cost – Baseline	6366	6366

Healthcare cost – Deteriorated	7783	7783
Societal cost – Baseline		
Societal cost – Deteriorated		
Utilities		
Baseline State	0.8	0.8
Deteriorated State	0.6	0.6

Model output

This section presents the overall impact of the intervention on healthcare cost and quality-adjusted life years (QALYs) for the total target population. Results represent the average per-patient outcome across all age-gender combinations (weighted by the age-gender distribution in the specified target country and age range).

Results are summarized in the table below and presented in a cost-effectiveness plane. The table shows the impact on incremental cost and health-related quality of life, as well as the incremental cost-effectiveness ratio (ICER: ratio between incremental costs and incremental effects). For both dominant interventions (i.e. more effective and less costly) and dominated interventions (i.e. less effective and more costly) this is shown instead of the ICER value.

The cost-effectiveness plane plots the incremental cost of the intervention on the y-axis and the incremental health outcome (measured in QALYs) on the x-axis. The diagonal line represents the willingness to pay (WTP) per additional QALY gained, which is the maximum amount that a patient is willing to give in exchange for a better quality of life. Therefore, WTP is also referred to as the threshold value (λ). Different thresholds may also be selected. Depending on the location of the ICER point (blue dot) in this plane, you would be able to interpret whether your intervention would be cost-effective or not. When the ICER point is within the lower-right quadrant, it means your intervention would always be accepted (it is more effective and cheaper), and when it is within the upper-left quadrant, it means that your intervention would not be accepted (it is less effective and more expensive). If the ICER point lies in the other two quadrants, then the intervention may or may not be accepted depending on the ICER and WTP threshold values.

Table 119: DS GRC – RUC 2 Incremental cost and HRQoL effects

Incremental cost (Healthcare)	1018.19
Incremental effects	0.000
Incremental cost-effectiveness ratio (Healthcare)	Inf

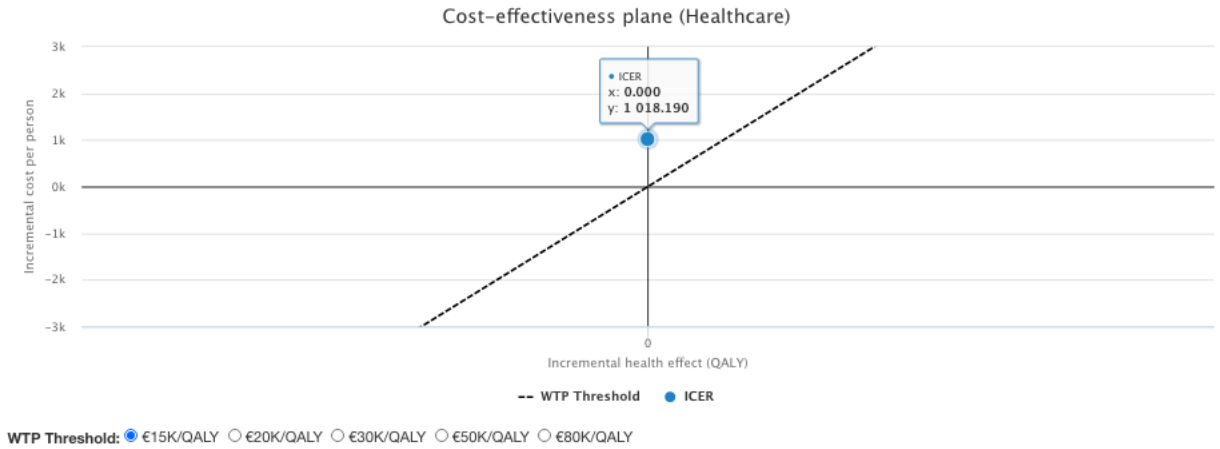


Figure 94: DS GRC – RUC 2 Cost-effectiveness

7.2.5 Conclusions

In the Greek DS, three pilot scenarios were conducted: the Mobility Scenario, the Smart Home scenario and the Integrated Care Scenario.

The purpose of the first two pilots was to assess how the use of the ACTIVAGE system can be beneficial in the daily lives of people with regard to their driving behaviour and their daily living. The participants in the studies were selected from several Greek regions and cover a wide age range above 65 years old. In case of the Mobility Scenario the age limit of 65 years old users extended to 55 years, due to the unfamiliarity of the elderly (over 65 years old) with the new technologies. Such differentiation in the minimum age limit allowed for the recruitment of users with higher familiarity rates concerning the use of new technologies.

The analysis of the evaluation questionnaires administered during the pilots indicates that the use of the ACTIVAGE system has an overall positive impact on the lives of older adults reflected to their ability to be more autonomous and independent.

In particular, regarding the mobility scenario, the system has a positive impact in terms of quality of life of the participating drivers, their safety, comfort and awareness towards sustainable urban mobility, as evidenced by the monitored progress from the beginning to the end of the pilot. Similarly, in the Smart Home scenario, a positive overall progress was observed from the beginning until the end of the pilot, in terms of their ability to perform activities of daily living, the Quality of Life of both the older persons and their caregivers, and their self-confidence about their own abilities and the use of the system.

The results are encouraging and demonstrate the potential benefits of a wide adoption of the ACTIVAGE system as well as that the initial goal of ACTIVAGE to enable the deployment and operation at large scale of Active & Healthy Ageing IoT based solutions and services has been successfully achieved. The particular details of the questionnaires' results can guide further improvements in the system and the study procedures in future studies with similar ambitious and user-centred goals.

Regarding the results of the third scenario of IoT enabled Integrated Care:

- Due to the delay in the public procurement of the equipment and the lock down due to the COVID19 pandemic, the recruitment of the patients did not reach the target (24 patients in the control group and 19 in the intervention group). The clinical study is considered underpowered and therefore a conclusion regarding the primary outcome cannot be reached, as far as the superiority trial design is concerned. Ancillary analysis regarding the noninferiority trial design could be considered however.

- The generic HRQoL (EQ5D scale) and the Disease Specific Quality of Life (PAID scale) did not show any statistical significant difference between the intervention and control group.
- The patients' acceptance and satisfaction regarding the IoT telehealth service is high.
- CUA from the Health Care perspective is inferior regarding the IoT telehealth services. However a Societal perspective HTA might be more appropriate, given the fact the IoT telehealth service is able to reduce the burden of the caregivers and the patient.

7.3 Local sustainability plan

7.3.1 Product/Service Definition

ACTIVAGE SERVICES in Greek Deployment Site

IoT –enabled services for autonomous living of Older adults

Key services of the Smart Home Scenario and Mobility Scenario of the ACTIVAGE project:

a. Support to indoor through efficient monitoring and improved coordination among care providers
b. Enable outdoor activities by providing safe and secure transportation and mobility through timely transportation awareness
c. Among the limitations was the reduced familiarity of older users' with new technologies either in indoor or outdoor activities and their reluctance to adjust with the requirements of technology.

IoT –enabled smarthome services for Family members, Caregivers/Health Professionals/Entities

Key services for caregivers and health-care services:

a. The ACTIVAGE service open new opportunities for enabling new family models especially in countries were older adults are not used to live alone
b. Family members and caregivers had a valuable opportunity to advance their roles and their quality of life through usable alarms (e.g. panic button use).
c. Support patients with chronic conditions as Diabetes Mellitus healthcare professionals for appropriate follow-up.

The technical solution of the monitoring platform regarding the Smart home Scenario and the Mobility Scenario

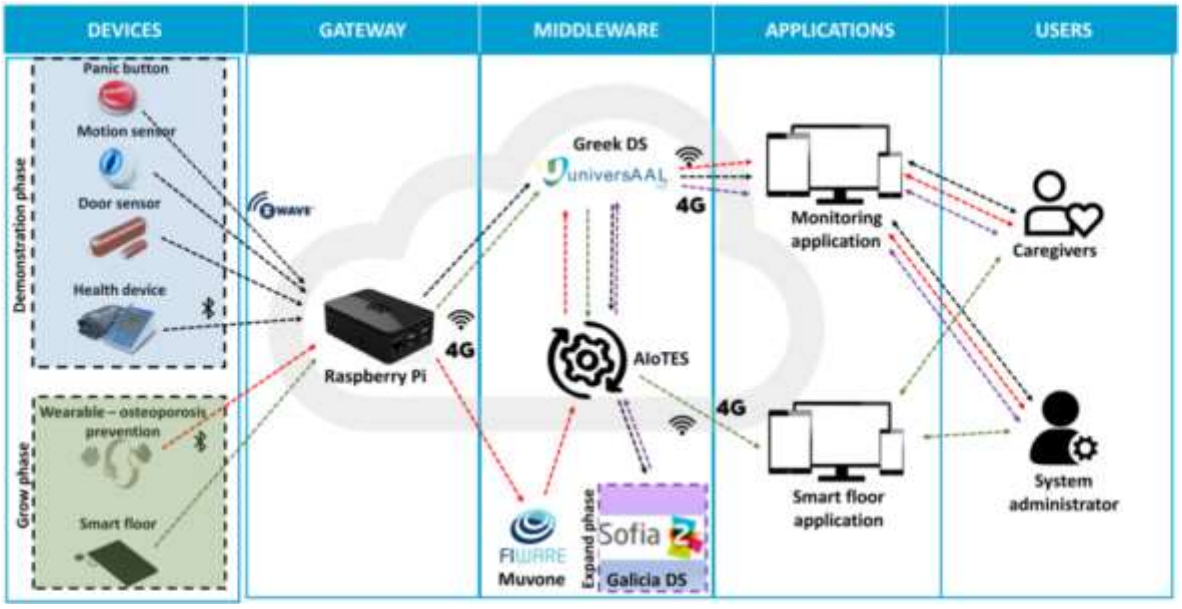


Figure 95: DS GRC Technical solution smart home scenario

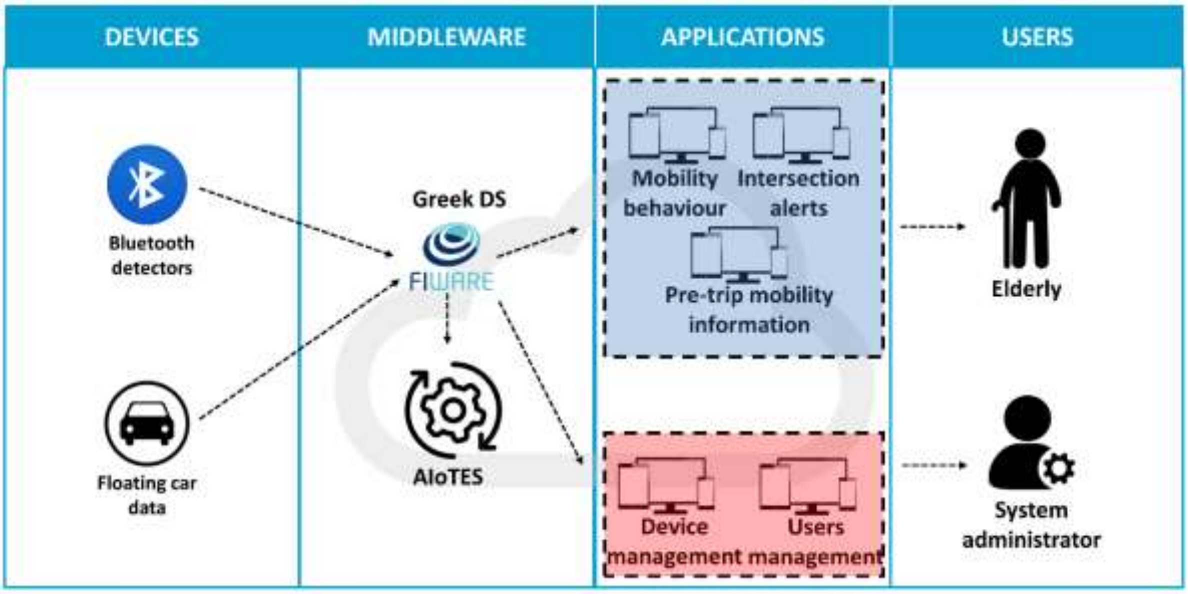


Figure 96: DS GRC Technical solution mobility scenario

Indoor and outdoor activities for:

Older adults

- Simplified and easy to utilize applications and devices, to gain high acceptance by the older people who lack technological background

Family members/ Caregivers/Healthcare Professionals

- More adaptable knowledge and awareness platforms to well –being, health and mobility domains.

7.3.2 Market Analysis

7.3.2.1 PESTEL analysis

Table 120: DS GRC PESTEL analysis

Political	Economical	Social	Technological	Environmental	Legal
Policies/ guidelines need to foster relevant activities of improved efficiency and quality of ICT and also non ICT services for older adults inclusion and improved quality of life.	IoT big data enabled technologies in the context of smart cities are close related to great economic benefits. However, to facilitate big data analytics' power and provide successful services huge investments in the underlying core enabling technologies are needed.	The socio-economic perspective is an important enabler to quality of life, health and urban development and the delivery of efficient services in line with the fundamental goals of sustainable development.	Technological innovation in IoT domain and AHA market strives to enhance a more efficient health care system	interoperability between different IoT devices, standards and protocols can form new technological and social environments for assisted living of ageing populations.	Assistive Ambient Living (AAL) technologies in ageing due to the bio-psycho-social exposure of individuals Relevant literature indicates ethical principles, such as autonomy, beneficence, non-maleficence, fidelity, justice, utility and independence need to be followed in AAL services' implementation[23].
Digitization of social and health services is considered to render large benefits for the economy, competitiveness areas and innovation. Recently the interest of Greek governmental policies for digital growth[24]	Smart environments hold the promise to guide competitive business models and contribute significantly to market economy enlargement. The so called 'white economy' for medical services for		Technological advancements in the domain of ICT and IoT enabled health care and well-being of older people, can benefit from the interaction and collaboration among diverse stakeholders such as institutions, enterprises, universities and users.	The implementation of novel computing environments can bring large benefits for e-health and e-mobility services' delivery. In tandem challenges remain for the digital transformation of real-time and sensitive high accuracy results	Within ACTIVAGE high considerations have been raised regarding the legal and ethical perspectives of IoT technologies implementation in systems architecture and devices/apps design. Beyond legal compliance with the new regulation ethical aspects have been studied

23 Panico, F., Cordasco, G., Vogel, C., Trojano, L., & Esposito, A. (2020). Ethical issues in assistive ambient living technologies for ageing well. *Multimedia Tools and Applications*, 1-13.

24 Tsakanikas, A., Danchev, S., Giotopoulos, I., Korra, E., & Pavlou, G. (2014). ICT adoption and digital growth in Greece. *Athens, GR: Foundation for Economic and Industrial Research (IOBE)*.

	the elderly population call for social inclusion in terms of affordability of medical expenses[25].		Representative paradigm is the Quadruple Helix Model[26].		thoroughly while a common ethos has been cultivated at project level with accordance to older adults rights' protection and data management upon core principles such as the principle of proportionality and minimization.

7.3.2.2 Market characterization

DEMOGRAPHIC AND SOCIAL TRENDS AT GREECE

In countries where life expectancy is constantly increased indicating the highest rates worldwide, healthcare is an imperative.

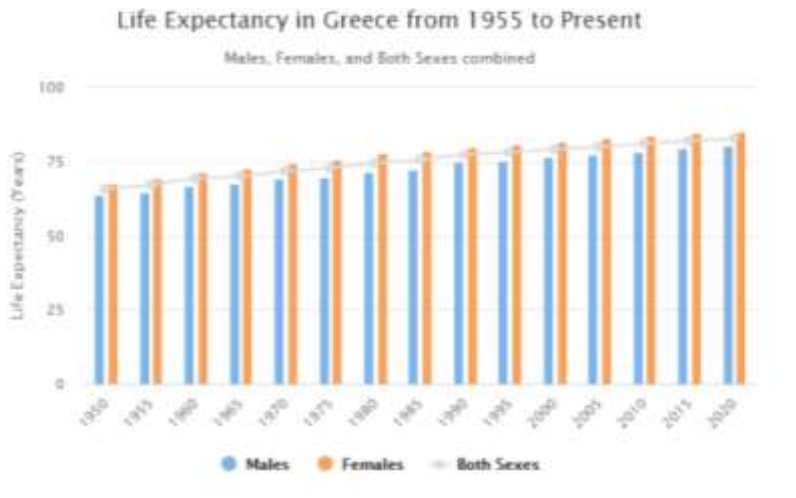


Figure 97: DS GRC demographic and social trends in Greece

DEMOGRAPHIC AND SOCIAL TRENDS OVER THE WORLD

25 Martinez-Fernandez, C., Martinez-Fernandez, C., Kubo, N., Noya, A., & Weyman, T. (2012). *Demographic change and local development: shrinkage, regeneration and social dynamics*. Paris: OECD publishing.

26 Leoni, S., Lepore, D., & Spigarelli, F. Aging and IoT: Developing innovative solutions in a Quadruple Helix approach.

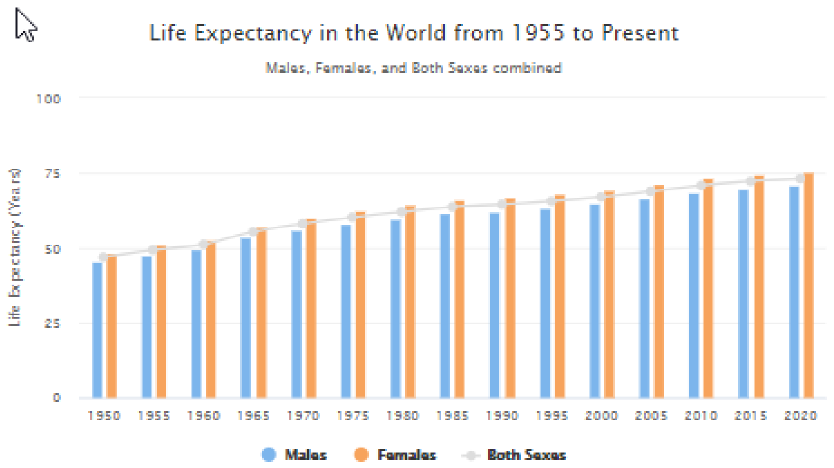


Figure 98: DS GRC demographic and social trends worldwide

SMART SERVICES FOR ROAD SAFETY AT GREECE

Table 121: DS GRC road fatalities evolution

	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	Change 2006-2016
Fatalities	1.657	1.612	1.553	1.456	1.258	1.141	988	879	795	793	*807*	-51%
Injured persons	20.675	19.766	19.010	18.641	19.108	17.259	15.640	15.175	14.564	14.096	*13.795*	-33%
Accidents	16.019	15.499	15.083	14.789	15.032	13.849	12.398	12.109	11.690	11.440	*11.439*	-29%
Vehicles (x1000)	6.996	7.380	7.729	7.911	8.062	8.087	8.070	8.035	8.048	8.076	8.173	17%
Fatalities/million vehicles	237	218	201	184	156	141	122	109	99	98	*99*	-58%
Fatalities/million population	149	146	140	131	115	98	89	80	73	73	*75*	-50%

Source: ELSTAT

During the past decade, Greece was among the EU countries with the worst road safety performance. However, Greece recorded an impressive reduction in road fatalities by 46% during the period 2009-2015. This impressive reduction in road fatalities during economic crisis was stopped in 2015[27].

7.3.3 Competition/sector Analysis

7.3.3.1 Competition profile analysis

IoT has become one of key market segments and focus of all key ICT players. Most positive forecasts state a compound annual growth rate, of IoT in manufacturing, at 27.2%, reaching a market size of more than 20.59 Billion USD in 2021[28]. Market for IoT devices, products, and services appears to be accelerating toward such an inflection point, based on four critical indicators: (i) supplier attention; (ii) technological advances; (iii) increasing demand and (iv)

27 Greek Road Safety Statistics – Best Practices, https://www.unece.org/fileadmin/DAM/trans/main/SDGs/Workshop_1_-_October_2017/Greek_Road_Safety_Statistics_%E2%80%93_Best_Practices.pdf

28 http://www.marketsandmarkets.com/Market-Reports/iot-manufacturing-market-129197408.html

emerging standards[29]. But there is no common architecture, methodology or framework, capable of combining majority of initiatives and developments, related to integration of IoT in NGI (resulting in NGIoT). Only about 10% of financial value, to be captured from IoT, is likely to be in devices; the rest will come from how they are connected, interoperate and, most importantly, how data they produce is used and governed[30]. Given potential 90% distribution of value to players, who provide technologies other than hardware (e.g. middleware developers, cloud/edge/fog operators, Big Data and AI developers), there is space for new players to enter

The global IoT market will grow from US $190 bn in 2018 and is projected to reach US$ 1.102 bn by 2026, at a CAGR of 24,7% in the forecast period (2019-2026) (Fortune Business Insight, 2019). The global IoT market share will be dominated by three sub-sectors: Smart Cities (26%), Industrial IoT (24%) and Connected Health (20%) followed by Smart Homes (14%), Connected Cars (7%), Smart Utilities (4%) and Wearables (3%) (GrowthEnabler, 2017, p.14). Total spending on IoT solutions in Europe is expected to surpass $241bn in 2022.

In a report from the LargeScale Pilots Programme (LSP, 2019), European Smart Cities spent €16,5bn on IoT technologies in 2018: 6% in connectivity, 38% hardware, 35% services, 21% software. 'Over 50% of Smart City opportunity lies in Services and Software (platforms, applications, and analytics), which are growing their shares' (LSP, 2019, p. 64).

Greece is a laggard in adopting digital technology solutions in healthcare compared to the rest of the European Union, according to a study by the Hellenic Federation of Enterprises (SEV) on the benefits of a digital transition in the health sector.

The study showed that Greece ranks 23rd among the 27 EU member-states in using modern technologies in the sector. This country ranks second-to-last in keeping digital records of patients' details and histories and lags considerably in health information exchange between health service suppliers and state entities, ranking 25th in the bloc.

There is a better picture in the availability of the personal health dossier by healthcare service providers, where Greece is in the 16th position.

The low quality of health services in Greece is partly attributed to a drop in funding during the decade of the financial crisis, as state spending on health is 7.8 percent of gross domestic product against an average rate of 8.8 percent among the countries of the Organization for Economic Cooperation and Development (OECD).

https://www.ekathimerini.com/250195/article/ekathimerini/business/greek-health-sector-lags-in-digital-tech-transition

Commercial potential: If ranked among sovereign nations, the European Silver Economy (the economy of the population over 50) would currently be the third largest economy in the world, behind only the USA and China. And it will only continue to grow[31]. The recent EC study estimates a baseline value of €3.7 trillion (2015) for Europe's Silver Economy, primarily comprising private expenditure by older people (50 plus) on various goods and services. Focusing more on senior care, this is estimated to be a $740 Billion market that is ripe for disruption because it still maintains outdated, inefficient processes that haven't changed in over 40 years in some cases[32]. Not only is this a multibillion market, but also the senior population is

29 http://public.deloitte.com/media/analytics/trends/analytics-trends.html

30 Making connections: Joep van Beurden on semiconductors and the Internet of Things, autumn 2014.

31 Silver Economy Study: How to stimulate the economy by hundreds of millions of Euros per year, EC Digital Single Market, May 2018

32 Redpoint Ventures, Medium.com, 2016

growing 20% every 10 years. According to a 2018 Accenture survey[33], 68% of seniors consider technology to be helpful in improving their health and understanding their medications. In fact, 61% are looking for new technologies to use. From a different point of view, due to the growing population, the costs of health and social care will rise substantially to about 9% of EU GDP in 2050[34].Without Digital Health solutions in the future, the already running at full capacity health institutions will most likely fail. Europe's health and care systems face serious challenges.

7.3.3.2 Porter's 5 forces analysis

Table 122: DS GRC Porter's 5 forces analysis

Force	Analysis of potential factor
Competitive rivalry	The global Internet of Things (IoT) in healthcare market size is expected to grow from USD 72.5 billion in 2020 to USD 188.2 billion by 2025, at a Compound Annual Growth Rate (CAGR) of 21.0% during the forecast period. oT market, with new disruptive ideas that will use innovations hold the promise of power to the edge while putting human in the centre of operation with next generation applications. ACTIVAGE leveraged the potential of IoT interoperability through real use cases' of IoT health domain, well-being, proving also tangible Key Performance Indicators (KPIs) for triggering active patient engagement and patient-centric centric service delivery through diverse channels.
Threat of new entrants	The entry of new competitive solutions both in terms of capacity and power of the interconnected devices, with several/different requirements and an increasement of operation, demands secure and trusted interoperability between deployments, with clear connection with cloud, semantics. ACTIVAGE is a unique ecosystem with clear outcomes that should be viewed as project's asset in the market area. Moreover the certifications of ACTIVAGE final products of social and health services are not the same in all EU countries. Different methodologies and lessons learnt from this wide network and its interconnections beyond their positive socio-economic outcomes, brought the opportunity of business value through ACTIVAGE.org. In terms of this new ecosystem, new requirements are defined in the diverse landscape of coalition partners to advance the business case of coordinated actions for providing services to older adults'.
Threat of substitutes	A major threat towards the establishment of ACTIVAGE is the existence of substitute products and services that can challenge the dominance of the product in the local market landscape. This threat often causes a limit on the price a product can be charged. For this reason, there is a need for continuous improvement and enhancement of services provided in order to not only maintain a high

33 Accenture 2018 Consumer Survey on Digital Health

34 Global Health and Aging, WHO

	quality level on the developed solutions but also improve them in order to protect the place of ACTIVAGE on the market chain. In that frame, ACTIVAGE.org will have to focus on attracting new partners with high-end expertise and innovative technologies that can improve the system even more and guarantee the reliability and stability of the solution down the road.
Bargaining power of suppliers	The presence of powerful suppliers reduces the profit potential in an industry. That is why it is important to not depend on a single supplier and try to find alternatives in order to keep the bargaining power of suppliers from increasing. Some options to follow are to try to establish long term partnerships with suppliers by asking for major discounts due to "costumers loyalty", increase the amount of possible suppliers or even try to develop from scratch substitute devices with similar functionalities with the ones in need.
Bargaining power of customers	The more informed and market-educated the customers are, the more demands and conditions can impose to on the price and quality of the service. That is why ACTIVAGE has to provide a clear sales channel for the costumers in which the focus should be providing high-end quality services with competitive prices. Another important strategy in order to tackle this threat is to increase focus on marketing campaigns in order to attract new customers and increase their level of engagement and enthousiasm towards ACTIVAGE product and its services.

7.3.3.3 SWOT analysis

Table 123: DS GRC SWOT analysis

STRENGTHS	WEAKNESSES
• Interoperability, easy and efficient integration of new platforms, seamless services connectivity • Large scale trials validated user acceptance, accessibility and usability • Innovative, user-led and sustainable solutions of supporting and extending ageing friendly environments through smart indoor (Smart Homes UC) and outdoor environments (Mobility UC) • COVID-19 outbreak empowers the digitization of well-being, health care and mobility of older adults	• Slow commercial enlargement • Fragmented solutions, no integrated solutions at hand • Value preposition still needs to be elaborated to provide performative business values
OPPORTUNITIES	**THREATS**
• Ageing population results in growing market • Development of e-health home care solutions, move from hospitals to	• Increasing competition due to the attractiveness of the health and the mobility sector due to small national market

homes and care centers is expected to enable high volumes • Extension of health-oriented applications towards integration of consumer oriented contextual and wellbeing data • Low-cost availability of accurate health sensors/devices • Availability of personal data enables new services and solutions of relevant market • Faster market introduction due to EU directive on medical devices and increasing demand of medical devices (prediction until 2022) and predicted growth of R&D expenses • Existing cultural background might help in user acceptance	• Dependence on National regulations. Not all legislation uniform in EU Well-established and large vendors • Slow AHA and integrated care adoption of ageing friendly Houses/ spaces due to the digital gap of older adults and in the course of the project due to the pandemic crisis • Lack of funding for ICT changes and ventor lock- in • COVID-19 impact on budgets

7.3.4 Value proposition and Targeted Customers

Table 124: DS GRC Lean canvas

Lean Canvas				
Problem • High scalability on future exploitation • Efficient and on time management on health –care and safe, informed mobility services • Convergence of IoT technology acceptance and older adults' behaviour.	**Solution** • Platform operation, promotion and services' development.	**Unique Value Propositio** • Sharing of data at semantic level • Digital transformation of crucial data for the daily living of older adults • Older adults' data sovereignty	**Unfair Advantage** The innovation of interoperability.	**Customer Segments** • Older adults and caregivers that are involved in the telecare and behavioural monitoring platform • Services' providers of the health and social public and private care domain • Hospitals and heatlh care institutions • IoT marketplace for smart homes and smart mobility of seniors.
Existing Alternatives • The component of interoperability is missing in most of case • Existing IoT telehealth and telecare services for elderly are limited in the market, and lack reimbursement model due to lack of CEA analysis and clinical outcomes evaluation	**Key Metrics** • Impact on quality of life as an outcome of AHA services • Trust And acceptance of digital transformation of services • AIOTES • HRQL and Health status evaluation • CEA	**High-Level Concept** ACTIVAGE-Solution for AHA services	**Channels** • Dissemination events • Publications • Networks • Calls for tender • Conferences • EXPO • Publications	**Early Adopters** • Municipalities and Prefectures • NGOs providing care services • Regional Health Authorities and Hospitals • Private Health and Care Service providers
Cost Structure			**Revenue Structure**	

• Human resources (Infrastructure and facilities) • System integration costs • Support activities • Sales and marketing • Cloud infrastructure	• Sales of the proposed solution • Maintenance

Table 125: DS GRC Value proposition canvas

Value Proposition Canvas				
Value map			Customer profile	
Gain creators	Product & Services		Gains	Customer Job(s)

• Advanced telecare services
• Personalised and integrated care with clinical infrastructures
• Intersection alerts' services
	• Well-being and health supported services in daily routine
	• Anbormal events' notification
	• Chronic diseases efficient management
	• Safety, awareness and security at mobility
			• Older adults
			  ○ Positive impact on their quality of life, well-being and health
			  ○ Identification and notification of risk situations
			  ○ Enhancement of autonomy and independent living of older adults living alone
			• Telehealth services' providers
			  ○ Bottom –up approach: products' assets upon user older adults, caregivers, healthcare stakeholders benefits
			  ○ Increased trustworthiness and acceptance by users
				• Carergivers/healthcare personell
				  ○ Exploit as much as possible the technological solution
				  ○ Monitor the health condition of older adults through tangible indicators for efficient diagnosis and interventions .
				  ○ Consider the sensitive relationship between patients/healthcare personnel.
				• IoT Services' Providers
				  ○ provide services of advance quality and efficiency
				  ○ Gain users' trust by introducing a legal and ethical grounded environment

Pain relievers			**Pains**	

• Monitoring and alert of risk incidents ○ Monitoring platform for daily data collection, analysis and assessment of personal traits and indicators ○ Support to health professional, caregivers, regarding the daily 'real time' picture of older adults through alerts (i.e. use of panic button) via an SMS, email or through platform notifications. • Exploitation of state of the art technologies The proposed platform exploits sophisticated cloud technologies, as well as state of the art IoT technologies leveraging AIOTES core functionalities. By being up-to-date with current technologies, the solution ensures data safety and the highest possible results accuracy.			• Older adult ○ Lack of trust due to the fact that they live alone ○ Emotions of stress and anxiety in case of emergency ○ Concerns of privacy and security • Caregivers ○ Effort and time to be in contact with the caregiver • IoT Services' Providers ○ Users' distrust of the proposed solution ○ Ucers' reluctance to accept the provided services ○ Additional effort and cost	

7.3.5 Strategy for local sustainability

7.3.5.1 Open Data strategy

At the time of writing the report, no datasets have been planned to be released.

7.3.5.2 Continuation strategy

Within the Greek Deployment Site the need sustainability strategic planning and management of ACTIVAGE technologies and solutions has been integrated in the whole management of the Greek Deployment site. Therefore, a concrete methodology has been introduced and applied to prove the usefulness and validity of existing methods and techniques to new research fields.

In particular long-term investments and effects of IoT based services from/to larger populations of senior people have been evaluated. To this direction synergies and trade-offs were planned to be identified across different domains while sustainability criteria and indicators are planned to be integrated in the evaluation process.

- A new service similar with ACTIVAGE: ‘’Provision of Independent Living and Safe Aging Services for the Elderly’’ has been initated
- Collaborative cluster Ageing@home, coordinated by CERTH/ITI
- Received by the European Commission the distinction of "Reference Site 3*” within the framework of the European Innovation Partnership (EIP) on Active and Healthy Ageing (AHA).
- Plan to join ACTIVAGE-ORG for future exploitation
- In this phase the GR DS the new use cases of Healthcare services due to COVID-19 has been extended through 2 forms of services: a. Telecare service for older adults during COVID19 lockdown by CERTH and etrikala of the Municipality of Trikala b. IoT telehealth service for patients with Type 2 Diabetes Mellitus during COVID19 lockdown by CERTH and etrikala of the Municipality of Trikala

7.3.5.3 Replication strategy

A proof-of-concept of the IoT Clinical Decision Support System (CDSS) Smart Blood and Pressure monitoring use case has been provide by the deployment site of Galicia. The use case of integrated care for patients with Type 2 Diabetes Mellitus and comorbidities has been extended by the Galicia Pilot site.

The additional functionalities of the new use case refers at remote monitoring of of patients with Hypertension. Thus, a semantic “translation” of the pulse measurement, also recorded for ACTIVAGE UC2, is made, providing an evaluation of the measurement taken. The measurement is being characterized as low, normal or high, based on national health standards and is presented in special designed widgets inside the ACTIVAGE IoT platform developed by CERTH.

7.3.5.4 Scaling-up strategy

The Municipal Enterprise Cities Net of the Municipalities of Central Greece with the competence center located in the Municipality of Trikala, deployed ACTIVAGE in 6 different Municipalities and disseminated the services in more than 10 Municipalities that are members of the Enterprise. Part of the exploitation plan is to explore the possibility of coming to an agreement with one or more of these cities in continuing the ACTIVAGE service after the end of the pilot. Some of them have already expressed their interest and alternative funding solutions for continuing the service are currently being investigated.

During the first wave of the pandemic crisis, COVID-19, two adaptions of the implemented services were introduced in order to meet the emerged needs:

- IoT telecare service for elderly during COVID-19 lockdown by CERTH and the Municipality of Trikala

-IoT telehealth service for patients with Type 2 Diabetes Mellitus during COVID19 lockdown by CERTH and the Municipality of Trikala.

However, having in mind that there is currently a second wave of the pandemic, both services could become a part of each Municipality's strategic approach in coping with the pandemic.

Currently, in the context of a new program of European Structural and Investment Funds, Pilot Sites Municipalities will apply by the end of 2020 for funding of scale-up infrastructures via the PA 2014-2020.

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Acronyms

ADMR	Aide à Domicile en Milieu Rural French National federation of association for person assistance
AGIRC-ARRCO	**AGIRC** Association générale des institutions de retraite des cadres **ARRCO** Association pour le régime de retraite complémentaire des salariés
APA	Allocation Personnalisée pour l'Autonomie
ARS	Agence Régionale de Santé
ADPA38	Association pour l'Aide à Domicile aux Personnes Agées Isère Association Housekeeping service providers for elderly
ARDH	Aide au Retour à Domicile après hospitalisation
ASSAD	Association De Soin Et De Services A Domicile Association Housekeeping service providers for elderly
AUC	ACTIVAGE Use Case
AVQ	Activité de la Vie Quotidienne ADL : Activity of Daily Living
CARSAT	Caisse d'Assurance Retraite et de la Santé au Travail National Health and retirement financing body
CCAS	Centre Communal d'Action Sociale Municipality Social Action Center
CEREES	(Comité d'Expertise pour les Recherches, Etudes et Evaluations en Santé).
CIAS	Inter Communal Centers for Social Action
CLIC	Local gerontology information and coordination centres
CNSA	Caisse Nationale de Solidarité pour l'Autonomie
CPA	Centre de Prévention des Alpes Alps Prevention Center
EHPAD	Etablissements d'Hébergement pour Personnes Agées Dépendantes Medicalized structures, nursing homes for dependent elderly people
ELSI **ELSA**	*Ethical, Legal and Social Implications* (ELSI-US) or *Aspects* (ELSA-Europe)
EPIC	Etablissement Public à Caractère Industriel et Commercial Public and industrial establishment

FFD	Fédération Française de Domotique
GIR	Groupe Iso Ressource. La grille AGGIR est constituée de 6 GIR allant de la dépendance la plus lourde (GIR 1) à l'absence de perte d'autonomie (GIR 6). https://www.service-public.fr/particuliers/vosdroits/F1229
IMA	Inter Mutuelles Assistance
INSEE	Institut National de la Statistique et des Études Économiques
IRT Nanoelec	Institut de Recherche Technologique Nanoelec Nanoelec Technology Research Institute
RUC	Reference Use Case
UAH	User Authentication Hub
SBA	Smart Building Alliance
SAAD	Service d'Aide et d'Accompagnement à Domicile Home Care Service Structure (private , public or associative)
SOLIHA	Solidaire pour l'Habitat National association for solidary housing
SSIAD	Service de Soins Infirmiers A Domicile Nursing Home Care Service. It works for the maintenance of elderly and / or dependent persons at home, by assigning nurses responsible for providing them with the necessary care.
SSR	Soins de Suite et de Réadaptation Follow-up care and rehabilitation

8.1 DS Experiment report

DS ISERE is located in the French Alps. The French department of Isère is a pioneering area nation-wide in terms of innovation in social and care service for Autonomy. The department of Isère is running IsèreADOM a flagship experiment in France which is the background foundation for Isère deployment site in ACTIVAGE.

The scope of DS ISERE is to create a **continuum of care** that combines **human and technical** assistance, bridging the different moments in an elderly person's life to limit the loss of autonomy and avoid unnecessary hospitalization.

The goal of DS ISERE was to test a **modular personalized home IoT KIT** integrated in caregivers or other professional's practice, to follow the evolving persons' needs to detect early sign of fragility, to prevent loss of autonomy, to enhance safety, comfort, energy saving and social link.

For this demonstration the DS ISERE experiment targeted 3 different populations (Figure 99) : active senior living at home (Panel 1), Frail people living at home with home carer support (Panel 2), Frail people in a rehabilitation hospital before going back home (Panel 3 Korian).

The goal was to evaluate the interest for the users in the different services proposed: **services enabled by the IoT solution** complementing **human assistance services**.

- To respond to the need for anticipating ageing and prevention (panel 1).

- Complement or support human aid aimed at maintaining or restoring autonomy (panel 2 & 3)

The expected feedback from the evaluation was to define the "minimum" set of services, functionalities and devices to propose efficient service to each of the three panel.

The ACTIVAGE kit was developed to be used both by autonomous seniors living at home (panel 1), seniors in loss of autonomy accompanied by a home help service (SAAD; panel 2), and elderly patients staying in a follow-up care and rehabilitation service and preparing to return home (panel 3). Almost the same set of devices is deployed for each panel, but the service proposed are adapted to each panel.

The aim here was to evaluate the commercial potential for an evolving offer of service based on the same IoT KIT of devices. Finally our goal is to analysis what is the best organisation of stakeholders to define, integrate and propose these services to the ageing population.

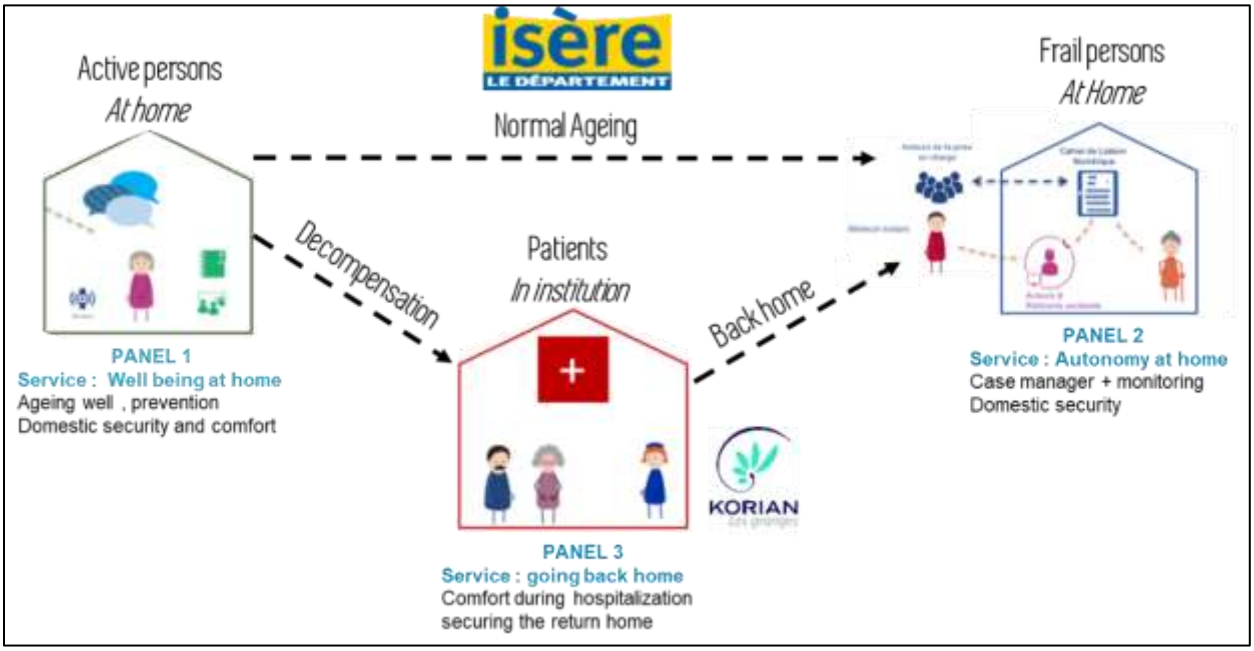


Figure 99 DS ISE Continuum of care: 3 different Panels involved in Isere Deployment Site

The different services define and tested at DS Isère during ACTIVAGE are describe for reach panel in the following tables, both technology and human based service are described. The Reference Use Cas (RUC) tested in the different Panel are summarized in Table 129.

Table 126: DS ISE Human and technology Service offer for Panel 1 ACTIVE seniors

SERVICE OFFER PANEL 1 : ACTIVE PERSONS			
	Function for HEATH AND WELL BEING	Functions SOCIAL LINK	Functions HOME AUTOMATION Comfort & Security
Technology enabled service	**Physical Activity** monitoring : Daily steps and covered distance	**Interactions with relatives :** eLio Family : Visio, photo, mails https://www.e-liofamily.fr	**Domestic Security and Alert** - State of the kitchen equipment - State of the front door - Automatic lighting - Gas and smoke threshold

	Monitoring of weight change	**Tablet appli :** games , cooking recipes **Access to IsèreADOM directory including closest :** **-** social activity - information & prevention actions - artisan- craftsmen https://www.isereadom.fr/	- Flood **Energy performance** - Indoor temperature - Air quality - Shower water consumption - Electricity consumption of chosen equipment - General consumption
Human assistance service	**Personalized service :** **- Phone Coaching** Health & Well-being : Phone with a nursed (IMA). - **Home visit** by an ergotherapist from Département de l'Isère	**Collective workshops and conference** - Discovery and use of a digital tablet - Energetic performance, eco-gesture and home adaptation - Design workshop: "an ideal home for health" - Nutrition for people aged over 55 - «aging well in my city» - « Inform and be informed »	

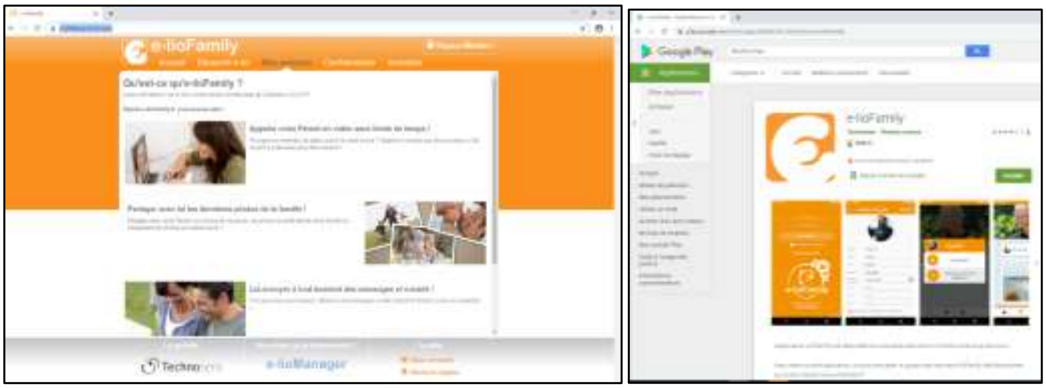


Figure 100 DS ISE Elio Familly from Technosens included in DS Isère Offers

Figure 101 DS ISE IséreADOM home page with directory of service and crafstmen

Table 127 DS ISE Human and technology Service offer for Panel 2 FRAIL seniors

Service offer PANEL 2 : FRAIL PERSONS

	Function HEATH AND WELL BEING	Functions SOCIAL LINK	Functions HOME AUTOMATION comfort & security
Technology enabled service	**Monitoring of « vigilance indicator »** **-** Weight change **-** Behavioural changes **:** Night activity (night rise and front door) Cooking activity - **Tele-assistance** (optional) - Digital link booklet **:** to share information with Sentinel caregiver	**Interactions with relatives :** eLio family : Visio, photo, mail https://www.e-liofamily.fr **Access to IsèreADOM directory including closest :** **-** social activity - information & prevention actions - artisan- craftmen https://www.isereadom.fr/	**Domestic Security and Alert** - State of the kitchen equipment - State of the front door - Automatic lighting
Human assistance service	**Home care service :** Caregiver plus Sentinel follow up from SAAD (Home Care service provider)		

Table 128 DS ISE Human and technology Service offer for Panel 3 HOSPITALIZED seniors

SERVICE OFFER PANEL 3 / PATIENT IN HOSPITAL			
	Functions PATIENT PROGRES	Functions SOCIAL LINK	Functions ROOM AUTOMATION Comfort & Security
Technology enabled service	**Activity Monitoring** : - Daily steps and covered distance - Day& Night activity (bed presence) - Autonomy for washing - Autonomy with pain management	**Interactions with relatives :** eLio Family : Visio, photo, mails **https://www.e-liofamily.fr** **Tablet appli :** games	**Automatic lighting** **Alerte** - Temperature thresholds - Abnormal shower duration - Abnormal inactivity in the bathroom
Human assistance service	**Classical hospital care service : from professional team** Gerontologist, nurse, physiotherapist, occupational therapist, catering, animation ...		

8.1.1 User engagement report

Concerning DS ISERE experimentation, the segmentation of user was built according to the User Situation: Home / Establishment and Active / Frail. The different Use Case (AUC/RUC) have been tested among the three-panel population has shown in the following table.

For DS ISERE it is therefore not meaningful to count the number of beneficiaries per AUC (ACTIVAGE Use Case) or RUC (Reference Use Case), we will do it by panel.

Each panel is experimenting different AUC/RUC, as detailed in the following figure and table.

The table below describe the RUC repartition among the three Panels

Table 129 DS ISE Table of Reference UC RUC versus Panels of DS Isère

	Living	At home	In institution

RUC N°	RUC Title	Panel 1 Active seniors	Panel 2 Frail senior	Panel 3 Hospitalised seniors
RUC_01	Daily activity monitoring	X	X	X
RUC_02	Integrated care		X	
RUC_03	Health parameter monitoring			
RUC_04	Emergency trigger		X	X
RUC_05	Exercise promotion	X		X
RUC_06	Cognitive stimulation			
RUC_07	Prevention of social isolation	X	X	X
RUC_08	Safety and comfort at home	X	X	
RUC_09	Mobility monitoring Active mobility			
RUC_10	Notification of abnormal situation	X		
RUC_11	Support for caregivers			

Table 130 DS ISE Total Number of recruited persons in the different panels

Panel	RUC	Elderly	Informal caregiver	Formal caregiver	Other stakeholder
Panel 1	RUC _01 RUC_05 RUC_07 RUC_08 RUC_10	63 + 3 testers			- Installers 6 - Occupational therapist : 2 - Local authority : 2
Panel 2	RUC_01 RUC_02 RUC_04 RUC_07 RUC_08	8	0	19	- Installers 6 - Home Care service companies Directors : 3
Panel 3	RUC_01 RUC_04 RUC_05 RUC_07	3		28	All the competences at Korian have been involved and trained: physiotherapist & APA, occupational therapist , day and night nurses, life aids…..
	TOTAL	**77**	**0**	**47**	**10**

Panel 1 – Active seniors: We recruited 110% of the target number of beneficiaries.

For Panel 1 the recruitment was strongly supported by the local authorities which promoted ACTIVAGE project and allocated an additional funding for the promotion (dance Live Show, conference ..)

Concerning Formal and informal Caregivers: This Panel concerns active people, without any specific dependence, so without needing any support. Therefore, no formal neither informal caregivers have been involved for this beneficiary.

Panel 2 – Frail seniors: we have only recruited 8 beneficiaries out of the 20 initially planned**,** because of the technical development delay we had to postpone the beneficiary recruitment.

For this panel “frail persons” we are targeting persons already engage with formal caregivers. The recruitment was delegated to the Home Care Service Structure - SAAD - to propose to their clients to participate to ACTIVAGE.

The first step was therefor to recruit the Home Care Service Structures. The Department de l’Isére selected 3 SAAD structure through a call for tender and has allocated an additional budget to finance this structure.

The main difficulty with this recruitment is due to the delay in the technology development which was not adapted to the SAAD time scale.

- at the level of the SAADs: The implementation of the project in the SAADs required strong involvement of the managers to inform their teams and potential beneficiaries.

  Information by telephone as initially planned is not efficient to explain the beneficiaries the project interest. Home visits or group meetings had to be organized to better embody the discourse. The time required for this action was too important regarding the workload of the SAADS managers.

- at project level: The time between the mobilization of the Home Care Service Structure (SAADs) and the implementation of the project was more than one year. During this long period, the teams have changed because of strong turnover in the SAADs.

  It needed additional resource from TASDA team to keep involve the recruited SAADs and beneficiaries while waiting for the technology to be ready.

The turnover in SAADs had an important impact for the project, this is a ground truth for the technology-based service proposed to Frail senior. Turnover of professional caregivers will be a barrier to be taken into account for service adoption by frail persons, and therefor for future commercialization of the service.

Finally, the professionals faced several difficulties to recruit beneficiaries despite the strong relationship of trust they have built with their clients.

- Difficulties for the professionals to present a project as complex as ACTIVAGE despite numerous supports by the team project and flyers, information documents…
- Lot of persons without any internet equipment: we finally managed to finance and install 4G Boxes
- Lot of people refusing : in addition to the confrontation to the dependency people tend to prefer to deny or avoid, they don’t want technologies, don’t want something new, don’t want to engage themselves or can’t see any advantage for them – the priority was the person itself

Concerning the recruitment of Informal caregivers: The beneficiaries felt deeply concerned by the risk of being a burden for their caregivers. In this respect, they refused to involve their relatives in the experimentation.

Panel 3 – Hospitalized senior

The KORIAN "Les Granges" follow-up care and rehabilitation hospital at Echirolles has been involved in the Isère experiment since the co-conception phase. In the initial plan we expected to involve a second institution from Korian Group. To test the solution as well in a Nursing home. The Nursing home Korian “Saint-François” in the Rhône Region has been contacted, but the problems encountered in “Les Granges” led us to focus the experience on this unique establishment. Reducing the number of targeted rooms to be equipped from 10 to 5.

At “Les Granges”, more than 40 Korian professional have participated to the co-conception of the solution during the BUILD Phase. All the competences at Korian have been involved:

physiotherapist and APA Adapted Physical Activity, occupational therapist, day and night nurses, life aids, gerontologist, psychologist, Hygiene and maintenance, Direction team, receptionist, planning manager, social worker. Among them, 28 have been trained to use the solution.

End of BUILD Phase, July 2018 a first room was operational in “Les Granges” connected to internet through Ethernet able, and one patient has been included for initial testing.

For cost and production reason, it was planned from the early beginning to move to wireless connexion of the rooms for DEMONSTRATRE and EXPAND Phase. Korian DSI requirements impose that two mode of connexion cannot be deployed in a same establishment.

We expected to equip 5 rooms in Korian “Les Granges” and moved to wireless connexion using Korian WiFi Network.

Despite the coordinated involvement of Korian, Technosens and CEA IT teams, it has not been possible to solve the problems of connection of Korian rooms to the Technosens and CEA networks. The solution has never worked reliably in the rooms which has prevented us from recruiting more than 3 patients in 2019. When the COVID problem arises, all has to be stopped because sanitary rules.

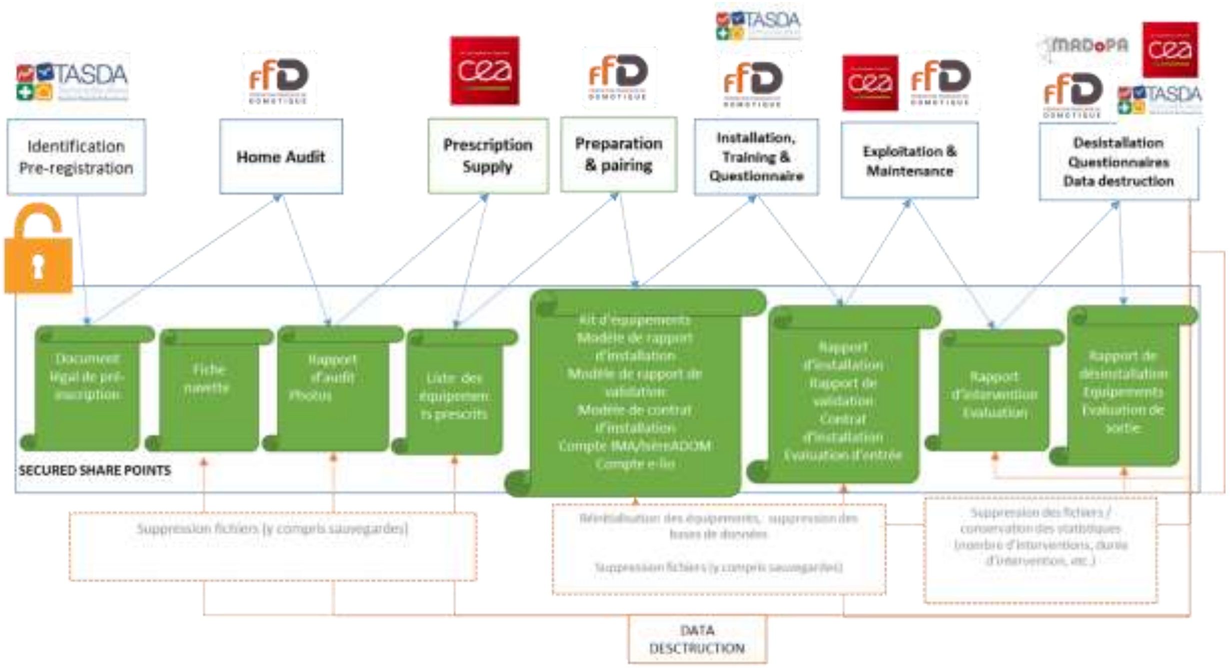
To at least get a feedback from patient about the proposed services, Madopa has organized a focus group with patient, results are described in Evaluation analyses section 8.2.4.3.

8.1.2 IoT infrastructure deployment

This chapter give a synthesis of the number of facilities and devices installed for the DS Isère experiment as well as the human based services proposed to the beneficiaries.

Same remarks than for the number of beneficiaries, it is not meaningful to count the numbers of installation or devices installed per AUC/RUC but by Panels for our DS Isère

DS Isère process for inclusion and installation and exploitation was set up to ensure total compliance with GDPR regulation. The whole process is described below with the different stakeholders involved at each step.



For the deployment phase itself the main step involve TASDA for the identification of the volunteers and pre-definition of their wishes.

As DS Isère plan to experiment a **personalized** solution, we added a first step of AUDIT of the home done by the installer for the adaptation to the home constraints. This step has been really mandatory for the smooth organization of the installation.

The installer audit, allows CEA to define the adapted set of device and prepare the box, then to the installer to realise the kit commissioning and pairing steps. A final validation was done between CEA and the installer prior to the installation at the beneficiary home.

The picture below shows an extract of the audit of a panel 1 home filled by the installer.

ACTIVAGE

AUDIT PANEL 1 – Fonctions #3

Suivi de l'état des équipements de cuisine :

Froid :
-Présence d'un réfrigérateur : oui - non.* 9/1.
Emplacement :
Prise accessible : oui - non.
-Présence d'un congélateur : oui - non.*
Emplacement :
Prise accessible : oui - non.*

Table de cuisson :
-Type : gaz - électrique.*
-Si électrique, connectée directement au tableau électrique :
~~oui~~ - ~~non~~ - ne sais pas.*
Si non, prise accessible : oui - non.
-Estimation de la puissance de la table : ______ watts.
~~-Si gaz, type de gaz : bouteille - gaz de ville.~~*

Four :
-Type : gaz - électrique.*
-Si électrique, connecté directement au tableau électrique :
~~oui~~ - ~~non~~ - ne sais pas.*
-Estimation de la puissance du four : ______ watts.
~~-Si gaz, type de gaz : bouteille - gaz de ville.~~*

Autres équipements :
-Four micro-ondes : oui - non
-Four d'appoint électrique : oui - non
-Autres :

ACTIVAGE

AUDIT PANEL 1 – Bilan

Récapitulatif des fonctions possibles à installer:

Fonction	Oui	Non	Remarques
Risque d'inondation	X		
Risque d'intoxication au CO	X		
Risque de fuite de gaz		X	
Risque d'incendie	X		
Eclairage automatique au lever de nuit	X		
Suivi consommation douche	X		
Suivi de l'état des équipements de cuisine	X		
Suivi consommations électriques		X	
Information sur les ouvrants extérieurs	X		2 portes
Qualité de l'environnement (station météo)	X		

Figure 102 DS ISE extract of an audit report

Table 131 DS Isère installed facilities

Panel	RUC	Private homes	Personal environments	Shared room in senior facility	Healthcare Daycare facility	Other spaces
Panel 1	RUC_01 _05 _07 _08_10	52				3 voluntary testers
Panel 2	RUC_01 _02_04 _07_08	8				
Panel 3	RUC_01 _04_05 _07				3	
Tester	RUC_01 _05 _07 _08_10					3 *testbeds*
TOTAL		**60**			**3**	**3**
Expected		**75**			**5 (10 initially)**	**3**

As mentioned earlier, concerning Korian we did not reach the initial goal of 10 rooms, because of technical difficulties, we reduce the number of establishment to one :"Les Granges". At "Les Granges" we equipped only 3 rooms because of network compatibility problem never solved.

The number of devices installed per home for Panel 1 & 2 depend of the home and the wishes of the beneficiary in terms of services. An average of 16 devices have been installed in the homes for panel 1 & 2 , with a minimum of 13 and a maximum of 22. The average cost of the kit is 1100€ (min 950€ max 1450€).

Table 132 DS ISE Total number of devices installed

DEVICES	Panel 1 INSTALLED	Panel 2 INSTALLED	Tet beds INSTALLED	Panel 3 INSTALLED	Total INSTALLED	*Total TARGET*
RUC	05-07-08	01-04-07-08	01-04-05-07- 08	01-04-05-07		
Tablet , phone, TV	45	7	3	5	**60**	*81*
Digital link booklet		8			**8**	*20*
Gateway	45	7	3	6	**61**	*97*
Dongle radio z-wave	45	7	3	3	**58**	*86*
Motion sensor	34	1	5	12	**52**	*333*
Button / switch	44	6	7	6	**63**	*75*
Door contactor	131	5	10	3	**149**	*311*
Energy meter	19	1	2	0	**22**	*75*
Wall plug meter	112	17	12	0	**141**	*161*
Pedometer	45		3	3	**51**	*51*
Bed sensor	0	5	2	3	**10**	*31*
Lamp	39	5	4	6	**54**	*86*
Air quality =	260		22	0	**282**	*225*
Netatmo / ext. T°	*46*		*3*		**49**	

Netatmo / int. T°	*46*		*3*		**49**	
Netatmo / CO2,	*46*		*3*		**49**	
Netatmo / humidity	*46*		*3*		**49**	
Smoke sensor	17		4		**21**	
Gaz sensor	28		4		**32**	
CO sensor	31		2		**33**	
Flood sensor	45		4		**49**	*75*
Hydrao shower head	43		2	4	**49**	*86*
Weight scale	29	6	2		**37**	*20*
Range extender	2				**2**	
TOTAL devices	**678**	**75**	**62**	**51**	**866**	***1813***

Human assistance service

As already explain in the introduction, the aim of DS ISERE is to create a continuum of care that combines human and technical assistance. Therefore, one goal of the experiment was to evaluate the interest for the users in the different services proposed: **services enabled by the IoT** solution complementing **human assistance services**.

For panel 2 the human assistance service was already proposed by the care professional from the Home Care Service Structure. Duplicated from IsereADOM experiment, a care manager called "Referent sentinel" was affected to each beneficiary of panel 2. A digital link booklet was used to collect and share beneficiary information between the beneficiary, the home carer and the Referent Sentinel on a same dashboard. A dashboard allows to share information about the beneficiary overall health and autonomy status to adapt the organization of care if needed.

Concerning Panel 3 the human assistance is the usual service given by KORIAN Les Granges team for rehabilitation journey of the patient and of course depend on the patient pathology.

For Panel 1, based on the territorial diagnostic and department de l'Isère former experience, four workshops on the themes of ageing well at home using digital tools, adapting housing or lifestyle habits were organised and led by local players (e.g. nutritionist, association for the improvement of housing). Two conferences led by sociologists were held on the social role of senior citizens. All the panel beneficiary have been invited to the workshops.

Individual, personal service have been also offered to panel 1 beneficiaries, in order to help people individually apply the principles discussed collectively during the workshops: phone motivational coaching led by nurses from IMA, and a home visit by an occupational therapist analyse the person individual situation and needs.

The table below summarize the human assistance service among the RUC

Table 133 DS ISE Human assistance service proposed for panel 1 beneficiaries versus RUC

Services proposed to Panel 1	RUC 01	RUC 04	RUC 05	RUC 07	RUC 08
Workshop: Discovery and use of a digital tablet	X			X	X
Workshop : energetic performance, eco-gesture and home adaptation	X				X
Design workshop: "an ideal home for health"	X		X	X	X
Workshop: nutrition for people aged over 55	X		X		
Conference: «aging well in my city»				X	
Conference: « Inform and be informed »				X	

Motivational coaching (by phone)	X		X	X	
Home visit by an occupational therapist	X		X		X

8.1.3 Experiment running report

8.1.3.1 Users participation

Number of drop-offs by the end of the experiment 30th of June

Table 134 DS ISE Number of drop off and reason for stooping

Reasons for drop-offs Panel 1	Number of drop-offs
Not interested anymore before installation	11
Not interested anymore because of technical failure or disturbing	10
Move house + not usefull enough	1
Heath problems + overload cognitive	1
Death	1
Commitment too hard to keep	1
Formal caregiver left the Home care service Structure, the beneficiary did not want to continue with another care giver	1

Total number of user actually in operation

For panel 1, the total number of beneficiary who has participated to the experiment until the end is 38 out of 63 recruited (60%) , and 73% for the installed persons. (38 out of 52 installed)

As planed in the Experiment Plan of DS ISERE, all the beneficiary homes have been de-installed. So, there is no more beneficiary equipped 1 july 2020.

Usage level of the solution and services

IoT enabled services (RUC_01_04_08) where active 24/7 for the security and comfort services.

A dashboard allows the beneficiary to consult the home parameter, but no tracker of this consultation was set. Therefore, the effective usage of the solution by the beneficiaries is not possible to quantify.

For panel 1, the effective usage of the human assisted service was quantified by the number of registrations to the proposed service.

We can see a high participation for the “technical” Workshop (tablet, energy , home adaptation) 67% participation (average of 34 participants out of 52 invited). The individual services offered (motivational coaching and visit by an occupational therapist,) have also been widely used: average of 23 out of 52 – 44% which is high for this population of active seniors.

The numbers are given in the following table.

Table 135 DS ISE Number of beneficiaries that have used the human assistance proposed in panel 1

Service / Activity	Collective or Individual	Number of participants
Workshop: Discovery and use of a digital tablet	Collective	37

Workshop : energetic performance, eco-gesture and adaptation at home	Collective	35
Design workshop: “an ideal home for health”	Collective	30
Workshop: nutrition for people aged over 55	Collective	12
Conference: «aging well in my city»	Collective	13
Conference: « Inform and be informed »	Collective	9
Motivational coaching from a IMA nurse (by phone)	Individual	25
Home visit by an occupational therapist	Individual	21

Device appropriation

Finally, to get a vision of appropriation of the IoT device by the beneficiaries, we have given the opportunity to the beneficiary to keep the most interesting devices of the KIT, the one they would like to use even after the end of the project.

This was proposed to panel 1 (Active senior) in order to determine the most popular devices and functions for this population.

The tablet was not proposed as Technosens will use it for another experimentation. A total of 22 beneficiaries asked to keep 29 devices. The most popular being the connected shower head and weight scale.

Table 136 DS ISE Number of devices kept by the beneficiaries of panel 1

RUC	Devices “adopted” by the beneficiary	Number
RUC_8 Safety & comfort at home	Connected shower head	10
RUC1_ Daily activity monitoring	Weight scale	7
RUC_8 Safety & comfort at home	Smoke sensor	3
RUC_8 Safety & comfort at home	NETATMO Station	2
RUC_8 Safety & comfort at home	Gaz sensor	2
RUC_8 Safety & comfort at home	CO sensor	2
RUC_8 Safety & comfort at home	Flood sensor	1
RUC_8 Safety & comfort at home	Wall plug, smart light , switch	2
	TOTAL	**29**

8.1.3.2 Operational effectiveness

During the development phase of experiment, we have been facing many difficulties to stabilize the selected IoT platform sensiNact that was initially designed for smart cities applications and not for smart home. Smart homes require to deploy a large number of instances of sensiNact running in parallel, one for each facility equiped and to have a reliable transmission of sensors' data as there is no redundancy of information. This development took longer than estimated and until the end of the experiment was not fully reliable.

DS Isère solution designed to be fully customizable and GDPR compliant, created a high level of complexity which leads to face high number of operational issues all along the experiment, and we did not succeed to totally solve them until the end.

Below is a schematics to explain the different causes of defects that can occur on the solution.

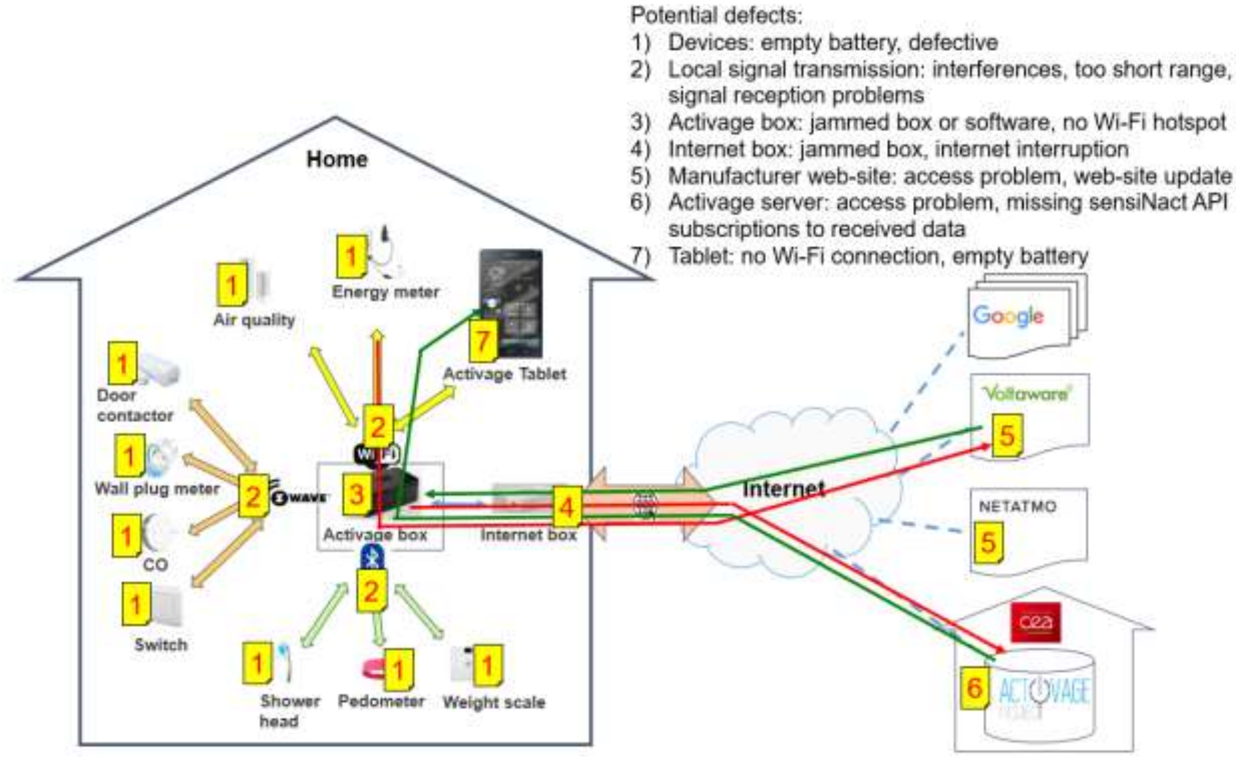


Figure 103 DS ISE schematics of DS Isère architecture and potential source of technical issues

As shown on above schematics, when a technical issue was reported by a beneficiary through the ticketing toll, the diagnostic was complex to establish because of the large diversity of possible causes of defects.

We have never reached sufficient reliability to have a meaningful counting of issues during operation. For example, it was needed several times to stop all the system for one or two weeks.

Instead of issues counting, a qualitative analysis of operational issues has been done:

During system's installation at beneficiaries' homes

At the end of the experiment, a workshop was held with the five installers to analyse their feedback about the installation and the exploitation phase.

The figure below shows the technical issues occurrence per of issues during the installation phase. More generally, almost all the installations have faced technical issues mainly because of the complexity of the global architecture. They would have needed a supervision tools to validate the functionality of the solution during the installation. The pairing of the devices during the preparation step was also considered very long and not reproducible because of Z_Wave device low reproducibility.

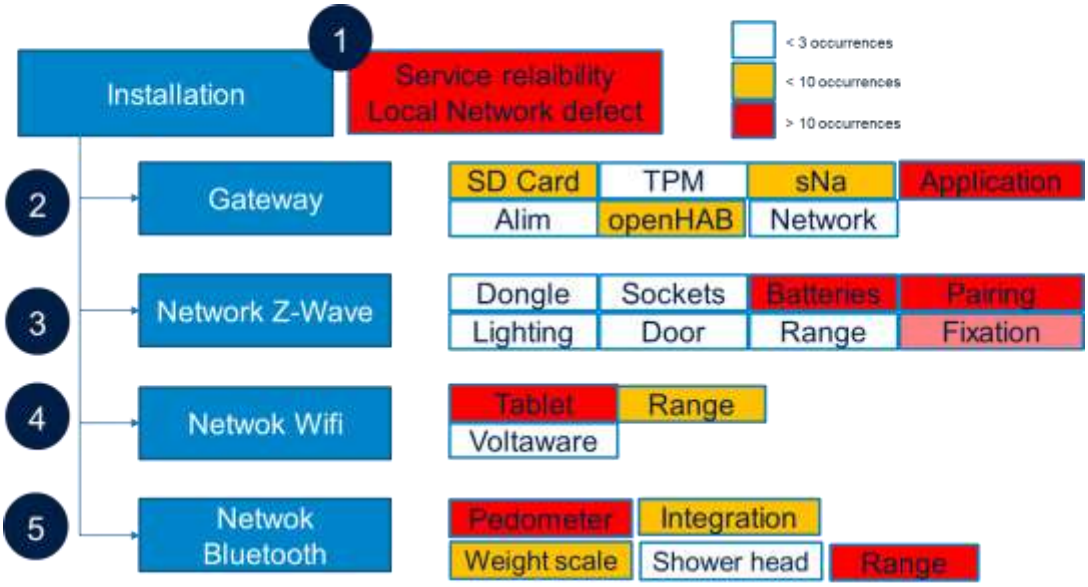


Figure 104 DS ISE Technical issues occurrence during installation phase.

During solution's exploitation.

Table 137 DS ISE Technical issues occurrence reported during exploitation

Panel	RUC	Number of issues	Description of main issues experienced
1 &2	01_04_05 07_08_10	< 10 occurrences	Netamo outside sensor was not water proof
1 & 2	01_04_05 07_08_10	> 10 occurrences	No reception of transmitted signal (Netatmo outdoor sensor or Hydrao shower head), often due to range's problems
1 & 2	01_04_05 07_08_10	< 10 occurrences	Jammed Netatmo
1	01_05 _07 08_10	> 10 occurrences	Inopportune lighting of automatic lighting
1 & 2 & 3	01_04_05 07_08_10	< 10 occurrences	Loss of configuration by pedometer
1 & 2 & 3	01_04_05 07_08_10	> 10 occurrences	Empty batteries of devices
1 & 2	01_04_05 07_08_10	< 10 occurrences	Memory overflow of Activage gateway due to sensiNact
1 & 2	01_04_05 07_08_10	> 10 occurrences	No update of sensor values on tablet due to failing of sensiNact API subscriptions to received data on Activage server
1 & 2	01_04_05 07_08_10	> 10 occurrences	Inopportune temperature's alert on tablet due to loss of threshold's configuration by sensiNact
1 & 2	01_04_05 07_08_10	< 10 occurrences	Access to manufacturer's web-site to send sensor data or to retrieve sensor data

1 & 2	01_04_05 07_08_10	< 10 occurrences	No Wi-Fi connection of tablet
3	01_04_05 07	> 10 occurrences	Unreliable Wi-Fi hotspot
	TOTAL	> 100 occurrences	

Maintenance during exploitation

A total of 37 maintenance for the 59 panel 1 & 2 installation have been necessary during the exploitation phase which lasted 15 month (March 2019 to June 2020).

Average response time to end-user requests/ inquiries (in hours).

At the beginning of the experiment, many beneficiaries notified several issues that were encountered by all beneficiaries and it was not possible to answer them individually and in a short time. Solution's running had to be stopped for one or two weeks several times to solve problems and a general information was made when the solution was again running.

Gradually problems became more personal and at the end response time to end-user request can be less than one day.

Effectiveness in incidents management (% of issues solved)

Depending on issues, their causes or only their temporary consequences were solved.

60% of causes of issues had been solved but for instance, until the end, there were still unsolved sensiNact API subscriptions' problems. Therefore we finally designed a supervising tool to identify in real time what were the missing subscriptions for each home, which helped us to quickly re-subscribe and to shorten our response time below ½ day. Thanks to this tool, we managed to quickly correct the consequences (no update of some sensor values on tablet) but not the cause (missing sensiNact API subscriptions to received data) of the problem.

Average response time to technical/ operational issues (From the time an issue is reported to the time the ACTIVAGE successfully addresses it (i.e. a working solution is provided)).

In order to be more efficient for the diagnostic of the technical issues, we finally designed a supervising tools to identify when/where was the problem, which helped us to correct more efficiently the problem and to shorten our response time below ½ day.

This tools was finalize quite late in the project, it allows to detect and correct the consequence of the problem but we did not manage to fully solve the intrinsic causes (in particular the failing of sensiNact subscriptions).

The specification of the life monitoring tools are to visualize the :

- Status of the gateways
- Status iof each installation
- Check sensor configuration
- Status of each sensor per installations
- Data synchronization
- Data display on the user tablet

The architecture of the Life Monitoring tool that was developed are given in the figure below architecture.

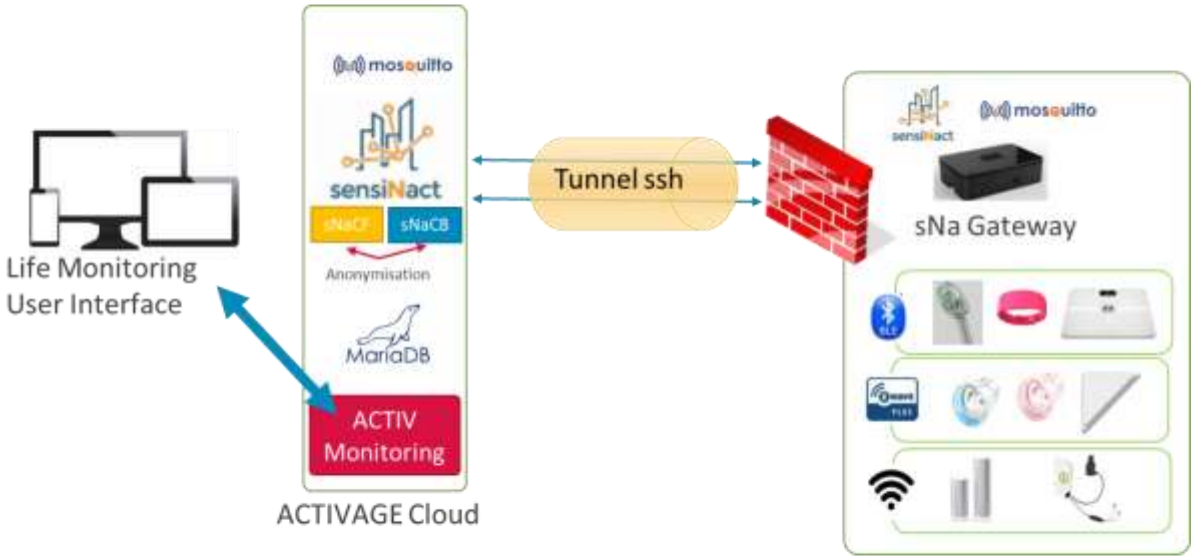


Figure 105 DS ISE Architecture of the Life Monitoring Tool

Two different configurations of the tool views are shown in the figure below.

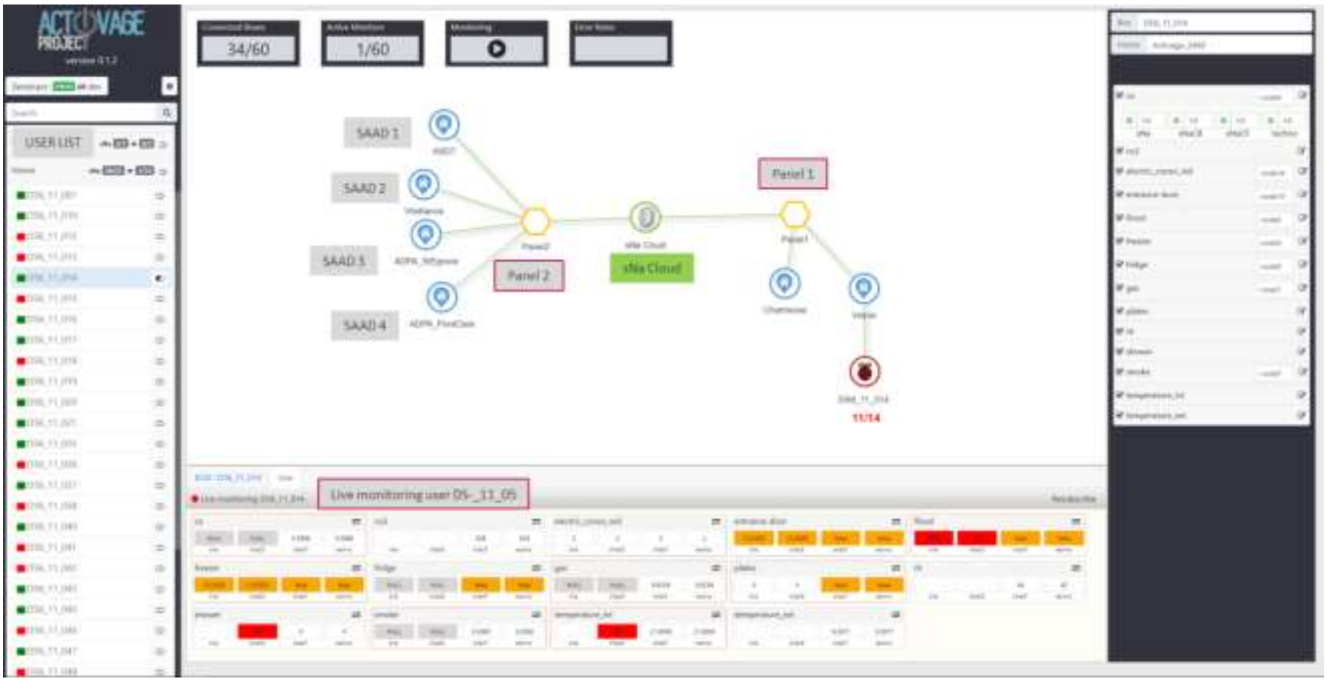


Figure 106 DS ISE Life Monitoring tool Global installation supervision screen

Figure 107 DS ISE Life Monitroing tool : beneficiary supervision screen

Nr of solution updates/ upgrades (per RUC).

All along the experiment, 6 updates of sensiNact on ACTIVAGE server were necessary.

16 remotes updates of Activage gateways were necessary to be compliant with new version of sensiNact on server, to improve or add reception of different sensors' data, to manage memory overflow, to better manage gateway's startup.

8.1.3.3 Use case exchange report

DS Isère was involved in two Open caller projects

Open call with MUVONE activity tracker application

This use case has been about osteoporosis prevention with a wearable device carried by the elderly and an associated application which raises inactivity alerts and promote physical activities for the elderly. This is done by monitoring user's physical activity, calcium intake, as well as exposure to sunlight by using the Muvone wearable device. For the data collection and analysis phase, the DS Isère planned to provide participating users with recommendations that encourage them to do physical activities.

The DS Isère currently does not have a solution to monitor in such detail the physical activity of the users suffering of osteoporosis and providing them recommendations. Furthermore DS Isère is already proposing an activity tracker using a pedometer wristband but the one selected was not really ergonomic for the beneficiaries: the attachment of the wristband is not adapted to elderdy and had no screen to display the step numbers which was expected by the users. We hoped to find a more suitable device with the MUVONE one.

The devices from MUVONE goes under the challenge of physical activity coaching/motivation of the ACTIVAGE project, which is also an important use case for DS Isère. DS Isère is interested in testing the solution which can bring interesting results in terms of osteoporosis prevention. Another interesting output from the experimentation can be to have feedbacks from the users in terms of using a wearable in their daily life, which is not always trivial for elderly people. DS Isere was also interested in the proof of technical interoperability through AIoTES.

The use case was shared with DS in Spain and in Greece. As MUVONE is based on FIWOO, a proprietary platform of Secmotic based on FIWARE, we decided to make use of the existing FIWARE bridge to the AIoTES SIL and just develop our own upstream alignments for data exchange through SIL.

The integration strategy has been clearly based on the AIoTES SIL: Secmotic to develop the upstream side of the integration using the FIWARE bridge to the AIoTES SIL and DS6 to develop the downstream side based on the sensiNact bridge to AIoTES SIL. Both Secmotic and DS6 had therefore to plan for the related semantic alignments.

The deployment was initially planned for up to 10 users in a test environment at the UNAPARTE demonstration apartment provided by TASDA. To that end, Secmotic to provide the DS with 10 Muvone wearables as well as access to their FIWARE context broker in order for Isere to retrieve the information via subscription and use the upstream and downstream alignment pair to receive the message in local data structure.

The evaluation of the solution was to be done from both user (easiness of usage, utility of the recommendations) and technical (successful data flow between the FIWARE and sensiNact through AIOTES SIL) perspectives.

CEA Received 5 wearables from MUVONE and has installed MUVONE gateway into test RPI in CEA Testbed. The data flow was validated from the RasperyPi to MUVONE sever

User interface : sunlight exposition, tablet apps : step counter MUVONE wristband

Figure 108 DS ISE Picture of MUVONE wristband and user interfaces

Conclusion: The experimentation was great in terms of technical evaluation of the interoperability between FIWARE and sensiNact through the AIoTES SIL. We managed to send data to the FIWARE platform, get it to sensiNact through AIOTES.

Unfortunately, due to the global covid-10 crisis we couldn't finalise the evaluation from the end-user perspective. We only had in-lab evaluations by the technical users.

Open call with CommonsLabs User Authentication Hub (UAH)

This use case with the company CommonLabs is about authenticating users by using several alternative means such as NFC cards, keys with RFID tags, fingerprints or traditional user name password in order to limit the access to sensitive information to only relevant and authorised users (caregiver, elderly person, patient, family, friends, etc.).

The deployment site currently does not have such authentication solution. The user having the data access device in the hand (e.g., tablets) can access the whole information. The CommonsLab solution can allow handling the rights to access various information collected in the Deployment Site in a finer way.

CommonsLab security solution is being integrated with DS Isère IoT platform sensiNact. Both solutions use similar security technology, which is based on the OpenId. The solution will be first deployed in CEA's test environment. If the results are satisfactory, it will be tested with some end-users from the DS. The evaluation will be mainly based on the user satisfaction (easiness of usage of the authentication system) as well as from the technical point of view (if the data access authorisation correctly handled). UAH is providing documentation for Keycloak configuration for user federation with other Keycloak and LDAP servers and exposes the needed OpenID configuration for relying parties to easily integrate for requesting user authentication.

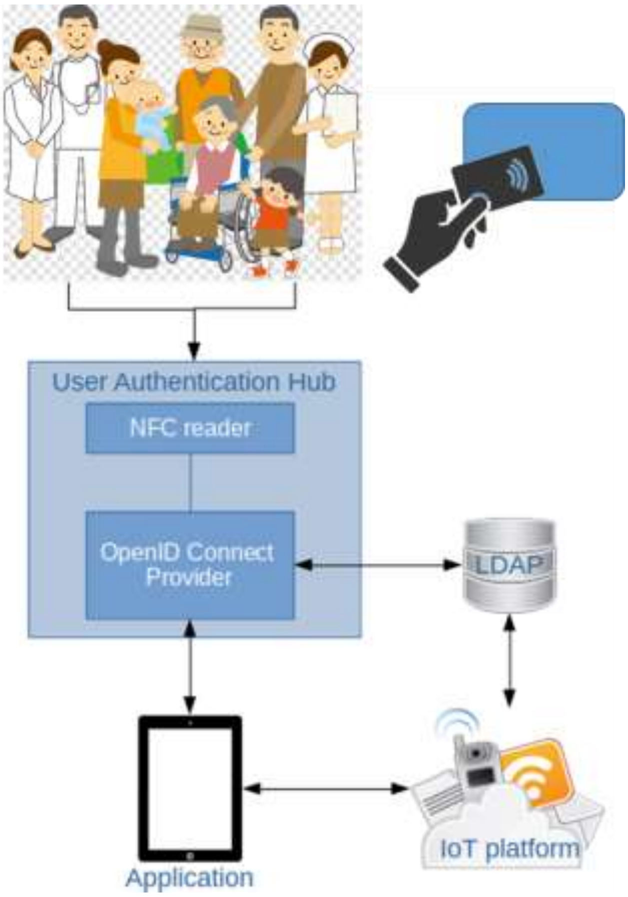


Figure 109 DS ISE Architecture of the User Authentication Hub implemented with CommonLabs

The experimentation went very well in terms of technical integration and interoperability with our security solution based on Keycloak and OpenId. The usability could only be tested in the PTL environment due to the covid-19 situation thus couldn't be validated by the end-users. However based on the first feedbacks of the beta users, it could be a good authentication and authorisation solution for giving relevant access rights to only necessary users (care givers, family, patient, etc.). The usability seems therefore to be acceptable.

Conclusion: It was a useful experimentation, rather from the technical perspective. It allowed us considering using similar NFC based authentication for our platform. We will thus continue on working on the security topic based on this experimentation and the results will be sustainable.

UAH was developed in close partnership with DS Isere, analysing the DS Use cases and identifying early on the needs. Clarity of requirements ensured the prototype was delivered as described. Unfortunately there was no time left for any improvement phase that could result in a more refined result.

8.2 Local evaluation report

8.2.1 Goal of local evaluation: primary and secondary endpoints

In DS ISE, the evaluation protocol is designed in order to co-design the value proposition, the personalized kits and eventually the services for Panel 1, Panel 2 and Panel 3 with clients, end-users, beneficiaries and stakeholders of the solution -patients, family caregivers, elderly people, professional caregivers, Korian, MDA, installers.

In order to involve all those stakeholders in the evaluation process, value proposition continuous improvement loops are conducted since the beginning of the pilot. Four loops are to be considered:

- Need opportunity identification: through territorial diagnosis, interviews, workshops, conference-debates, focus groups that provide specification books for P1, P2 and P3
- Acceptability, QuOL and usability evaluation: Global KPI questionnaire, local KPI questionnaire, UTAUT questionnaire, EQ5D3L questionnaire
- Reliability: technical evaluation (false positive, false negative, breakdowns, dataloss)
- Usage evaluation: semi-conductive interviews with a socio-anthropological methodology at home with beneficiaries (P1) and focus group (P3)

In addition to this process, a Cost-effectiveness evaluation has been led by the end if the pilot following the instructions provided by WP6 (ICER = Ca -Cb/ DeltaQualy). Scalability reports are ongoing. (Korian, done in July 2020, MDA, planned in September 2020).

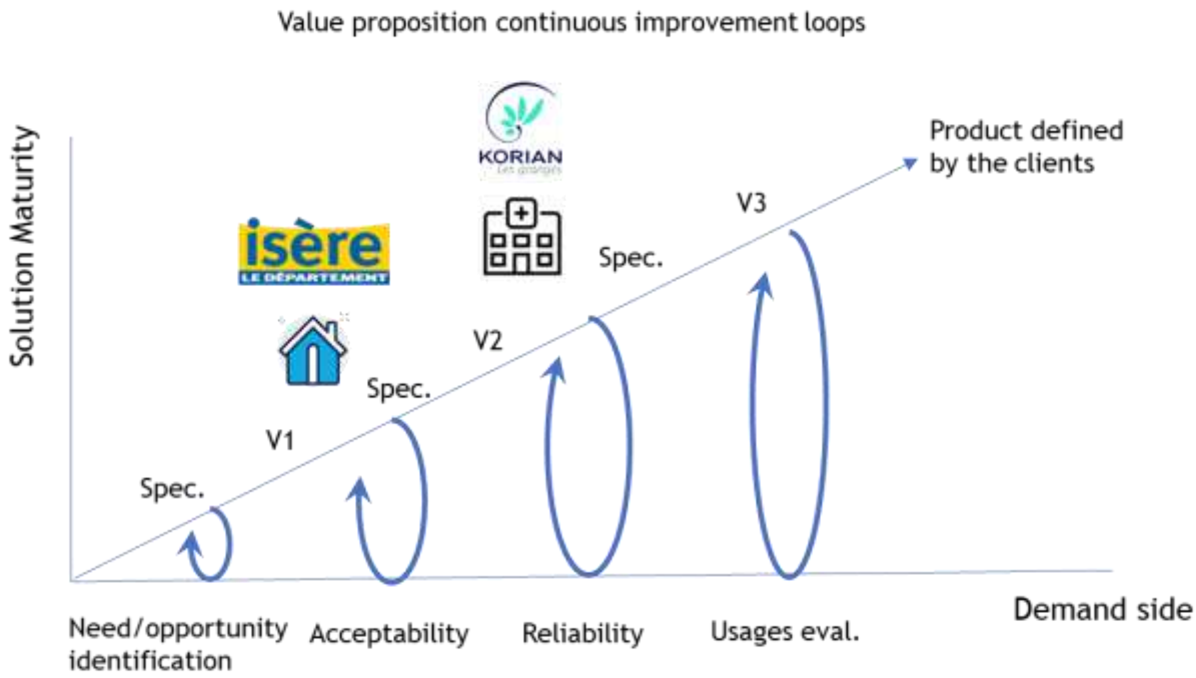


Figure 110 DS Isère continuous improvement development and evaluation loop

8.2.2 Local KPI collected

One will find below the list of local KPI's that were supposed to be collected following DS ISE evaluation protocol. For panel 3, due to Covid, these KPI's have been explored through semi-conductive interviews with professional caregivers before the pilot and through a focus group with patients but not properly measured as this part of the experiment has been cancelled due to the Covid.

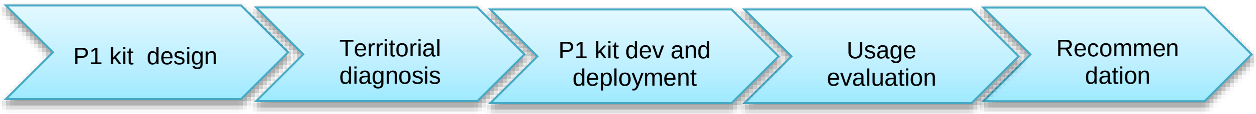
Global items (UTAUT, Global questionnaire, EQ5D3L, ICER) and most of local items have been measured through questionnaires that can be found in Appendix. Other items are measured through a "Usage evaluation": 20 semi-conductive interviews with a socio-anthropological methodology at home with beneficiaries (P1) and focus group (P3). The item Scalability is measured through semi-conductive interviews with appropriate stakeholders (the potential service provider included in the consortium. It has been done for P1, P2 and P3, and the result YES for P1 & P2 and NO for P3 (Local reports have been issued in September 2020 to sum up the interviews decision-makers in Korian and CD38).

Table 138 DS ISE Local KPI Table by panel

Name	Data Source		measur.unit	When
Panel 1, kit adoption by the beneficiaries	Exit survey	50,00%	%	End of the ex
Panel 1, impact on QuOL (beneficiaries)	Input and exit survey EQ-5D	1,2	%	Start/end
Panel 1, satisfaction level (beneficiaries)	Input and exit survey	66,00%	%	Start/end
Panel 1, impact on care relationship (old person-informal caregivers	Usage evaluation	Positive	%	2018
Panel 1, Use of data	Data analysis	Increasing re	%	Start/end
Panel 1, efficiency in health promotion	Usage evaluation	Efficiency im	#	2018/2019
Panel 1, scalability	Organisationnal analysis	Scalability	Y/N	2020
Panel 1, robustness	Nb of faults	Decrease	Number	2018/2019
Panel 1, trust in IoT and digital (reliability)	Input and exit survey	Progress	%	Start/end
Panel 1, trust in IoT and digital (protection)	Input and exit survey	Progress	%	Start/end
Panel 1, trust in IoT and digital (data privacy)	Input and exit survey	Progress	%	Start/end
Panel 1, trust in IoT and digital (cyber security)	Input and exit survey	Progress	%	Start/end
Panel 2, impact on QuOL (beneficiaries)	Input and exit survey	1,2	Y/N	Start/end
Panel 2, kit adoption (beneficiaries)	Exit survey	50	%	End of the ex
Panel 2, satisfaction level (beneficiaries)	Exit survey	66	%	End of the ex
Panel 2, impact on care relationship (old person-professional caregi	Usage evaluation	Positive	%	2018/2019
Panel 2, impact on care relationship (old person-informal caregivers	Usage evaluation	Positive	%	2018/2019
Panel 2, trust in IoT and digital (reliability)	Input and exit survey	Progress	%	Start/end
Panel 2, trust in IoT and digital (protection)	Input and exit survey	Progress	%	Start/end
Panel 2, trust in IoT and digital (data privacy)	Input and exit survey	Progress	%	Start/end
Panel 2, trust in IoT and digital (cyber security)	Input and exit survey	Progress	%	Start/end
Panel 2, Impact on QuOL (professional caregivers)	Usage evaluation EQ5D	1,2	%	2018/2019
Panel 2, Impact on QuOL (informal caregivers)	usage evaluation EQ5D	1,2	%	2018/2019
Panel 2, scalability	Organisationnal analysis	Scalability	Y/N	2020
Panel 3, kit adoption by the beneficiaries	Exit survey	50,00%	%	End of the ex
Panel 3, hospital discharge optimization	Exit survey	Optimizatior	Y/N	End of the ex
Panel 3, trust in IoT and digital (reliability)	Input and exit survey	Progress	%	Start/end
Panel 3, trust in IoT and digital (protection)	Input and exit survey	Progress	%	Start/end
Panel 3, trust in IoT and digital (data privacy)	Input and exit survey	Progress	%	Start/end
Panel 3, trust in IoT and digital (cyber security)	Input and exit survey	Progress	%	Start/end
Panel 3, Impact on QuOL (professional caregivers)	Usage evaluation	1,2	%	2017
Panel 3, scalability	Organisationnal analysis	Scalability	Y/N	2018/2019
Panel 3, reliability (false positive)	Exit survey	5	Number	2020
Panel 3, reliability (false negative)	Exit survey	0	Number	2020
Panel 3, robustness (faults)	Exit survey	Decrease	Number	2020

8.2.3 Local evaluation protocol

8.2.3.1 Panel 1



Territorial diagnosis (Internal deliverable “Diagnostic territorial”)

NOVEMBER 2017

Baseline questionnaire (Global questionnaire, EQ5D3L, Local KPI Questionnaire)

JANUARY 2020

Conference-debates

March-October 2019

Intermediate questionnaire (Global questionnaire, EQ5D3L, UTAUT, Local KPI Questionnaire)

MAY 2020

Usage Evaluation: 20 semi-conductive interviews with beneficiaries all along the deployment, Internal deliverable “Rapport d’évaluation des usage de l’offre Panel 1 Activage”

JUNE 2020

Final Questionnaire (Global questionnaire, EQ5D3L, UTAUT, Local KPI Questionnaire)

JULY 2020

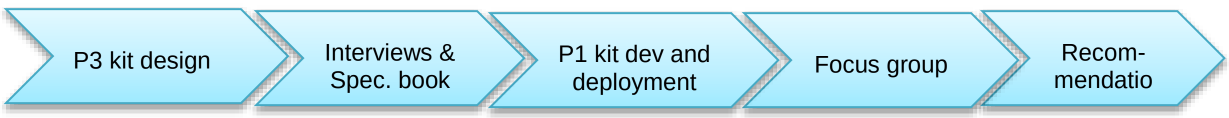
8.2.3.2 Panel 2

Baseline questionnaire (Global questionnaire, EQ5D3L, Local KPI Questionnaire)

Conference-debates March-October 2019

Baseline questionnaires MARCH-JUNE 2020 (Global questionnaire, EQ5D3L, UTAUT, Local KPI Questionnaire)

8.2.3.3 Panel 3



Workshops & 15 semi conductive interviews with professionals feeding a specification book (Internal deliverable “Specification book” DATE) APRIL 2017

Development, deployment, tests of the solution, staff training MAY 2017-JUNE 2020

Focus group with 4 patients - Internal deliverable: “Rapport d’étude Activage, Panel 3, De l’ajustement de l’offre avec les acteurs de Korian les Granges à la perception de l’acceptabilité de l’offre du point de vue des patients », AUGUST 2020

8.2.4 Analysis of results

Table 139 DS ISE Number of questionnaire answered per panel

	EQ5D BAS.	EQ5D INTER	EQ5D FINAL	UTAUT INTER	UTAUT FINAL	SPQ BAS	SPQ INTER	SPQ FINAL
Panel 1	48	32	28	28	27	46	30	34
Panel 2 Seniors	0	0	0	3	0	7	0	0
Panel2 Professionals caregivers	0	0	0	0	0	9	0	0
Total seniors	55	32	28	28	27	53	30	34
Total seniors + pro	55	32	28	28	27	62	30	34

Table 140 DS ISE Number of participant involved in the evaluation steps for each panel

	P1	P2	P3
Recruited seniors (socio-demo)	51	8	3
Seniors participating until the end	38	7	0
Recruited Pro caregivers (sociodemo)	0	9	43
Self-employed IoT installers	5	5	0
Seniors equipped	52[35]	8	3
Global questionnaires	48	16 :7 seniors 9 pro	0
Qualitative interviews	39	0	19
Focus groups	0	0	6
Workshops and conference	151	00	0

8.2.4.1 Panel 1

To put it briefly, one may say that senior participants included in the Panel 1:

- Understand the kit
- Rather trust NTIC and IoT
- Don’t see or expect any impact of the kit on their quality of life (physical, social, etc.)
- Were disappointed by the solution deployed

Kit adoption: 62% would not continue with the kit.

Quality of Life: 71% of the P1 beneficiaries answer Neutral when asked about the impact of the kit on their QuOL in Final questionnaire (Neither positive nor negative impact)

35 One nsenior left the pilot just after the installation (52 installed, 51 participants registered in the socio-demo table).

Quality of social Life: 84% of the P1 beneficiaries answer Neutral when asked about the impact of the kit on their QuOL-social life- in Final questionnaire (Neither positive nor negative impact)

Physical activity: 37,5% of the P1 beneficiaries answer Neutral and 43% No opinion when asked about the impact of the kit on their QuOL-Pysical Activity- in Final questionnaire (Neither positive nor negative impact = 80.5%)

Acceptability of the IoT solution in Final questionnaire: 7,5 /10

Predictable Usage of the IoT solution: Not at all in the final questionnaire (decrease all along the pilot)

Trust in ICT/IOT (reliability): 8,6 (ICT: 8,75/10 – IOT: 8,4/10)

Efficiency in Health promotion: to be improved. A demand for this aspect is clearly expressed in semi conductive interviews of Usage evaluation

Degree of confidence in data privacy, protection, cyber-security: 7,8 / 8 / 9 (scale from 0 to 10, 0 being total lack of confidence, 10 being total confidence)

KPI – impact on care relationship (informal): 84% of the P1 beneficiaries answer Neutral when asked about the impact of the kit on their QuOL-social life- in Final questionnaire (Neither positive nore negative impact). Neutral + No opinion = 93%

Scalability: interviews to be done by mid-september

Robustness: as explain in detail in Chap 8.1.3.2. Operational effectiveness, the robustness of the solution never reached a production maturity, it was therefore not possible to quantify through KPI the level of robustness during the experimentation.

Is the solution satisfying (is it useful for you)?

0 Not at all // 10 Absolutely

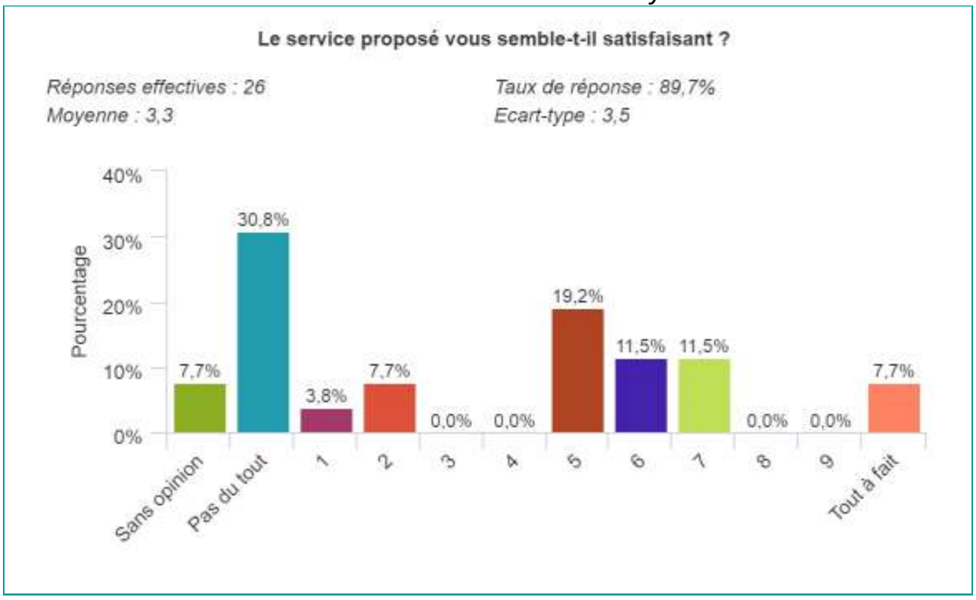


Figure 111: DS ISE P1, Intermediate questionnaires, 26 answers

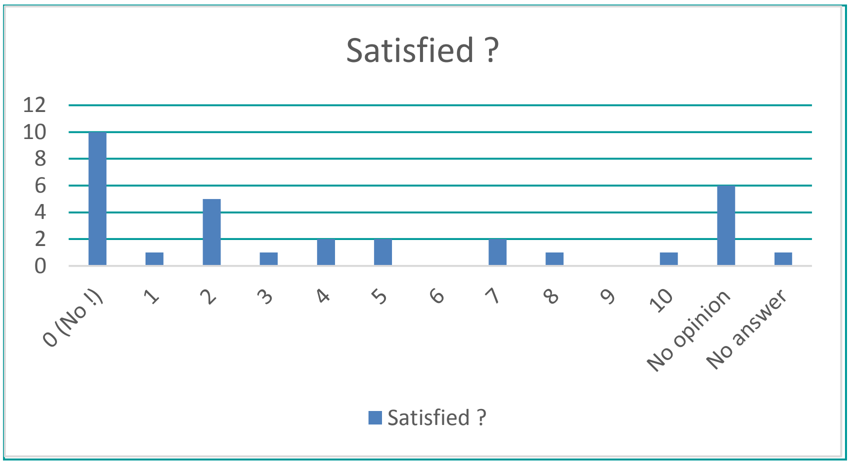


Figure 112: DS ISE P1, Final questionnaire, 32 questionnaires

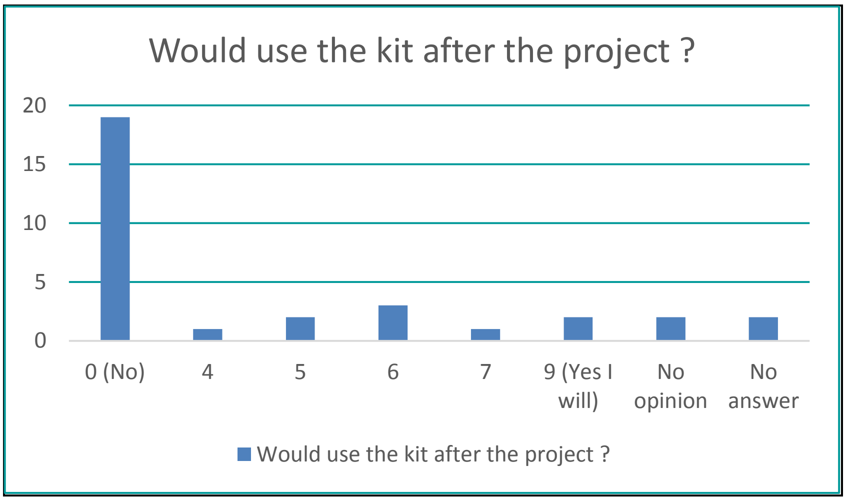


Figure 113: DS ISE P1, Final questionnaires, 32 participants, 30 answers

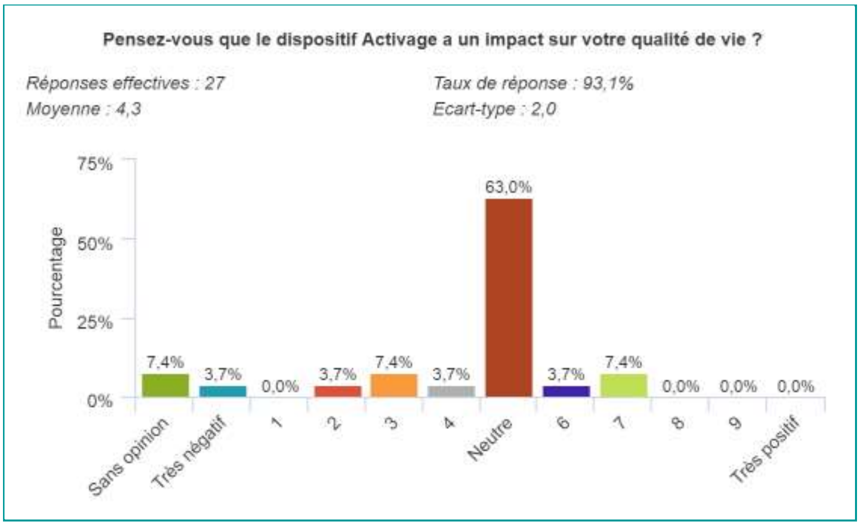


Figure 114: DS ISE P1, Intermediate, Impact on QuOL, 27 answers

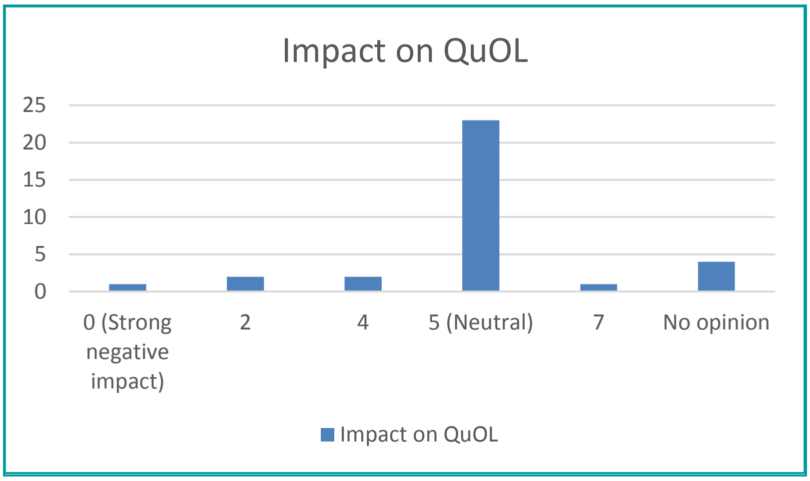


Figure 115: DS ISE P1, Impact on QuOL, 32 questionnaires

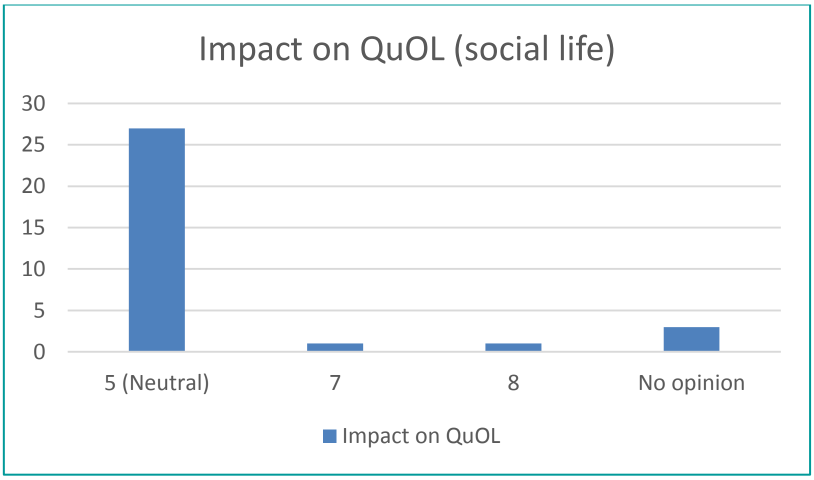


Figure 116: DS ISE P1, Final, Impact on Social QuOL, 32 questionnaires

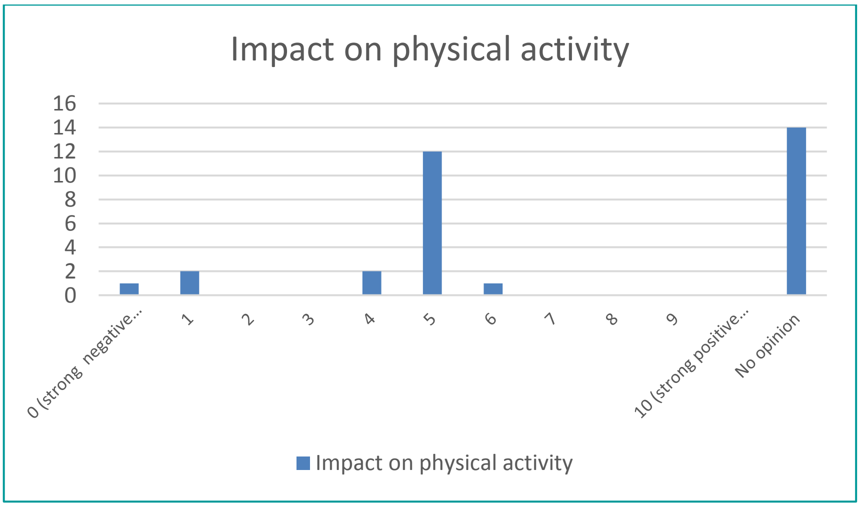


Figure 117: DS ISE P1, Final, Impact on physical activity, 32 questionnaires

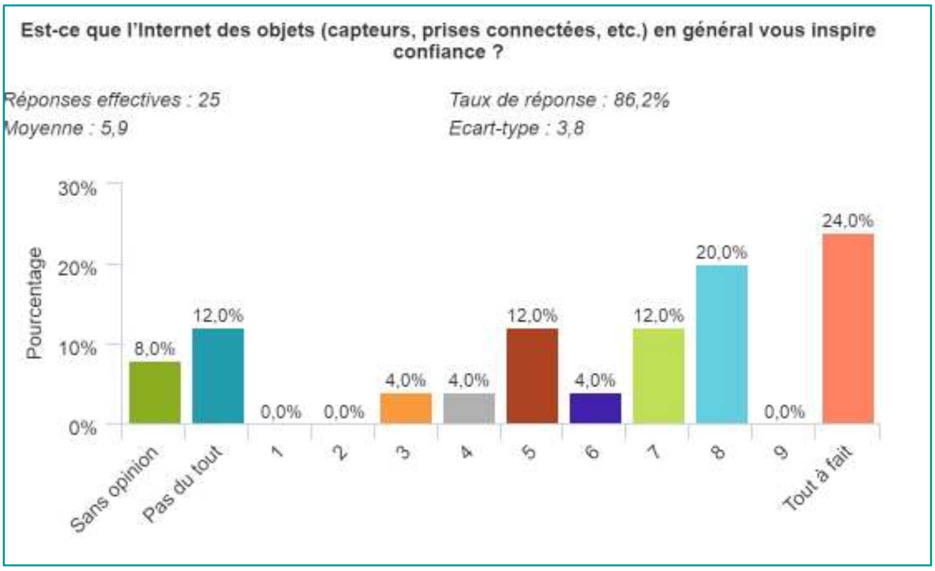


Figure 118: DS ISE P1, Intermediate, 25 answers, Trust in IoT

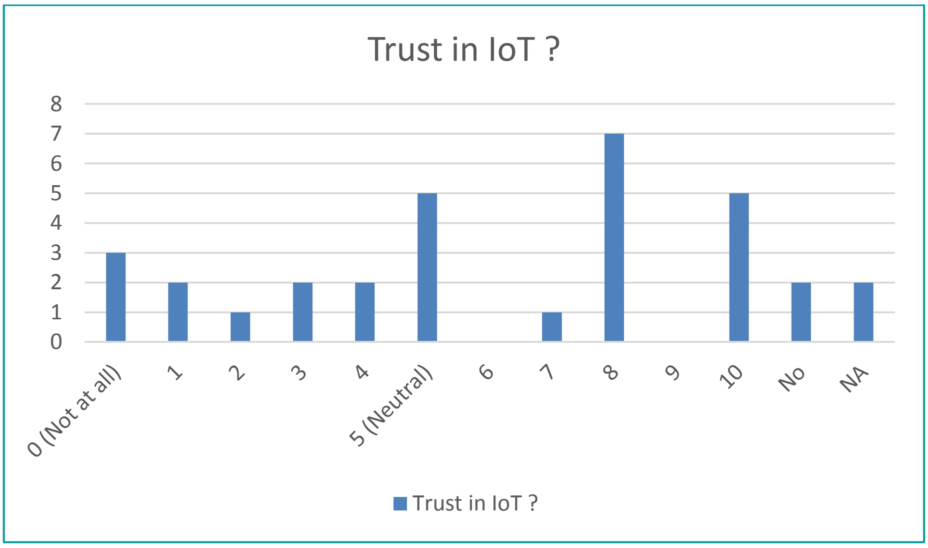


Figure 119: DS ISE P1, Final, Trust in IoT, 32 questionnaires

Usage evaluation PANEL 1

The information we have about the usage evaluation of the solution by the users (both beneficiaries and caregivers), is built through the qualitative interviews we conduct with the beneficiaries and is given in the Evaluation chapter 2.

- The qualitative interviews we conduct with 20 beneficiaries,
- The 345 feedbacks from 37 beneficiaries (email, phone calls, informal discussions during the workshops…)

Table 141 DS ISE Qualitative Usage evaluation for Panel 1 & 2

Device / Service	Usage level Panel 1	Usage level Panel 2
Podometer	PRO • Support for physical activity	Not proposed

	• Support for care relationship with pro caregivers CONS: • Unsightly • Not ergonomic, uneasy to use, difficulties linked to fine motor skills • No access to data directly on the device (for the patient) • Results difficult to understand	
Motivational coaching	PRO: Particularly appreciated by elderly people post stroke or feeling isolated or lonely. CONS: Distant Call center which implies difficulties (the interlocutor may ignore the specificities of patient's ecosystem	*No Proposed*
Weight scale	PRO: Participants would ask for it and would mainly keep it after the experiment Particularly relevant when weight monitoring and coaching on this aspect are done during the motivational coaching by phone.	PRO: Participants (patients and informal caregivers) would ask for it and would mainly keep it after the experiment Better when an ergotherapist present the device and train the patient to use it without risks of fall. CONS: Risks of fall; the chosen object is too heavy, difficult to carry or to move,
Smoke sensor	PRO: Useful, make you feel safer CONS: Bad perceived reliability (gas detection)	
Water leak detector	PRO: Useful and reassuring	
Door contact	PRO: Reduces the number of risky moves inside house (eg. Go down the stairs to check if fridge's door is closed) CONS:: • Comes off and fall too easily because of non-permanent fixation • Missing audible signal	
Lighting automation	PRO: Customizable by the beneficiary himself CONS • Not reliable enough : Random system operation • Too bright light at the beginning of the experiment.	
Connected plug	PRO: • Good appropriation : Hijacked function: using the residual light to walk at night • Useful to control energy consumption CONS: Non-significant Data : should be more explicit	
Shower head connected	PRO: • Meaningful data for users • Users don't feel constrained to reduce their consumption of water CONS: • Random functioning in the different houses • Shower head uneasy to use (weight of the sensors)	*Not Proposed*
Workshop and conference	PRO: Specialists' presence, talks and presentations are mainly appreciated, in addition to the Kit installation CONS: After the conferences, an individual follow-up, at home, more customizable, is missing	*Not Proposed*

Digital tablet	PRO: Users project to use or to buy the device after ACTIVAGE. Many of them would like to transfer some of their data through USB Key in the tablet. CONS • Quick discharge of the battery • Too much time to charge the device • Ergonomic difficulties (fine motor skills) • Restricted features: eg. No access to a web browser	
Home visit by an occupational therapist	PRO: Beneficiaries overall satisfaction	Not Proposed
Digital notebook (IsèreADOM)	Not Proposed	PRO: Corresponds to an evolution of social workers skills and practices CONS: Poorly used directly by elderly people
Bed occupancy sensor	Not Proposed	PRO: Not at all disturbing for the elderly people, relevant according to professional caregivers

The kit designed for the Panel 1 usage evaluation has been conducted through semi-conductive interviews at home, with socio-anthropological methodology in Voiron (10/20), Saint-Laurent-du-Pont (2/20), Saint-Joseph-de-Rivière (1/20), Miribelles-Échelles (2/20), Saint-Cassien (1/20), Coublevie (1/20), Tavernolles (1/20), Grenoble (1/20) et Moirans (1/20), with 20 beneficiaries-end-users of the kit, starting the interviews in JULY 2019 and ending the interviews in FEBRUARY 2020.

This evaluation has been performed by MADoPA project managers. Through a socio-anthropological approach, the added-values perceived by the elderly people and their informal caregivers are collected and analysed, as well as barriers and opportunities perceived by those people in the deployment and use of the kit in their ecosystem. MADoPA is clearly focusing on the impacts expected, observed, feared by the elderly people in their daily life and from their point of view. They define the « quality » that is evaluated. The interview guide, the methodology as well as the report describing the results are available in the Appendix document.

Barriers and opportunities

Globally, one may say that MADoPA's survey identifies in this cohort a taboo or a psychological block about «prevention» or «prevention of autonomy loss». The participants mainly feel that the kit is «not for them» but perhaps for older people, their older parents or neighbours. They often perceive themselves as caregivers more that dependent persons. They may feel stigmatized by the offer.

However, the functionalities deployed appears to be not extremely attractive for the Panel 1 participants. The IsèreAdom phonebook is already available on Internet, as other local and popular phonebooks. Sensors included in the experiment do not feet those seniors need and expectations. This Panel is not in need for help regarding their social life, and regarding that, they do not need a new device or new technological means to keep connected to their relatives and neighbours. When facing an emergency, they prefer direct human contacts

Motivational coaching is mainly appreciated and even if Panel 1 participants don't see immediately how they could use it or benefit from it in their daily life, they eventually fin dit relevant and useful.

Barriers according to elderly

- Who pays?
- "We're caregivers, not elderly loosing autonomy". The target client is not the good one

- Why should we help developing a kit which will not meet a need? Could it be customizable?
- WHo is going to manage, feed and coordinate the platform? How the kit could give access to local services when those services don't exist? How to make the offer local, adjusted, relevant in each specific ecosystem?
- How could the offer adjust to a « family » care relationship?
- Couples. In a couple with different level of autonomy, who will benefit from the offer? With which consequences on wedded lives?
- Who will ensure the data privacy, who will secure and control the information?

Opportunities:

- Set-up a connected grievance notebook, offering quick and smooth information feedback (for the local authorities)
- To develop and support communities and networks (associations) of active elderly people
- To develop a collaborative « place » to share information about health
- Providing help for important decisions (move, renovations, choice of a new accommodation, choice of heating system, etc.)
- To support and value informal caregivers and volunteers
- To create a system to identify and support broken or isolated people
- Build a co-design methodology and a continuous improvement approach for the Activage solution

MAIN RECOMMENDATIONS

- To switch from a « loss of autonomy prevention » to a « solidarity/empowerment » approach to support local actions
- Even classified « healthy », participants to Panel 1 also face small health problems. They would like some support regarding those small problems of their daily life.
- To value care and caregivers
- To value already existing services, networks, local organisations and associations
- Mutualisation of what already exists. Taking poverty into account.
- To answer explicit needs, promptly, in a flexible way, with a high level of customization
- To create a continuum « local solidarity »/ « health promotion »/ «sustain autonomy»
- To adapt the kit to local specificities, making it local through « cultural » dimension and with respect with municipalities' different ecosystems

RELEVANT SERVICES

- To support and to populate existing services and networks (mobility, clubs, parties, animations, sports).
- To make information available, understandable, relevant (local, reliable) and customizable
- Collaborative sharing of information, linked with local solidarities
- Support to find and identify relevant information
- Gaming (online) and networking for elderly gamers
- To develop local access to information (« point-info », stands, markeplaces, shops)

- To allow money savings for sustainable living at home of elderly people; these savings should be discreet, non-discriminating

USEFUL FEATURES

- Networking platform, to value existing solidarities, events, services, associations, actions
- Information platform (nature, environment, culture, services, health, health providers, health services, craftsmen)
- Platform to simplify daily living (solving small problems faced in the everyday life)
- Platform for support (energy poverty, social life, administrative procedure)
- Motivational coaching platform, with contact persons at a local scale
- Monitoring and self-measure devices adapted to each person condition
- Support in the building of a domotic system
- To enrich cultural and spiritual experience
- To detect and measure energy poverty, support and follow-up of the energy performance improvement

NEW CRITERIA TO RECRUIT PANEL1 PARTICIPANTS

By the end of the experiment, it appears clearly that the cohort recruited is heterogeneous and that a recruitment based on levels of autonomy should have been privileged (instead of a recruitment based age, living status and clinical condition).

8.2.4.2 Panel 2

Panel 2 has been set up lately to ensure the best reliability for the kit and faced a premature termination due to Covid. Consequently, this part of the experimentation, planned and designed for 12 months has been shorten to three months. Intermediate questionnaires were cancelled (not relevant anymore on such a short duration) and final questionnaires postponed to mi-September, due to Covid.

KPI for the Panel 2 including professional
Frail Senior – T0

- Quality of Life: 6/10
- Quality of social Life: 4/10
- Physical activity: 3/10
- Impact a priori: 6/10
- Acceptability of the IoT solution a priori: 7,5 /10
- Usage of the IoT solution a priori: occasional
- Trust in ICT/IOT (reliability): 8,6 (ICT: 8,75 – IOT: 8,4)
- Degree of confidence in the digital (ICT/IOT) vs system: 7,5 vs 7,6 (ICT: 7,7 – IOT: 7,3 vs ICT: 8 – IOT: 7,2
- Degree of confidence in data privacy, protection, cyber-security: 7,8 / 8 / 9
- KPI - care relationship (informal): 6
- KPI - care relationship (professional): 5,7

Professionals T0

- Impact on QuOL (professional caregivers) Quality of life at work: 7,1
- Impact on quality of life at work a priori: 5,9
- Quality of social life at work: 7
- Impact on quality of social life at work a priori: 5,5
- impact on care relationship (old person-professional caregivers): Impact on relationship with beneficiary a priori: 6
- Impact on relationship with relatives *a priori*: 6
- trust in IoT and digital (reliability) *a priori*: 2,3 (6 max)
- trust in IoT and digital (data privacy) *a priori*: 3,1 (7 max)
- trust in IoT and digital (protection) *a priori*: 2,4 (7 max)
- rust in IoT and digital (cyber security) *a priori*: 2,7 (7 max)
- Frequency of use *a priori*: 7,2
- Acceptability *a priori*: 6,1
- level of appropriation (professional caregivers):
    - Ease of use *a priori*: 7
    - Data's utility for professionals: 7

Persona P2:

Due to the small number of participants (7) and the short duration of the pilot, the results are here presented through a Persona which represents and illustrates the « average » participant to Panel 2.

Madeleine (57% female/ 43% male), 72 years old (average date of birth : 1951,6), retired (71% of the cohort is retired), single (50%), living alone (71%) in apartment (71%), 3-room apartment (av. 2,9) where she is tenant (71%) in a city (57%). 2 children (av. 1,7) and 4 grandchildren (av. 4,2) that come twice a month to see her (50% 1 to 2x/month ; 33% 1 to 7x/week) and call on a regular basis (57% 1 to 7x/week). A housekeeper and a life support work 58h per month (av. 58,4) in her house and she does not pay for that, and a nurse comes regularly at her house (as 71% of the cohort). Former employee (80% of the cohort), she does not feel at ease with the kit, has no skills in technologies. She has a phone (57%), a mobile phone (100%), a computer (71%) connected to internet (86%).

Madeleine a faces some difficulties (av. 7,7) to walk (100%), to take care of herself (57%), to do her daily activities (86%). She suffers from « moderate pains » (57%) preventing from doing some activities (av. 7,4) but feels moderately anxious (57%). She goes outside once a day (av. 1,1) and do not foresee to leave her apartment (57%). The organisation of care settled for her allows her to stay at home in good conditions (86% absolutely) and she feels well at home (86% yes, absolutely). She thinks she has got a good quality of life (av. 6,6 - 43%), but her social life could be improved (av. 4) and she expects a rather positive impact of Activage on her QuOL (43% -> 6), on her social life (43% -> 6), her relationship with relatives (29% -> 7) and with professional caregivers (29% -> 6).

Madeleine rather trust technologies of information and communication (av. 7,7) and IoT (. 6,1). She has no fear regarding ACTIVAGE, and ACTIVAGE reliability (50% de No fear). It is very easy for her to give her consent for data access (86% de 10, av. 8,6) because she trusts her Life Support and does not think that it is necessary to ask for this consent regularly (like 57% of the cohort). She has no fear regarding confidentiality (50% -> No), data protection (50% -> No) or cyber-security (67% -> No). She is willing to share her data with her relatives (67%) and professional caregivers (67%).

According to Madeleine, sensors could only provide a little help in her daily life (av. 5,5, 5 meaning « no impact » and 10 « Help a lot »), but at least, ACTIVAGE kit is not perceived as disturbing (av. 1, 83%-> 0, 0 meaning « not at all disturbing). ACTIVAGE kit is rather acceptable in the Baseline questionnaire, should be easy to use. The access to the data is moderately interesting. She thinks she would check her data daily (33% on a daily basis, 33% from time to time).

She is particularly interested by health data, weight (100% of the cohort find it very interesting), night activities (75%), and data related to comfort. However, if she was to keep 3 sensors, she would keep weight scale, bed sensors, and sensors in her kitchen.

UTAUT T0, Panel 2 (3 participants)

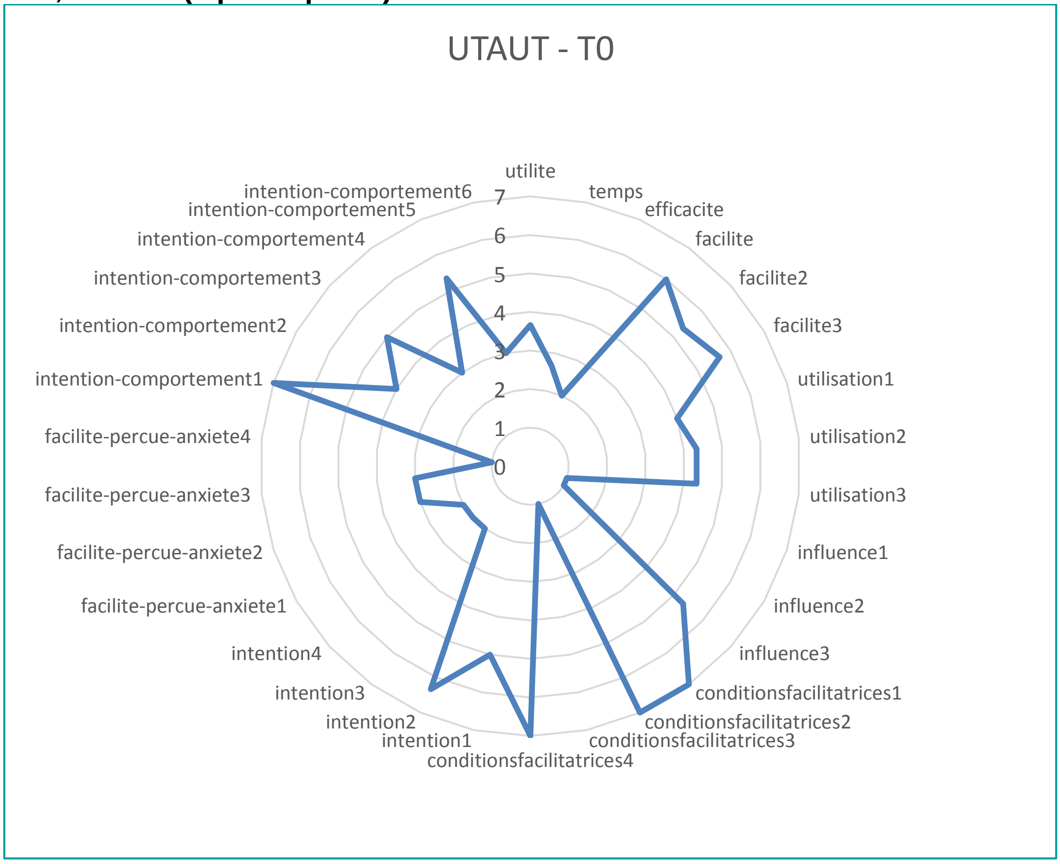


Figure 120: DS ISE UTAUT results for Panel 2 at T0

8.2.4.3 Panel 3

Initials needs and expectation from Korian professionals

In March 2017, in order to identify needs and opportunities for an IoT kit in room before any deployment, 15 interviews are performed with professionals in the rehabilitation center Les Granges, in Echirolles (nurse auxiliary, cleaning person, social worker, cook, animator, dietitian, occupational therapist, management trainee, day nurse, night nurse, physiotherapist, doctor, neuropsychologist, psychologist, pharmacist. The interviews are structured as follow:

Part 1/ Your work and life at work

Part 2/ In your daily activities at work, do you miss any data?

Part 3/ How could conceive the potential utility of an IoT Kit in your rehabilitation center?

Part 4/ What could be the impact of the kit on the relationship Hospital/Community medicine

Professional caregivers at Korian les Granges would use IoT for:

- Improve the continuum Rehabilitation center-home, hospital-rehabilitation center
- Improve room customization
- Improving the food offer, prevent undernutrition
- Secure drug administration
- Falls detection
- Enhance information flow
- Gains of time in daily routine
- Optimize the discharge
- Detect apathy

So, in 2017, before the starting of the pilot, Korian's professionals at Les Granges' expectations were : to better know the patient, to gain time, to offer a more customizable and secured stay, to help the patient to come back home at the right moment and to keep in touch with the patient. At that time, no clinical benefit is expected.

Co-conception process for panel 3:

Following these interviews, a team was define to participate to the co-conception of the solution and service to be experiment at "Korian Les Granges", altogether 45 professionals representing all the competencies at Korian have been involved in several work sessions. Session were conducted with CEA technical team both at CEA testbed where a Korian room has been duplicated, to show the possibility of the technology.

A specification book was co-written with all the participant. The different functionalities specified are classified in three type :

- Function to follow the patient progress and autonomy
- Function to for social linl with the relatives
- Function for the Comfort & Security in the room through room automation.

Evaluation through Focus group

As explain before, because of the recurrent connexion problem thane the Covid situation, only 3 patient have been included in the experiment for Panel 3. Therefor the questionnaire were not meaningful to conduct the evaluation analysis. It was therefore proposed to organize a focus with a group of patient to have a qualitative evaluation of their potential interest in the proposed solution and services.

In June 2020, after the experimentation's suspension due to Covid19, a focus group is conducted with 4 patients at the rehabilitation center Korian Les Granges. This focus group aim at collecting some results despite pilot's suspension.

The results presented here include also feedbacks collected by MADoPA during the pilot's set-up, the kit design, the equipment of the rooms, patients' recruitment with professional caregivers.

Participants

- Four patients (volunteer)
- Two occupational therapists

Duration: 2 hours
Conduct:

- Activage Room's visit, demonstration of some functionalities
- Activage kit for panel 3 features presentation
- Roundtable
- Focus group, feedbacks on features, one by one
- Feedbacks on patients use of technologies
- Feedbacks on patients discharge and how the see their return home
- Individual interviews with each patient

Focus group synthesis

- All patients are in a rush to come back home. They suffer from the feeling of being less autonomous, losing their status, losing their strength. They would like to get back their life as it was before hospitalization
- Asked about technologies, spontaneously, they mainly refer to phones, smartphones, and tablets
- Patients show little interest for ACTIVAGE Panel 3 kit and its different features and even less for the potential deployment of those technologies in their houses.
- Patients seem reluctant to test or use the kit in their room

Analysis

This lack of interest seems to rely on those reasons:

- In the rehabilitation center, the offer seems to represent, for them, another mental load, another mental stress that they don't want to suffer from during their stay
- At home, even patients living at home would assess during the focus group that they have good people around them, that they trust and appreciate, on which they can rely on, and consequently, they don't need, according to them, additional technologies
- They mostly want to return to the previous situation, before hospitalization
- They do not want to have things done for them, it gives them the impression that they're not able anymore, that they are losing autonomy (even if this loss of autonomy is a fact)
- The utility of the kit is not self-evident, even for people clearly and explicitly exposed to autonomy loss.

Analysis by function

E-lio box: could be interesting, but for other people, not for them, for lonely people, that do not have people around, who suffer from boredom, that do not have phones, smartphones, or tablet. This box could be acceptable in the rehabilitation center but not at home. They would much more appreciate some training and support to use existing technologies like smartphones and tablet, some help to use some applications (they mention WhatsApp). Using WhatsApp would be more relevant and less stigmatising (they could use it to chat with their grandchildren).

Podometer: according to those patients, steps' monitoring is not a relevant incentive. It would not motivate them more to do their training. They do not see any added-value from this device in their rehabilitation, but only constraints (mental stress, learning to use the device).

Pain assessment: According to patients, this feature on the tablet or on TV screen could be interesting in the rehabilitation center because sometime, patients do not dare ask professional caregivers when they feel pain. Conversely, they agree that it is uneasy to choose a number between 1 to 10 to assess a level of pain. Those patients do not see any interest for this feature when they are at home. They have strong reservation about sharing information collected through this pain monitoring to their doctor.

Lighting automation: according to those patients in the focus group, lighting automation is not disturbing in the Rehabilitation center, even if they do not see a clear added-value or utility to this device. Conversely, they wouldn't like to have this equipment in their home. At home, they feel at home, they are familiar with the place, they don't need those lights, according to them.

Notification of abnormal situation: monitoring activities and detecting abnormal activities seem quite new for those patients, and they hardly see what it could be. They refer to telealarm more spontaneously because they are familiar to this technology. According to them, this can be relevant other people, not for them (people with « big problems » or being lonely (not living alone but not benefiting from informal caregivers).

Room temperature: this feature is perceived as useless, trivial by the patients involved in the focus group. According to them, perceived temperature is much more important than real temperature.

By the end of the project, an interview has been performed by MADoPA with a Korian Senior Officer for Scalability report. The main result of this interview is that ACTIVAGE technology is only a mean to improve the service and the care delivered in patients' rooms. The middleware aspect is not mentionned in the interview (AIOTES or SENSINACT) by the senior manager. In the same way, this senior manager does not make any mention of an IoT or data analysis specific added-value. Digital Technology here are perceived as means to improve social life and «remote-controled room» in hospitals and rehabilitation centers.

This is consistent with DS6 goals. DS6 Isère was not aiming at spreading a product but to experiment (1) a continuum of care combining human care and innovative technologies to prevent autonomy loss (2) through a customizable IoT kit.

8.2.4.4 Installer evaluation

At the end of the experiment a workshop involving the team of installer, department de l'Isère Tasda and CEA technical team has been organized to collect the feedback from the point of view of the installers.

Technical feedback. We asked to the installer their feedback gained from ACTIVAGE but as well from their professional expertise about the protocols, the sensors types and the solution developed for ACTIVAGE. Only four of the five installer have been participating to the workshop.

Feedback on the protocols

Table 142 DS ISE PRO and CONS of the different commercial protocols

PROTOCOLE	PRO	CONS
Z-WAVE	Large range of devices	Problem of pairing Failure rate 1/0 and frequent de-pairing
	Meshed Network	Low autonomy ,if long range or pairing pb

ZigBee	Meshed network	Limited range of devices
	Protocol more reliable	Limited data
		Not compatible between version, no interoperability
KNX radio	Reliability	Not meshed
	Good Autonomy	Functions mostly électro-techniques
Bluetooth	Compatible with smartphone	Short radio range
	Easy pairing	Integration cost for each device
Wi-Fi	Large range of devices	Low autonomy
		Complex to deal with IP addresses
		Not well suited for wireless object
		Integration cost for each device
		Risk of interference with other Wii services
		Not meshed
EnOcean	Autonomy Battery less	Big devices
		Reliable
		Not very interoperable
		Switch not adapted to elderly (strength)
		Limited range of devices
X3D	High reliability	Proprietary Protocol
	Meshed network	Limited range of device
	Long autonomy 10 years	
Lora	Long range	Low cover of the network
		Emerging protocol Limited range of product

Complementary remarks

Z-wave :

- Sensative device have longer autonomy
- Fibaro device more reliable plus

WiFi : Vimar : good quality of switches

Feedback about the devices used in ACTIVAGE KITS :

Table 143 DS ISE Pro and Cons of the different devices installed

TRADE MARK	ADVANTAGES	DISADVANTAGES
Netatmo	Multi-sensor	Outside module not waterproof
		Data access via supplier server
		Reliability depends on Wi-Fi quality and stability
Voltaware	Small	reliability depends on Wi-Fi quality and stability
		Data access from supplier server
		Installation not easy: wire too short
Raspberry		Low reliability (SD Card)

		Not adapted for production / exploitation
		Memory limitation
Nodon		Pairing difficult and random
		usage complex
Switch Buzzer		No feedback on status → difficult usage
		Reliability defective series
Wall plugs	Esay to pair	reliability: defective series
	small	Limitation to 2500W
		usage defect because of ON/OFF switch
Fibaro eyes		light measurement not efficient
		Commissioning problem
		Not easy to attach with sticker
HYDRAO shower head	easy to install and use	limited range when far from the box
		Too heavy for elderly
Tablet	Dashboard of the home	The tablet in Kiosk mode limited to ACTIVAGE app Person would have use it more if other application would have been accessible
		Need to add louder sound and visual alert
		Problem of refreshment of the appli not real time
		Tablet often discharged

Other remarks about the Gateways :

- Orange Pi
- Odroid : 80€, more power and reliable
- Jeedom : proprietary Not for development
- EnergEasyConnect : multi-protocol via dongles, closed environment

Selection criteria of devices for a reliable installation:

- Meshed Network
- Autonomy
- Relaibilty
- Large range of product from the same protocol
- Easy pairing and installation
- All cost: Supply, Commissioning and Maintenance

Conclusions When possible: wired sensor should be chosen because much more reliable and sustainable

Feedback on the ACTIVAGE installation and exploitation process

Table 144 DS ISE PRO and CONS of the ACTIVAGE installation and exploitation process

PROCESS STEP	PRO	CONS	REMARKS
Audit	really mandatory for a smooth installation	Delay between Audit and installation	need dedicated team to take the appointment
		Time to take the appointment with beneficiary 15 calls. Many cancellation	SMS could be a good tool to take the appointment

Preparation Commissioning	good to have a dedicated place to do the commissioning	low stability after commissioning Need to retest it before installation	Need for a supervision tool
	good support from CEA expert team	Pairing sometimes difficult, random	Need for a testing tools
Installation	Mandatory to be with a social worker who explain the solution	Questionnaire too long Social worker should concentrate on the explanation of the solution	Questionnaire should be done at another visit
		Too much information given during the installation, people forget most of it	Organize a second visit to explain after short time of use
		Low stability of the subscription. Need to redo the commissioning on site	
		Some problems with Fibaro and switches	
		Attachment with sticker not reliable	
Maintenance	Efficient remote support from CEA team	Missing a supervision tools to help diagnostic of technical issues cause and check during intervention	Many maintenances for incomprehension of the usage
	Maintenance allow to re-explain the service and how to use it to the beneficiary	Many maintenances because of battery and falling of the sensors	Remote maintenance and updates would be necessary
		Too many Ticket at the starting because of reliability problems Hotline team overloaded, time response too long at the beginning	Need a dedicated team for the hotline

Feedback on the process time

Answer form four installers. All have enlightened that working with frail person requires more time and different skills than for classical home installations.

Table 145 DS ISE Process time estimation by steps

PROCESS STEP	1 Hour	2 Hour	4 Hour	1 Day	2 Days
Audit step : Taking the appointment, Audit & report , Prescription			3 installers	1 installers	
Preparation step : Kit Commissioning & testing	2 installers	3 installers			

Installation step Taking the appointment, installation and explanation	4 installers	
Exploitation : Taking the appointment, Maintenance	3 installers	1 installers

General feedback on the solution and potential optimization

Specific oriented and closed questions have been asked to the installers;

Table 146 General question for optimization of the solution

QUESTIONS	NO	NOT SURE	YES
A wired offer would have brought more reliability			4 installers
The extra cost of installation of a wired solution will be profitable in term of cost saving (maintenance, failure)		4 installers	
The ephemeral aspect of the installations generates problems (fixing, etc.)			4 installers
The paring system via push button is not efficient	3 installers	1 installer	
The preparation time is exponential to the number of objects to be deployed.	4 installers		

Potential organizational optimisation

What kind of support service and stakeholders could optimize the service efficiency?

- Interface with occupational therapist team for audit to prescription the appropriate solution
- Dedicate team to handle appointment with the beneficiary : time saving
- Centralized supply and logistic support
- Legal and ethical support team (insurance , responsibility …)
- Advice on state and regional aid and subsidies

The ideal Kit

Finally, a brainstorming session was organized by Tasda, to define from the point of view of the installer experience what would be the IDEAL KIT for elderly

The most interesting function that were raised are:

- Monitoring and analysis of consumption = Electricity, water, gas
- Prevention of domestic risks: flood and abnormal consumption, fire and falls
- Home Automation (domotic) :

- Live scenarios personalised with the customer at the installation: heating, lighting, shutters, security alarm, etc.
- Remote lighting control

- Automated Access to the home: intrusion security and alarms / Door lock check, possibility of remote unlocking (e.g. opening to a carer)
- Personal monitoring: weight / pedometer - With direct data feedback

The user interface should:

- Present multimodality of the alerts: sound/light or even voice command (overall, move towards vocal interaction and sound or vocalized alerts).
- Propose a fixed screen to displays some data (for people not used to smart phones or tablets)
- Data value should be given with a referencial (comparison of personal evolution + reference, to be able to act according to the data).
- Flexible control: remote control, application on a fixed screen or on a "regular" screen.
- Clear operating instructions (written, presented as a "recipe" and displayed in a strategic place such as inside the electricity meter)
- Personalise to guide use: the kit is completed with pictograms, colour codes, labels,

The solution should be operated locally (no external sever)

The installer should deliver with the solution: a backup description of the installation, the codes, and administrator access code: "it's the law but it's not always done".

The interaction with the other stakeholder acting for / with the elderly

The final question was about interaction with the different stakeholder the installers interact with when working at frail persons home, what are the best practice with them.

Table 147 DS ISE installer interaction with other stakeholder acting with the beneficiary

STAKEHOLDER	QUESTIONS & BEST PRACTICE
Occupational therapist	• Always ask if the elderly as a dedicated occupational therapist and ask to be in contact • Its absence, in a situation of severe disability, can be an indicator of a deteriorated relational situation (avoid shifting expectations onto the installer). • Partnership installer / occupational therapist could optimize the prescription of the adapted solution • Need to invest time in building this partnership with the network of occupational therapist, • Need to form and acculturate them to domotic.
Family and relative	Almost always present in case of frail persons . Carry two types of fears : • mistrust towards the installer who could “abuse" his elderly relative, • fear of "becoming redundant" (useless?) if the parent becomes more autonomous thanks to the technology

	• Also a user
Home care professional	Also a user of the solution. Need their support to alert when the solution is dysfunctional All the operating instruction should also be address to them Ethical problem can arise
Social landlord	Possible links that need to be built : • How to involve the social landlord in the definition of the solution in this kit? : • Potential interest for the landlord : • Limit unpaid bills through consumption information for better budget management. • Adaptation to the ageing occupant population • Potential extra cost : who pays for the needed installation
Mutual, insurance, pension fund	Potential financers Installers could work as sub-contractors for Mutual insurance proposing the service

8.2.5 Conclusions

ACTIVAGE, a path for tomorrow's solutions

ACTIVAGE solutions' deployment have faced many difficulties in DS Isère (mainly maturity and reliability technical issues and after January 2020, Covid19). Those difficulties have limited the possibility to provide in-depth analyses of usages. Designing and providing an « Ideal technological kit » that would support ageing people in a smooth way, in addition with human aid provided by care providers and coordinated by local authorities is still an open project. However, some cross-sectional results prefigure services of tomorrow:

- In the three panels, senior participants ask for a regular support and training for TIC usage. Even active seniors of Panel 1 (high autonomy level) are willing to participate to workshops, conferences, meetings that may help them to stay up-to-date. Learning and training are fully part of the service that is to be developed and in which the kit is to find its relevance.
- All sectors involved in sustainable living at home for elderly people will be impacted and shall work hand in hand in the development of the solution deployed. The pilot in Isère shows that nurse auxiliary, installers, tech providers, local authority, craftsmen, insurance companies or mutual insurance companies have to work together to provide a robust business plan for an ACTIVAGE solution.
- Regarding this kind of solutions, strong local roots are expected by all stakeholders. The service deployed shall be adjusted to local ecosystems and fit with local policies (land use policies, health policies, social policies, active and healthy ageing policies) engaged by Département de l'Isère.

Going to scale by Panel

Panel 1

CD 38 (Département de l'Isère) has deployed a web platform IsèreADOM for all seniors (panel 1,2 & 3) providing:

- Information on geotagged local services

- A connected phonebook of professional caregivers at home, including specialists of home automation

CD 38 is also developing a teleconsultation platform designed by Technosens (through grants for installation -liberal physician- or grants for care home building

Panel 2

- 20 nursing homes have been equipped with Elio Box during the Covid19 episode, on a volunteer basis. The department is aiming a large-scale deployment (equipping all nursing home asking for the technology and benefiting of a sufficient internet connexion).
- The digital notebook developed in ACTIVAGE will be also systematically deployed by the department for elderly people facing autonomy loss. Social workers are now trained to use those digital notebooks.

Panel 3

Korian is developing and deploying, in direct collaboration with Technosens, two solutions using functionalities developed and tested in ACTIVAGE DS6 even if not linked to IoT:

- Connected tv screens to intensify, ease and smooth social for patients in rehabilitation centers (SSR) nursing homes
- -«Remote controlled room» through a domotic system in room that can be controlled by the patient.

An offer at home «Oriane», service oriented but deploying at a national scale teleassistance or falls monitoring. If «domotic» and «social life» are clearly prioritized, IoT technologies could be used and included in those offers if they could provide a breakthrough in preventing and detecting falls.

8.3 Local sustainability plan

8.3.1 Product/Service Definition

The innovative ACTIVAGE experiment of DS ISE is aimed at people over the age of 60. It is supported by IsèreADOM[36] system set up by the Isère General Council.

IsèreADOM is an innovative and unique system in France that opens up the actions of the health and medical-social worlds. Both are evolving in parallel in France. These two worlds do not communicate which causes serious consequences on the management of the elderly person situations since it delays the actions to be undertaken to help them.

IsèreADOM not only offers digital services (a directory of local service providers and a whole range of services offered by the General Council), but also a new organization of home support services. Indeed, a digital link book allows all medical professionals or assistance to the person to mention information or observations on the physical or mental health of the elderly person. Thus, depending on the authorized access to information, the elderly person, their relatives, family caregivers and professional caregivers benefit from useful information to provide the optimum service.

These information are followed by a “Sentinel referent” (a care manager), who is often the Head of a SAAD (professional caregivers Service). His function is to launch alerts when he detects a situation that is getting worse. The Sentinel referent therefore brings together professional

36 Could be translated as “Isère at home”

caregivers from the health and medical-social worlds who work together to develop a common solution to elderly problem.

In Isère, the ACTIVAGE experiment offers connected products or digital services to elderly in addition to the human help. Human help still remains essential although expensive. It has therefore been proposed to all a kit of products and services that can meet their particular needs. So, the kits have been designed to suit each profile in order to encourage people to use them. DS ISE aim was to incite people to become familiar with this new technology and no longer be afraid of it.

The objective of ACTIVAGE to search for interoperability between objects has highlighted other issues related to the technique, the organization of the ecosystem and the user. Most seniors are not in the habit of using digital objects and services. As extraordinary as they may seem, their handling seems complex, the operation remains opaque. Therefore, new technology generates a strong apprehension, even a feeling of rejection. It is therefore necessary to provide important support to allow the introduction of these objects at home.

Table 148: DS ISE Zoom on final user

	Panel 1	Panel 2	Panel 3
Description	Active seniors	Elderly persons with loss of autonomy	Hospitalized old persons (convalescing)
Objective of DS ISE ACTIVAGE project by elderly profile	Encourage them to use digital technology regularly in order to become familiar with these techniques, no longer fear them and therefore accept them later when they are necessary to maintain their autonomy.	Offer them digital tools that improve their daily life and reassure family caregivers.	Provide them with digital tools - to make their hospital convalescence stay more enjoyable - to motivate them to install these tools at home upon their return.
Feature	They make their own choices	They accept	They undergo
Behaviour	They enjoy themselves and want to enjoy their free time	They fear being compelled to leave their home and want to remain mobile in their daily life	They find it harder to adapt to new ways of life
Aims of elderly support	**HEALTH PREVENTION: Staying active, changing behaviour to age well and adapt to new technologies** Information Opening to connected objects	**HOME SUPPORT: Remotely monitor person and home, to delay loss of autonomy** Help with the actions of daily life Social Connection	**BACK HOME: Facilitate safe return to home. Monitor individuals to respond quickly** Mobility Social Connection

Marketing vision	People need to be attracted to be motivated to use digital services	It is necessary to accompany senior in its loss of autonomy and convince his children and professional caregivers (SAAD) to use new technology	Patients need to be effectively supported in the use of new technologies to make them want to go home with connected devices.
Business vision	Offer a varied, playful, attractive offer	Propose a discreet watch, which does not hinder the freedom of the elderly while reassuring the relatives	Provide effective oversight that gives senior confidence

The idea of DS ISE is to avoid situations of rupture in a life course that could lead to a worse state. On the other hand, DS ISE wants to help going back to earlier state if better. Experimentation seeks to propose solutions to all situations:

Either:

Or:

- Panel 1: seniors are often equipped with a smartphone or tablet, which facilitates experimentation. The idea is to offer them digital tools adapted to their way of life and to encourage them to «play» with by observing data uploads. Indeed, they are still available for a new learning. Thus, we can hope that in the future, they will accept this technology more easily when they really need it (panels 2 and 3), or even that they will anticipate their future needs.
- Panel 2 people are poorly equipped and therefore not used to new technologies. The idea is to give them easy to use tools to maintain the social link, to facilitate their daily life (automatic lighting), to watch over their safety with the domestic sensors and if they wish to use the services of teleassistance[37] in case of fall.

37 Remote assistance: for instance, if an elderly person falls and can no longer gets up, she can press a button (on specific watch or necklace) to talk to a person able to send either relatives or public rescue to help her.

We considered the person as a whole and focused the products and services offered on his different needs of the person: well-being, social connection, security of the housing, energy performance of housing.

Zoom on devices:

Several reflections, based on experience, have guided the approach of DS ISE:

- First of all, for panel 1, it seemed useful to focus on housing (domestic safety) for adaptation of the beneficiaries to new technologies, before focusing on health.

  Active senior doesn't really have health need (except to prevent it). It is possible to get them to use connected objects first on a "risk-free" domain to learn how to use these tools and play with them. We then hope that senior will adapt to the use of these connected objects and will want to go further, alone, to look for health prevention tools in relation to his personal worries.

- For panel 2, we are continuing to focus on home safety and entering health. Adapt products and services to personal needs. The use of connected products must be flexible and match to each person. The idea is to maintain products/services as long as they are useful and to propose others if necessary.

- For panel 3, the goal was to get patient to test and get appropriate to the technologies enabled services while a journey in the rehabilitation hospital. Then to eventually decide to install them in their home upon your return. This is the ambition that DS ISE has set for this population on which the social link and the monitoring of physical progress are paramount.

Table 149 DS ISE Service and device for panel 1 & 2

	Panel 1	Panel 2
Well-being	• Pedometer • Connected scale	• Connected weight scale
Social link	• Tablet or touch screen device with easy communication service: videophone, photo exchange • Workshops and/or conferences on topics related to living well and aging at home.	• Tablet or touch screen device with easy communication service: videophone, photo exchange
Housing – Confort & Security	• Gas detector • Carbon monoxide detector • Smoke detector • Flood detector • Plugs connected to know the condition of kitchen equipment (electric hob and oven) • External door opening detector (or fridge or freezer, etc.) • Automatic lighting device	• Gas detector • Carbon monoxide detector • Smoke detector • Flood detector • Plugs connected to know if kitchen equipment is on or off (electric hob and oven) • Front door opening detector (or fridge/freezer door, etc.) • Automatic lighting device • Teleassistance[38] (optional)

38 "Teleassistance" is a tool created in the 1980s, this system of home box and necklace or watch, or even mobile phone, makes it possible to secure the person indoor or outdoor. In stressful situations, elderly people can press a button (on necklace or watch, or

Home consumption	• Electrical meter sensor for general consumption monitoring • Plug connected to a device of their choice to monitor its power consumption • Connected shower head to know and control the water flow of the shower • Weather Station

The needs of panel 3 are different because people are in hospital. They are no longer in a critical situation but resting and recovering for a period of 3 weeks. We therefore offered them a connected room to help them keep in touch with their family and enable them and medical team to follow their progress.

- E-lio digital communication system (from Technosens). This simple communication system has the advantage of being installed on the bed-room television. This is familiar device for anyone. Elderly master the system operation. This system allows them not only to communicate with their loved ones but also to interact with the medical team on pain assessment;
- Different sensors to monitor the progress of the person in terms of both mobility and toileting, as well as their daytime and night-time activity;
- Sensors for automatic lighting and extreme room temperature.

Table 150 DS ISE service and device of Panel 3

Panel 3	
Patient progress monitoring	• Bed Occupancy Detector • Motion detector • Pedometer
Social link	• Tablet or touch-screen support with e-Lio communication service: video system, photo exchange, message exchange
Health monitoring	• Tablet for sharing information with caregivers on pain level

even mobile phone) to get in touch with a human platform which is open 7/24. Talking with the user, professionals will assess the situation and make the necessary arrangements by moving relatives or by calling emergency services directly.

8.3.2 Market Analysis

8.3.2.1 PESTEL analysis

Table 151: DS ISE PESTEL analysis

Element	Factor	Business Impact
Political	2019, March: Libault report given to government = 175 proposals for a new and strong policy for elderly people in France. Should lead to a law.	Positive impact on ACTIVAGE solution: This report explains how France can go from the present to future i.e. from the management of elderly dependence to support of elderly autonomy Most important points are: - making jobs linked to old people more attractive, - coordinate medical actions and everyday life actions (France is today working in silos). - Think the person as a whole and take care of all her needs - Work on health prevention not only physical but also cognitive plan.
Economic	2020, June: vote of the principle of the national payment of dependence (Social Security 5th branch "autonomy")	Positive impact on ACTIVAGE solution: it means that government will pay for people losing his autonomy. As far, no detail is known. But we could imagine elderly could get money to use new technology (which was planned on the law project "old age and autonomy" and pay for training to use them, or more people taking care of them at home.
	French cost chain is quite complex: Major role of Conseil Départemental: is defined as the pilot of elderly social help	Negative impact on ACTIVAGE solution: indeed the cost organization combines private and public actors. People know the Conseil Départemental (CD) as main actor of elderly policy. Indeed, CD it has been confirmed in its role of elderly social assistance leader since the "décentralisation" laws beginning of 2000's and in 2014. The well-known leader is the Conseil Départemental. It has different ways of financing loss of autonomy :

Element	Factor	Business Impact
	Others actors for loss of autonomy:	- social assistance (including APA[39]) which is a mandatory right, defined by national rules - social action which depends on each Département policy -“conference des financeurs” which enable each Conseil Départemental to decide what type of financial help it will allow to what type of needs. → These 2 actions depend on each CD own social policy. Positive impact on ACTIVAGE solution: There are also several different public or private actors that could finance (directly or not) old age dependence but people is mostly not aware of it (CNAV, CNSA, ARS, Private health insurance companies, Retirement funds, social housing authorities Moreover, information is not fluently spread among users, so that nobody knows where he can ask to help or money. impact on ACTIVAGE solution:
Sociological	2019, October: El Khomri report = National mobilization plan for the attractiveness of jobs linked to elderly New technology is unknown and frightened for old people	Positive impact on ACTIVAGE solution: we can hope that carers will be better considered, better paid and could have a better training Negative impact on ACTIVAGE solution: people do not understand how it can be helpful for themselves to improve their autonomy, to comfort family careers, and give important information to professional careers: more objective information, remote watch, data trends on long-term, …
Technological	Technology could give careers information about how the old people are living: are they changing their habits. Can propose service to prevent and alert domestic risk and prolonge elderly autonomy at home.	Positive impact on ACTIVAGE solution: Technology has been experimented to complement human assistance. Stakeholer along the whole value chain were involved in ACTIVAGE which enable to build the new economical ecosystem that still need to emerge for a sustainable to create the future home care complete service definition
Environmental	Public financial aid for connecting housing (ANAH)	Positive impact on ACTIVAGE solution:

39 APA = Allocation Personnalisée d’Autonomie : Universal right defined by French law is a personalized funding for the assistance to daily acts of life for frail or dependent persons. The funds amount varies according to the level of dependency and therefore the needs of the elderly but the maximums of each category are identical in the whole of France.

Element	Factor	Business Impact
		Synergies can be built to help dependent people fight energy poverty and spare energy in their own home. Social housing associations are keen on IoT in their properties not only for energy saving but also to monitor behaviour of elderly renters.
Legal	CNIL[40] regulation: to protect personal data And GDPR	Positive impact on ACTIVAGE solution: people are comforted in these regulations as their private data will only be seen by those who are allowed to.

8.3.2.2 Market characterization

Size of French market

Retrospective

According to INSEE[41], in France, people over the age of 60 represent 26.7% of the French population in 2019, or 17.54 million people. The growth of this population is very important since 23.9% over the last decade (2009-20019), while the French population has only increased by 4.17%. Over the previous decade (1999-2009), +60-year-olds had grown by 15.9% compared to 6.9% for the total population. It is therefore obvious that the share of the elderly represents an increasingly larger share of the French population.

At the same time, there was a decrease in the assets segment (20-59 years) which had grown little between 1999 and 2009 (growth of 5.5%) and decreased by 2.4% over the past decade from 34.08 million in 2009 to 33.26 million in 2019.

Projection

According to INSEE, the proportion of the elderly in relation to the French population will continue to increase in the coming decades. Projections predict 29.2% of people over the age of 60 in 2029; 30.9% in 2039 and 32.1% in 2059, or almost 1/3 of the French population.

If these percentages are compared with the other sections of the population, it can be seen that in 2059 only 45.8% of the population aged 20-59 will have to support 32.2% of the population composed of elderly people (not counting the 22.1% of young people aged fewer than 20). If you just look at seniors, you're going to have a ratio of 1.4 caregivers to 1 senior, which will be a difficult financial situation.

The situation will then be very different from that of 1945, at the end of the war and mythical date of creation of the French Social protection system. The balance then was that 57.7% of the labor force had to care for only 11.5% of the elderly (a much more comfortable ratio of 5 to 1.

This demographic change is due to the post-war baby boom and to health progress, which has led to a significant increase in life expectancy. If we are naturally to rejoice in this, we must also consider:

40 CNIL = National Commission for Information technology and freedoms. French institution created in 1978 is in charge of watching on personal data protection in any paper or computerized files, either on public or private fields.

41 INSEE : Institut National de la Statistique et des Etudes Economiques. National institute of statistics and economic studies.

- The weight of the "sandwich generation" (45-65 years old) between helping the youngest and helping the oldest;
- The needs of this elderly population.
- Both of them have serious consequences for loved ones and society.

Status in Isère department

The department of Isère is very populated and very vast. It has today almost 1 .3 million inhabitants spread over 7500 km². This mountainous department is economically attractive although it is part of the attractiveness zone of the 3rd largest French city located 100 kilometers away: Lyon. This is why it presents a very heterogeneous distribution of the population on its territory. In 2017, the agglomeration of Grenoble (main city of the department) concentrated nearly 450,000 inhabitants on a total population of 1.253 million in the department. While urban and peri-urban areas continue to grow (+0.4% and 0.9% per year respectively between 2011 and 2016), isolated municipalities lose 0.5% of their population each year over the same period. The loss of population is mainly due to the natural balance, suggesting an older population in small cities.

The population of +60 is now over 300,000 (which may represent the total population of other French department). 20,000 of them receive an allowance from the Departmental Council to pay for services linked to loss of autonomy. The proportion of the elderly is currently 24.4% compared with 50.2% of the active population. INSEE forecasts that it will reach 30.2% in 2049 (against 46.1% of inhabitants aged between 20 and 59).

Population characteristics

In France, fragile and dependent people receive a financial allocation called APA according to their state to take charge of professional caregivers. The former have difficulty managing their daily life but are still able to live alone if caregivers can help regularly. Dependent people, for their part, need help every day. It would be impossible for them to live without daily help.

As Amélie Carrère and Claire-Lise Dubost recall in their study «State of health and dependency of seniors»[42], it is the loss of autonomy and health problems that decide an elderly person to leave his home and enter a retirement home.

In 2015, studies[43] highlight that dependent people naturally go to specialized institutions, while fragile people tend to stay at home. Indeed, 81% of elderly people receiving APA at home are fragile. In institutions, 59% of people are dependent.

In 2015, figures[44] show that in France, it is after 85 years that one enters institution for the elderly people, thus marking the impossibility to stay at home because of an installed dependency. In fact, 68.1% of residents of institutions for the elderly are over the age of 85, compared with only 15.6% aged between 80 and 84.

People over the age of 85, like the rest of the elderly population, are growing rapidly: from 1.25 million in 1999 to 1.51 million in 2009, to double their growth in the following decade and reach 2.23 million in 2019, 3.9% of the French population.

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42 France, portrait social, édition 2018 - Insee Références : https://insee.fr/fr/statistiques/3646032?sommaire=3646226&q=etat+de+sant%C3%A9%20seniors

43 Insee Références, édition 2018 - Santé - Handicap - Dépendance (p.97) https://www.insee.fr/fr/statistiques/4277754?sommaire=4318291&q=DEPENDANCE+PERSONNES+AGEES

44 Insee Références, édition 2018 - Santé - Handicap - Dépendance (p.97) https://www.insee.fr/fr/statistiques/4277754?sommaire=4318291&q=DEPENDANCE+PERSONNES+AGEES

Market segmentation

The elderly market includes retired people regardless of their state of health. Overall, in France, this segment of population is considered to start at age of 60 years old.

This large size group is then divided according to its general state. We have first the active seniors, then those who apply for APA to their Departmental Council. APA is funding for seniors who apply for it and are assessed through the AGGIR national grid. This one includes 6 categories: 2 for active seniors, 2 for frail seniors (with more or less difficulties) and 2 for dependent seniors (more or less severe). Whether people are at home or in an institution, they can receive this allowance, which allows them to pay for the services of professional caregivers (help with the household, help with the toilet or dressing). We have information on the number of people in each category.

In 2008, the number of dependent persons was 199,200 compared to 441,100 in 2015; The number of fragile persons was 483,400 in 2008 compared to 528,200 in 2015.

The situation of the elderly is therefore complicated. On the one hand, they are increasingly numerous at the expense of their caregivers, whose proportion is decreasing. On the other hand, the increase in their life expectancy mechanically forces them to a growing fragility or even a heavier dependence, which informal caregivers are not able to support. It is therefore necessary to compensate certain needs with technological aid, supported by professional human aid.

Market needs

The needs to compensate for the frailty or dependence of the elderly are enormous. APA provides financial support for some of the needs of professional caregivers, but many family caregivers provide much-needed support for the survival of their loved ones by providing volunteer hours of work.

In 2008, a study by the CNSA traces the characteristics of these caregivers, mostly family members, who work discreetly with a dependent person. Caregivers are:

- 4.3 million to take care of a person aged over 60 living at home;
- The single carer (who is the first help of the assisted person in 64% of cases) is very often the spouse (in 44% of cases). Thus, it can be assumed that 56% of caregivers do not live on site and may need a technology relay to alert or inform them.
- Carers are, on average, 52 years old and 47% of them are active.
- The amount of work done on a volunteer basis and often on a daily basis by informal caregivers is often referred to as a “burden”. A study by the DREES[45] states that:
- 3.9 million caregivers provide practical and daily assistance to their elderly loved ones in their everyday activities. Others provide “only” financial, material or moral help.
- “Two out of ten caregivers are qualified as having significant loads (medium or heavy)”[46].

This free works is necessary for some old people who are would not survive without it. Needs are important for them and cost much. In 2016, the DREES calculated that dependent people at

45 SOULLIER Noémie, « Aider un proche âgé à domicile : la charge ressentie », Drees, Etudes et Résultats n°799, mars 2012.

46 SOU.LLIER Noémie, « Aider un proche âgé à domicile : la charge ressentie », Drees, Etudes et Résultats n°799, mars 2012, page 2

home have to pay €80/month. This figure is only an average since what people have to pay varies according to 2 criteria:

- the level of dependency: the higher it is, the higher the amount of APA paid by the Departmental Council and the higher the remainder payable by the beneficiary (in monetary value). According to this study, it would vary between 174 and 52 per month depending on whether one is very dependent or little dependent.
- The level of income of the person: the amount of what dependent people has to pay increases with the income of the beneficiary.

Actors of Autonomy market

Roles of the actors

The sector of assistance to the elderly in France suffers from a superposition of actors more or less known to the general public and whose missions are not always very clear.
This chart tends to clarify the role of every actor.

Table 152 DS ISE Autonomy sector stakeholder and roles in France

ACTORS	MISSIONS
Conseil Départemental	• Legal social assistance leader at loss of autonomy of older persons • Gateway to information on the elderly ecosystem • Assessment of the person's level of dependency • Proposal of a support plan tailored to the individual's needs • Financial contribution to support for the daily acts of life via the APA[47] • Funding of various needs related to dependency according to the policy of the department via the Conference of Funders • - Supervisory body for home help and support services
Pension funds	• - Information • Health prevention action • Financing of part of dependency-related needs (members of the Finance Conference of the Departmental Council) • Invest in Silver Economy start-ups
Health private insurance companies	• Additional medical expenses not paid by public health insurance fund • Financial contribution to some expenditure relating to health prevention
SAAD[48]	• Help to the person at home • Meals brought at home

47 APA: Allocation Personnalisée d'Autonomie. It is paid by the Departmental Council on state funds and local taxes. It mainly covers human aid to ensure the acts of daily life, but can also be used to purchase technical aids such as cane, wheelchair, medical bed, occasional stay in temporary accommodation, etc.

48 SAAD : Service d'Aide et d'Accompagnement à Domicile. Often a private, not-for-profit organization, it offers assistance with the actions of daily life (hours of housekeeping or toilet help).

CCAS[49]/CIAS[50]	• Support for the daily activities • Meals brought at home • Socio-cultural actions and social link development; • Measures for the improvement of housing
ANAH[51]	• Actions against housing poverty; • Actions against poverty in terms of energy expenditure.
Social landlords	• Actions against housing poverty; • Actions against energy poverty • Health prevention measures • Actions in terms of social link development.

8.3.3 Competition/sector Analysis

8.3.3.1 Competition profile analysis

The notion of competition is not adapted to an experiment such as the ACTIVAGE project in France. On the one hand, because it is public actors who will intervene; on the other hand, because, beyond the aspect of technical interoperability, the ACTIVAGE project in Isère has mainly measured the interaction between the actors of dependence, thus the ecosystem around the elderly.

In France, daily life help that is offered to the elderly depends on government since it finances part of the loss of autonomy through the APA[52]. Each department therefore collects funds according to its elderly population, which it distributes according to its territorial needs.

At the same time, each department chooses to spend its own funds on the areas for which it is responsible to ensure solidarity, according to the particularities of its territory. The Département is responsible of public policies: health and social action (that is, assistance to people with social difficulties, the disabled and the elderly) and other skills focused on the territory.

The ACTIVAGE experiment can therefore only be supported by a public authority, which allows users to have only a small financial contribution to pay.

With the ACTIVAGE experiment, Europe wanted to measure the interoperability of connected objects at home and the transition from regional/national demonstrators to sustainable and interoperable solutions at European level. It was done. Conclusions have been drawn. But as far as DS ISE is concerned, the experimentation also made it possible to assess the workings of the complex system that has been set up and to highlight the weaknesses in order to achieve the objective. Technology is certainly the focal point of experimentation and has guided actions throughout these months of experimentation, but the human factor, and among other things the organization, has proved to be essential.

What does the ACTIVAGE experiment in Isère consist of?

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49 CCAS : Centre Communal d'Action Sociale. Organisme public ayant des compétences diverses et variables : aide aux actes de la vie quotidienne (aide-ménagère, aide à la toilette), mais aussi actions socio-culturelles et lien social, voire des actions en faveur de l'habitat

50 CIAS : Centre Intercommunal d'Action Sociale. Organisme public ayant des compétences diverses et variables : aide aux actes de la vie quotidienne (aide-ménagère, aide à la toilette), mais aussi actions socio-culturelles et lien social, voire des actions en faveur de l'habitat

51 ANAH : Agence Nationale de l'Habitat. S'adresse aux propriétaires de logement contrairement aux bailleurs sociaux qui répondent aux besoins des locataires.

52 L'APA (Allocation Personnalisée d'Autonomie) goes to elderly people, given by the Conseil Départemental from funds allocated by the state to each department on the one hand and local taxes collected by the department.

Figure 121 DS Isère illustration of the Continuum of Care and adaptable technology KIT

The DS ISE ACTIVAGE experiment is based on the technology: an interoperability platform (sensiNact of AIOTES IoT platform) that recovers all the data transmitted by the various sensors installed at home, transmits the home automation data to the user, allows to use e-lio (simplified digital communication system for the elderly) and the teleassistance box.

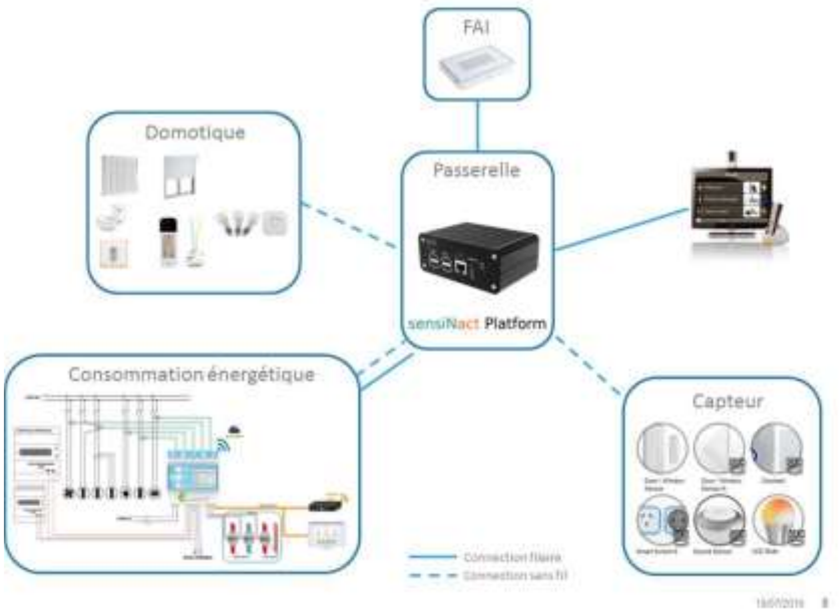

Figure 122 Schematics of the adaptable Technology Kit deployed in DS Isère

The competitive advantage of the ACTIVAGE solution over other projects of this type lies in its full-scale experimentation and the action of the Departmental Council of Isère.

Competition with any other similar experiment does not affect what is most visible, namely the sensors, devices or services offered to the user, even if this choice is decisive for gaining public acceptance, but rather the effectiveness of the interoperability tool technology. It determines the proper flow of information and thus the satisfaction of users, whether they are end users or sponsors. So the information system in general is paramount.

But the success of the system is also due to the coordination between the actors which is essential to its implementation on the ground. Experimentation has shown that it is not the industrialists who are best placed to install the equipment at home. Entering an elderly person's home is not easy, making them adhere to the system (even if they have given their prior consent), training them and reassuring them about how the system works, the right to privacy and the use of their personal data is not simple. It is therefore necessary to rely on professional caregivers if the person is not able to equip himself. However, these professionals are under the supervision of the Conseil Départemental.

So it's a real system, with well-oiled wheels that needs to be put in place. The sponsor, the Departmental Council has the responsibility of success much more than the industrialists who must bring tools or objects technologically reliable and simple to use. But those are the one which are subject to competition.

Costs

This system has a significant cost for the Conseil Départemental:

- In terms of an information system which must be strong enough
- In terms of internet equipment which is sometimes a problem (especially outside urban areas)
- In terms of human management:
    - Professional caregivers, as close as possible to the elderly, who will watch over them, launch alerts, and seek solutions to a situation which shows signs of deterioration. Professional caregivers are also prescribers to older people and facilitators of acceptability. They are an essential link in the overall system.
    - Technicians who will maintain the installed tools and sensors.

Barriers to entry:

- Management costs of professional actors:
- Numerous active SAAD with a strong turnover;
- Having to sign contracts on their objectives with the departmental council
- Financial costs:
    - A robust, secure and shared information system at departmental council level;
    - setting up of free digital services which will be an easy access to all: directory of local professionals, calendar of local activities or events, etc.
    - monthly or one-time product or service support payment for the elderly (who often have a low income)

The costs are therefore broken down into:

- Fixed costs for technology: the information system and digital services;
- variable unit costs: the purchase of connected goods, their installation, and the training necessary for optimal use.
- Recurring variable costs on the human side: help and follow-up.

Economies of scale therefore do exist:

- At the level of fixed costs such as the information system or digital services;
- At the level of the initial reflection and experience which has been carried out for several months. The time spent, the funds invested in the ACTIVAGE experiment, the energy expended and the feedback that results are instructive investments that will be weaker the larger the user community will be.

This is why it may be interesting for the Departmental Council of Isère to share its information system and its experience with other departments that have nothing concrete to date and that are afraid of such an investment.

Ultimately, we cannot ignore the products and services that will be offered to end users. These must meet the real needs of users (maintenance or development of social links, security within housing, mobility, local information, etc.), but also be technically reliable and very easy to use in addition to having ergonomics adapted. These last points are obviously the responsibility of manufacturers. It is up to the sponsor to choose them well according to its territory.

The Conseil Départemental de l'Isère is particularly advanced in the area of support for the elderly, in comparison with other French departments. It is a very populated department (therefore with many elderly people), economically dynamic, which therefore has financial means. In terms of management of the elderly the Conseil Départemental de l'Isère relies today on the IsèreADOM system which has been operating for 2 years. It is a territorial platform that proposes a comprehensive and open-ended approach to monitor older people. A digital link book allows each worker to record their observations during their visit to the elderly person. The synthesis carried out by the "Sentinel referent" allows him to identify a situation at risk. He is hen able to alert and mobilize all professional caregivers (health and social), in order to find solutions to avoid a worsening of the situation.

ACTIVAGE will complete the initial system by providing new information.

At the level of ACTIVAGE one cannot therefore strictly speak of competition, even if it is clear that there are other projects in France that could interest some Conseils Départementaux.

On the opposite, several other departments could be interested in ACTIVAGE by taking advantage of the economies of scale undertaken by the Departmental Council of Isère.

8.3.3.2 SWOT analysis

SWOT analysis of ACTIVAGE system in France today.

Internally, the strengths of the ACTIVAGE project are linked to the support of the Departmental Council, head of legal social assistance for the elderly. Weaknesses stem from the choice of products tested and difficulties in mobilizing the SAAD in the long term of such an experiment.

From an external point of view, ACTIVAGE benefits from a legislative environment and a will of the State favourable to its development in France. The downside is mainly related to the fear of technology. But well accompanied and with simple connected tools, the elderly should be able to pass this milestone.

STRENGTHS	WEAKNESSES

Overall vision of the person: help in everyday needs and the health needs of the person.
Adaptation of help for elderly according to the events of his life course
Support from different prescribers in the world of autonomy:
- Support from the Departmental Council, leader of the policy and actions in favor of the elderly. Hence the legitimacy of the project:
  - provides political direction, strong intent to all actors in the territory
  - Federate around its entity the SAAD
  - Communicates effectively with seniors
- Support of SAAD network, prescribers to PA
- Support of the professional Sentinel referent (care manager) network (in the future).
Support and reinsurance for family caregivers: the project proposes an additional and objective means to follow elderly situation.
	Mixed interest of users: difficulty in maintaining the interest of active seniors (panel 1) which decreased after a few weeks of use.
	- Irrelevant choice of devices?
	- Difficulty to face an unenviable future, therefore difficult to accept?
	
	Human problems: significant turn-over at the level of SAAD. (profile 2)
	
	Technical problems: problems of interaction between ACTIVAGE computer systems (middleware) and the health facility (profile 3)

OPPORTUNITIES	**THREATS**
State Interest in ageing: Reforms in preparation for a likely law on old age - Law HPST (2009): fluidity of the health routes with the diffusion of the “nursing home outside the walls” to gradually move from people home to nursing home when loss of autonomy. - Major national citizen consultation on dependency (2018): maintenance at home, support for family caregivers, improvement of working conditions for professional caregivers, study of the cost of loss of autonomy for the elderly, simplified access to health for the elderly, development of alternative and intergenerational living places. - Libault Report (2019): among the 175 proposals developed by the report, priorities are highlighted on: - Improving the quality of services for the elderly; - The end of silos to meet the diverse needs of the elderly; - Develop early prevention to improve the physical and cognitive autonomy of the elderly and to increase healthy ageing. - El Khomri Report (2019): proposes ways of exploiting the support jobs of the elderly. ACTIVAGE system contributes to the promotion of the profession of professional assistant by other missions.	**Apprehension about new technologies**, hence the need for heavy and expensive support for elderly **Difficulties breaking into the elderly market:** - a population in loss of autonomy which refuses digital technology: fear and demonstration of its suitability for current life - younger seniors who mainly use social ties and access to new knowledge, but do not see the benefit of equipping themselves now with tools that they do not yet need. **Technological challenges:** - At home: network and user knowledge challenges (should improve over time) - In healthcare: difficult interoperability between internal and external information system **French system in silos evolving without communication**: on the one hand health, on the other hand daily support. **Administrative complexity/opacity** in terms of information and financial support.

- Vote on the principle of national empowerment for autonomy (June 2020): French National Solidarity - Opportunity: The French system offers almost no other alternative than the retirement home to the dependent person. However, this alternative only materializes when the person is forced to do so. An ecosystem such as ACTIVAGE is an opportunity to stay at home longer and to come back to it safely. (Response to the HPST law that seeks to streamline health pathways, by disseminating, among other things, an «Nursing home outside the walls»)	

Table 153 DS Isère SWOT Analysis

8.3.4 Value proposition and Targeted Customers

8.3.4.1 Lean Canvas

Lean Canvas – Panel 1				
Problem	**Solution**	**Unique Value Proposition**	**Unfair Advantage**	**Customer Segments**
Gradual disinterest of seniors for the connected objects offered. The consumption monitoring devices feedback consumption data. The user simply reads the figures for his consumption and remains "passive"	Offer devices with which seniors can "play" and find interest in them every day. - So applications on which they have an action to carry out: management of certain elements (e.g: remote monitoring of housing), or data that they can compare to those of a community.... (e.g of a sports, nutritional or on behavior improvement)	The senior takes control of his digital tools by dint of using them. He is active, suggest that he be with digital.	As part of health prevention work, the presence of a team of motivational coaching professionals is specific to ACTIVAGE. The CD Isère is an excellent showcase for the ACTIVAGE system. Indeed, the department was rewarded by the Senate in 2018 for its actions towards the elderly.	Active seniors (physically and cognitively), rather aware of preventing their health and improving their living environment

	- Another solution: put the data into perspective through regular motivational coaching. The device would then have its full meaning			
Existing Alternatives	**Key Metrics**	**High-Level Concept**	**Channels**	**Early Adopters**
Contact of the project team + communication on the objectives and developments of the ACTIVAGE project.	- Number of people equipped - Number of people participating in prevention programs in their territory - Number of people making arrangements for their accommodation - Number of requests for assistance schemes Pension funds, Conference of CD funders		The Departmental Council has all the legitimacy and means of action to communicate with the population and direct them towards the ACTIVAGE system. Other public institutions such as CARSAT or mutual health organizations will also be able to communicate on the subject of health prevention.	Young retirees wishing to improve their health in general (walking, improve their diet) or deal with a recurring problem: overweight, diabetes, quitting smoking.
Cost Structure		**Revenue Structure**		
In France ACTIVAGE system is carried by public authorities. The bulk of "revenues" will therefore be brought through budgets allocated by the public actors involved. Each actor is aware of the importance of helping seniors at every moment of their lives and to allocate a budget to this challenge. Each of them has a particular interest to participate: electoral reasons for the Departmental Council or reasons of profitability in the medium term for the ARS[53] and mutual-health, as well as for the CARSAT whose prevention is part of its missions. Nevertheless, depending on the policy decisions determined by the institutional actors, users will be asked to participate in the form of purchase of equipment or subscription.				

Table 154 DS ISE LEAN CANVAS Panel 1

53 CARSAT = Caisse d'Assurance Retraite et de Santé Au Travail. CARSAT provides the social service of the Health Insurance. As such, one of its major missions is the preservation of autonomy and social support after discharge from hospital for sick, disabled and / or elderly people.

Lean Canvas – Panel 2				
Problem	**Solution**	**Unique Value Proposition**	**Unfair Advantage**	**Customer Segment**
SAAD turn-over and lack of staff Lack of internet connection among seniors Cost of additional materials and services	Equipment of objects connected to the home, which are useful or complementary to the accompaniment of human aid. Provision of a tablet with all data uploads and the digital link booklet	Provide the “right service” at the “right time” for better targeted prevention and maintaining the person’s autonomy. Limit trip breaks due to lack of anticipation	The provision by the Department of information system tools, operating procedures of the business lines and financing. The presence of relays in the field, to support the SAAD.	Fragile and dependent people.
Existing Alternatives	**Key Metrics**	**High-Level Concept**	**Channels**	**Early Adopters**
Regular training and strong support for professional caregivers teams (SAAD) Development of the offer of tablet and web connection as part of teleassistance. Pooling of developments with other territories	- Number of comments in the digital link book, by author profile. - Evolution of fragility over time - Degree of quality of life at home.	- Evolution of fragility over time - Degree of quality of life at home.	The Departmental Council has all the legitimacy and all the means of action to communicate with the population and direct it to the device ACTIVATION	The SAAD’s professional helpers are the driving force.
Cost Structure		**Revenue Structure**		
Fixed costs: tools Information System, support team, training. **Variable costs:** number of tablets and connected objects used		Integration of APA spending (local tax budget) **Revenue model:** local public policy **Life Time Value:** 2 to 4 years (average APA payment time = 2 years) **Gross Margin:** this does not concern the Department.		

Table 155 DS ISE LEAN CANVAS Panel 2

8.3.4.2 Value proposition canvas

Service offer “Cocoon” : Well being at home

BUSINESS MODEL– Value Proposition = domestic risk prevention and health prevention.

Key partners	Key activities	Value proposition	Customer relations	Customer segments
Institutional actor: Département, Pension funds Local actors : CCAS or SAAD	- health and wellness monitoring (coaching) - Sensor and tablet management; - Provision of data and web information on the tablet; - Animation of a network of local actors;	My health and well-being: motivational coaching and nutrition tips/ recipes My activities, my desires: Social Link Service (e-lio) Access to local social networks Outings, activities, Games Advice to be helpful and helpful My Comfort: Feeling Safe at Home/ Feeling Comfortable at Home and Energy Performance Tips	Selling through mutual funds, pension funds, landlords?	Retirees who have demonstrated a willingness to act for aging well at home
	Key ressources		**Distribution channels**	
	Tel platform for telemonitoring Local Directory Local actor for the network NTIC integrator (tablet and sensors)		The local actor (Serena IMA) ensures the implementation visit?	

Cost structure	Revenues source
Telephone operator time/ Coaching license Directory license of CD38 Hardware: tablet, sensors Installation time at home Data hosting Time of the local actor	Subscription per month Sensors and tablet sales at the end of subscription ?

Table 156 DS ISE Value Proposition CANVAS Panel 1

Service Offer “Ageing well at home with a care manager”

BUSINESS MODEL- Value Proposition = staying at home

Key partners	Key activities	Value proposition	Customer relation	Customer segments
Institutional actor: Département, Pension funds Local actors : CCAS or SAAD	- Choice, sensor management and tablet; - Integration of data and web info on the tablet; - Home support with sentinel monitoring	Promote MAD (stay at home in the best conditions, avoid avoidable hospitalizations) through a process that detects situational shifts, opens up management services, and adapts support or care plans "at the right time". Mobilization of existing silver economy actors and strengthening of their business practice in the area of identification and prevention.	Target: Departement, pension funds in live and commercial prospection + lobby with CNAV et CNSA Target SAAD : via Departement	Frail people
	Ressources clés		**Distribution channel**	
	SAAD mobilized as Sentinel referent - An Information system for the digital file		Conseil Départemental	

Cost structure	Revenues structure
- Auxiliary time of life and area responsible for sentinel monitoring - Cost of hosting and maintenance of the website: beneficiary area - Time back office, rights management and access Hardware: sensors and tablet	Teleassistance: monthly subscription, with possibility of support under Aid Plan via Conseil Départemental Sentinel referent: Pension funds, CARSAT and Conseil Départemental: one package per beneficiary according to the one's autonomy level.

Table 157 DS ISE Value Proposition CANVAS Panel 2

BUSINESS MODEL– Value Proposition = coming back home in security

Key partners	Key activities	Value proposition	Customer relation	Segments clients
SSR KORIAN Les Granges (convalescence establishment) Département	- Data management and detectors management - Well-being evaluation, risk evaluation, patient evolution	improvement of the return to home after a stay in SSR, through: - better monitoring of patient needs, risks and progress during hospitalization - remote patient monitoring to reduce new hospitalizations	- Direct relation through SSR - Through physicians - Through the Département	Hospitalized patients
	Key resources		**Distribution channel**	
	- SSR KORIAN clinic - Information System		Within the framework of help plan supplementary services	

Cost structure	Revenues source
• Devices : sensors, E-lio box, tablet or TV • Health care professionals • Back office, access right management time,	• paid service for the social link • National Health solidarity for medical services

Table 158 DS ISE Value Proposition CANVAS Panel 3

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8.3.4.3 Business model

At the DS ISE level, the elderly were considered at the different levels of autonomy she might go through. The objective of ACTIVAGE experiment is there to ensure continuity of support throughout the life of the elderly person.

The DS ISE approach is a systemic approach to aging:

- on the one hand, by considering the different types of old age needs and taking into account their evolution in terms of autonomy;
- on the other hand, by building an ecosystem around the person. This system will include:
  - the circle of family and professional caregivers,
  - Private and public actors;
  - Medical and medical-social worlds;

This is in itself an innovation, since in France medical and life support needs are different worlds which never meet. Each world has its own competences and financing, its own operating rules and its own targets.

Brakes to ACTIVAGE solution

In France, brakes can be seen at different levels:

- **Financial restraint**: It is clear that in France the elderly and their families do not want to pay for loss of autonomy. The proof of this is that private insurance companies that guarantee the risk of loss of autonomy do not have any subscriber. Generally speaking, French people are reluctant to pay for the loss of autonomy and generally only manage to do so when they are compelled to (pay for a retirement home). Before this final phase, human help could be set up at home because mostly paid by the Departmental Council. This explains the lack of commercial success of connected products for the elderly.
- **Psychological brakes:**

  New technologies emerged about 20 years ago, which meant that today's older people did not have access to them during their working life. They are now confronted with the unknown which cannot be hung up on knowledge they already have. If the intuitive and tactile side is suitable for children and young people, it is not suitable for older people who are afraid to hurt, to break and therefore do not dare using it. They are disarmed, feel globally devalued and experience a situation of failure in the face of a technology used by toddlers. It therefore tends to reject this type of technology even if it believes it can be useful to it.

  This was not the case for the ACTIVAGE experiment since the end users were voluntary. But it was observed earlier that some elderly people refused innovative objects because they differentiated it (negatively in his eyes) from their alter ego.
- **Didactic brake**: As a result, the elderly need long training, at regular intervals, followed by support for the use of these technological objects. Family caregivers sometimes have time to teach and train their parents; professional caregivers do not have time and are not trained in this support today.

Business model possible solution

A solution led by a public actor

Just like illness, disability or retirement, French people believe that it is up to the public authorities, thus to the national community, to assume financial responsibility for this risk. The subject is on the agenda of all governments, but without concrete action.

The solution can only be global and public. The Departmental Council is the public institution able to lift all these hurdles, provided that it has financial means. As a leader in legal social assistance for the elderly, CD has the legitimacy to steer the ecosystem of loss of autonomy. A local actor, he implements public policies towards the elderly. In the French administrative world, CD is identified as the interlocutor for the elderly. In addition to its financing role, the Departmental Council has:

- an information mission on the various services and actors of the elderly ecosystem, which it manages through Clic[54],
- An assessment of the level of dependency/autonomy;
- Through the SAAD of which it is the supervising body, the Departmental Council is in a position to value, distribute, install, make accepted, train the elderly in the new technologies. It is also able to train home help professionals in the use of new technologies. It therefore represents an indispensable support for any project of a technological scale.

The Departmental Council seems to be able to benefit from support at state level. Indeed, French society is becoming aware of the burden of dependence on the elderly. In 2018, a major national consultation was initiated by the State. Several reports followed on the subject of dependency. A new step was taken last June by the vote of the National Assembly which validates the principle of creating a new branch of the Social Security which would assume for the risk e dependency (or part of this risk) from 2021. We don't have details to date, but this is good news for seniors, their caregivers

Partners acting around Conseil Départemental

The Departmental Council cannot alone assume all the needs and expenses. The ACTIVAGE business model therefore makes it necessary to group other institutions (public and private) around it. The Departmental Council, which manages the social and medico-social aspects, could collaborate with the ARS, which manages the health field. Today, the management could be organized around the departmental council with the various other private or public actors. Each of them has a particular interest to participate: reasons of planning and economic development of the territory for the Departmental Council, or reasons of medium-term profitability for the ARS[55] and private health insurance companies, or simply meet its basic missions for CARSAT[56], ANAH[57] and home help services (private and public) whose prevention is part of the missions.

France has many administrations that cover the solidarity needs of the population. It is the participation of all these actors gathered around the flagship project piloted by the departmental council that will make the project optimum.

The financial division would be as follows:

Table 159 DS ISE Stakeholder in the value chain for the different panels

	PANEL 1	PANEL 2	PANEL 3

54 CLIC = Local gerontologic information and coordination centres

55 ARS = Agence Régionale de Santé. Local health agency in charge of health policy (especially on prevention)

56 CARSAT = Caisse d'Assurance Retraite et de Santé Au Travail. CARSAT provides the social service of the Health Insurance. As such, one of its major missions is the preservation of autonomy and social support after hospitalization of the sick, disabled and/or elderly.

57 ANAH= Agence Nationale pour l'Amélioration de l'Habitat. Public agency. Helps owners to enhance their living place.

Leader Distribution channel	Pension funds	CD (APA)
Social link part	Departmental Council	Departmental Council (APA)
Medical part	ARS	ARS Private health companies
Help part	Departmental Council (APA)	Departmental Council (APA)
Other potential funders	Private health companies – Social landlords	Pension funds Social landlords CNAV CNSA

If requested by the old person or his or her relatives, each of his or her agencies may bear part of the costs of prevention or support for dependency. But the actors are numerous, the steps often cumbersome and the users often poorly or not informed.

If we focus on panel 2, the business model puts the Departmental Council at the elderly system center. First of all because it is close to the elderly: it is the CD that assesses the level of dependency and the person, and it is the guardianship body of professional caregivers. The Departmental Council also has this territorial vision necessary to put in place a coherent policy or an efficient information system. In addition, it is able to concentrate around it the other funders and organize the financial flows efficiently.

A platform of services around Conseil Départemental

With an identified leader and natural partners, the challenge would be to create a service platform at the department level, or even several departments depending on their size, to create economies of scale. In fact, services have been consolidated together for a few years. This restructuring of the sector is made necessary by economic constraints and requested by the State.

The idea of a service platform already exists within the Departmental Council of Isère which has set up a Sentinel system around a Digital Link Book. As mentioned above, the Sentinel referent summarizes the various remarks written on the Digital Link Book by the professional caregivers who come to the elderly person's home. As a "care manager", if the Sentinel referent identifies a slip situation, he invites all caregivers to discuss around a table, in order to find the best possible solution for the fragile person.

Collaboration between human being and technology

The economic model, while techno-centric, cannot do without human action at all operational levels. Overall for the coordination of actors and services around the elderly, but also:

- For the assessment of needs and level of autonomy;
- Information and motivation to use these new tools;
- when installing the hardware;
- During training and learning;
- For monitoring information;
- For maintenance

Competitive advantage

The competitive advantage for ACTIVAGE is the showcase that represents the department of Isère. Implementing a dynamic policy and investing heavily, Isère was rewarded by the Senate in 2018 for these actions towards older people.

The department relies on an active policy of its SAAD to encourage them to evolve by gaining in productivity and to be more effective in maintaining autonomy. The IserADOM system based on human observation and information sharing by all stakeholders was a first step. ACTIVAGE will be the complementary step.

The existence of a connected objects platform is also a good way to encourage digital innovation by local start-ups. Links with French Tech would be created to promote economic development in this area.

The dynamic of innovation towards the elderly is also used with consular chambers such as the CCI (Chamber of Commerce and Industry) and the CMA (Chamber of Crafts and Crafts). This link encourages traders and artisans to adapt or develop their offers for the elderly. ACTIVAGE is therefore a lever that contributes to the dynamics of local economic development.

8.3.4.4 Business model panel per panel

The approach chosen by the DS ISE presents slightly different business models from one profile to another.

Panel 1 : Active seniors ecosystem actors
Coordination by a public actor
Value Proposition = Stay active, prevent domestic risk, improve habits to age well and adapt to digital technologies.
Main distribution channel: Pension Funds

Figure 123 DS ISE Ecosystem of actors for Active persons Panel 1 offer

Table 160 DS ISE Service / Cost / funder for Panel 1

Panel 1 profile	Offer	Potential funders	Costs

They make their own choice They enjoy themselves and want to enjoy their free times	Auto-Evaluation of one's risks and health weakness	Active seniors	0
They are themselves caregivers and are aware of well-aging	Information, health prevention and well-aging workshops	- Private health insurance companies - Pension funds - Departement Concil	None as it is usual missions
Health prevention	Weight tracking Mobility tracking	- Pension funds - Auto-formation	150 €
Need to entice them to use digital technology	Monitoring of energy consumption Domestic risk prevention	- Departement Concil - ANAH or social landlords - Pension funds	Purchase : 300 € Subscription: 10€/month
Help them improve their health	Motivational coaching	Private health insurance companies	

Panel 2 : Actors in the frail people ecosystem (

Value Proposition: Home Support. Living safely at home with tools that also reassure family

Coordination by a public actor: the Departmental Council

Main distribution channel: the Departmental Council:

Secondary channels: private health insurance companies, IMA, SAAD

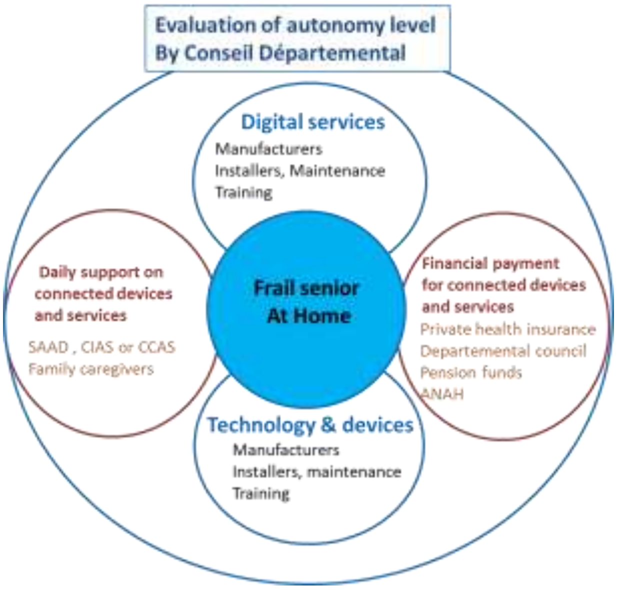


Figure 124 DS ISE Ecosystem of actors for Frail person Panel 2 Offer

Table 161 DS ISE Service / Cost / funder for Panel 2

Panel 2 Profile	Offer	Potential funders	Cost

They agree	Assessment of Autonomy and Definition of an Aid Plan for elderly	Departement (APA)	None because included in its usual missions
They fear leaving home and want to remain mobile	Evaluation Occupational Therapy	- Private health insurance companies - Pension fund	200€
	Connected scale		100 €
Risks: - Domestic accident (fire, etc.) - Falls due to lack of mobility or malnutrition, - Depression: lack of social connection	Home safety kit (leak detectors, smoke, etc.)	- ANAH or social landlord - Département	150 €
	Tablet and easy communication system (e-lio)	- Département - Private health insurance - Pension fund	Purchase : 300 € Subscription : 10€/month
	TéléAssistance	Department (APA)	Subscription: 30€/month

Panel 3 Actors in the hospital elderly ecosystem

Value proposition: Safe return to home. Monitor the elderly to respond quickly; Maintain a strong social bond with loved ones.

Coordination by public actors: the Departmental Council with the ARS

Main distribution channel: ARS

Secondary channels: mutual health, IMA, SAAD, Departmental Council

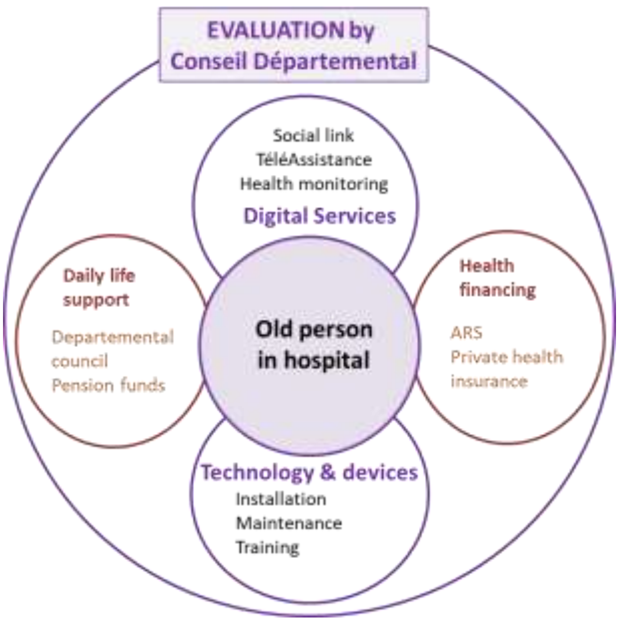


Figure 125 DS ISE Ecosysem of actor Hospital and Nursing Homes – Panel 3 Offer

Table 162 DS ISE Service / Cost/ Funder Panel 3

Panel 3 profile	Offer	Potential funders	Costs

They undergo	Assessment of Autonomy and Definition of an Aid Plan for elderly	Conseil Départemental	None as it is included in its mission
They must keep moving	- Motion detectors - Bed presence detector - Pedometer		200 €
They must maintain social ties	Tablet or touch screen with e-lio easy communication service	ARS	530€ purchase/room Subscription = 18€/month

Financement ecosystem stakeholders :

Table 163 DS ISE Different funding actors and their actions in France

ACTORS	FUNDING
Conseil Départemental	- Provision of an appropriate information system; - Managing actions as a social assistance leader - Assessment of the person's level of dependency - Proposal of a support plan tailored to the individual's needs - Financial participation in the accompaniment to the daily acts of life - Participation in motivating, installing and assisting the use of connected objects - Payment for digital services (e.g.: Teleassistance) - Support for social link tools or services (e.g. tablet, internet connection) + training
Pension funds CARSAT	- Payment for household safety equipment - Management of equipment related to the prevention of loss of autonomy
Private health companies	- Payment for connected medical equipment
SAAD ou CIAS/CCAS	- Human help for actions linked to the person's daily life - Payment for the use of connected tools and services (supported by the CD)
ANAH	- Payment of connected objects related to home energy management
End user	- Extra payment if necessary

8.3.5 Strategy for local sustainability

To date, further deployment is planned in stages:

- The first step will aim to consolidate and deploy IsèreADOM at the level of the department, within the framework of the public policy of the APA.
- The second step will be to pool IsèreADOM investments with other territories, to lower costs and evolve the national framework for Sentinel monitoring.

- The third step will aim to gradually integrate connected objects into the accompaniment of the elderly. Connected objects will be interfaced with the digital link book to enrich prevention solutions.

In parallel with these three steps, communication on home automation equipment related to thermal efficiency, safety and comfort within the home will be developed.

8.3.5.1 Open Data strategy

Concerning DS ISERE we do not plan to make data set available on open data repository.

The collected data from the beneficiary home are not possible to be share because of GDPR regulation.

Furthermore, even if anonymized the data set are not reusable without a detailed contextualisation (which sensor in which room, on which object, information about the beneficiary situation …).

As engaged in the DPIA, all data from user will be destroyed by CEA at the end of the project.

8.3.5.2 Continuation strategy

The ACTIVAGE experiment is over and there has never been any question of continuing the tested technology KIT after the European experiment. The testers were informed as soon as they were recruited. A proposal had been made to continue and optimize the technology maturity within the H2020 project which was not selected for funding. So there is no continuation planned with the testers of the ACTIVAGE experiment.

The DS ISE did not intend to continue the ACTIVAGE experiment as such. Its objective was to test products and services that could be suitable for those over 60 years of age and to see how to encourage them to use new technologies at home, test the installation phase and understand how the ecosystem could be organized around the elderly.

On the other hand:

- Some DS Isère partners are responding to calls for European projects to continue piloting about connected objects integrated into prevention and home support processes.
- TASDA is also keeping this in mind, with Unapparté. Together, they equipped a demonstration apartment with connected objects to raise public awareness about prevention and security, train professionals and evaluate innovations.
- Korian is also continuing its research on the integration of connected objects into its accommodation and care facilities.
- Technosens is still working on the integration of connected objects with e-lio, its simplified interface social link tool.
- IMA is involved in other projects on ageing at home. She is ahead of her thinking regarding her positioning in home support. The integration of connected objects in its offers would complement the offer of teleassistance and human assistance offered today.

Currently and in the coming months, the objective of the Departmental Council is to disseminate the IsèreADOM system throughout the territory through the APA. It will therefore first be necessary to continue the human monitoring organization of the elderly by signing contracts with the SAAD to generalize the global vision by the Sentinel referents. Indeed, it seems essential to begin by establishing a global vision of each situation and to reinforce the interactions between actors on the ground to allow a quick and effective response with a person who is becoming fragile.

Learning from the ACTIVAGE project

The ACTIVAGE experiment provided information to the partners:

- KORIAN IT department has set up a new network architecture to enable new digital technology experimentation and integration into Korian group. For the testing and evaluation phase, a dedicated is used K-IOT (Korian IOT) which generate a dedicated WiFi network for the experimentation, totally separated from the Korian Exploitation network. Then in the furtur for the production, Korian IT will keep 2 separate network: one dedicated to the IOT separated from the Business Exploitation network.

Moreover, the Korian IT department has set up a specific infrastructure “Korian LAB” for testing solutions before deploying, a network environment that simulates an establishment, which could have enabled the resolution of the network compatibility problem faced during ACTIVAGE.

- Two installers of DS Isère, La Fée Connectivité and YAABA, based on the conclusions drawn from their action on ACTIVAGE will reuse the technical audit procedure set up during ACTIVAGE prior to installation for a project similar to ACTIVAGE, sponsored by the Department of Aveyron. A cohort of active and frail seniors will be equipped with a voice assistant and home automation devices related to the security of travel within the home. A second cohort will be made up of people with visual, motor or mental disabilities. A teleassistance solution will be proposed to them to react quickly in the event of a fall.
- The progress made during the ACTIVAGE project to increase the robustness of the sensiNact middleware in the AHA domain will exploited by a researcher from CEA-Leti Levent Gurgen that recently launched the start-up KENTYOU, to commercialize sensiNact on the smart city segment. http://www.leti-cea.com/cea-tech/leti/english/Pages/Industrial-Innovation/Demos/SensiNact.aspx and www.kentyou.com.
- IMA has evolved in its vision of the market and the role it can play as an assistance.

Connected objects seem to reinforce the fight against the loss of autonomy and remote monitoring of the elderly. Supported by the teleassistance, they can be very useful to accompany and follow the situation of the person equipped. New technologies can allow them to stay at home longer.

Covid crisis

The Covid health crisis has cut testing by several weeks but has been an opportunity to expand some services. The partners of the experiment suggested services quite different to the testers:

- For social, IMA via the Teleassistance service has called all its users to help isolated elderly people. At the same time, coaching by phone went on.
- the equipped Korian establishments have generalised the use of e-lio Box (from Technosens company) to promote the social link.
- The Isère department generalised the use of e-lio among the elderly.

The results of the various panels of the ACTIVAGE experiment are integrated into services currently on the market. ACTIVAGE has enabled:

- raise the awareness of the Department and the actors in the medico-social sector on the added value of connected objects for people who are losing their autonomy;
- strengthen the local economic development, as mentioned above with CCI (the Chamber of Commerce and Industry), CMA (Chambre des Métiers et de l’Artisanat), and French Tech industry;
- to maintain research and innovation projects on this theme

8.3.5.3 Replication strategy

On the strength of its field experiences and the devices it implements, the Departmental Council of Isère begins to propose the IsèreADOM device to other requesting departments. He has already launched pilots in several other departments.

For the department, the objective is to share costs (information system, developments).

Aid for loss of autonomy requires a well-oiled ecosystem with clear governance recognized by health and medico-social actors. The Isère Departement, which is very far ahead in this field, intends to gradually make use of its experience to interested institutional actors. The Isère Department seeks to pool its resources in order to share its costs (the information system). On the other hand, each territory will be able to customize the services it offers to the elderly. The business model is not quite defined at this level, but tends towards a subscription version.

Today, responsibility for dependency or loss of autonomy is not clearly defined in France. The value chain is not sufficiently developed and all Silver Economy players are still looking for their business model.

8.3.5.4 Scaling-up strategy

DS ISERE continuation plan is based on one hand on ISERADOM with the local authorities on the other on the industrial partner business plan (Korian, Technosens) that integrate part of the services tested during ACTIVAGE in their commercial service offer.

Department de l'Isère

Aware of the merits of the technology for the support of frail people, the Isère department plans in the medium term to link ACTIVAGE to the existing IsèreADOM environment. This one is human-centred with a technological element: the digital link book. It is the observations made by all the field professionals, who know the elderly well, that make it possible to set up a support action for them, after synthesised by the referent Sentinel and collegial reflection. In addition, technology-based observations as tested during ACTIVAGE will provide an objective view in the medium/long term period, in terms of the criteria for changing behaviour that may go unnoticed to the professional.

The Department is generally in favor of home automation. The issue of technical feasibility arises nevertheless at the level of the territory and therefore of budget. It will be brought to the reflection of elected officials.

At the user level, the business model considered today is a monthly subscription. In order to simplify user acceptance and improve the general monitoring of the elderly, it may be advisable to link it to the social and emergency service of teleassistance. At first glance, the cost of subscriptions could be prohibitive for the elderly or their families, but communication around this device could highlight the argument of "staying at home" to which the elderly are much attached. Moreover, the subscription could be partially covered by the social assistance of institutional actors. Each of them has an interest in ensuring that the person lives as well as possible at home.

The service structure developed by the Isère department is suited to the inclusion of the ACTIVAGE environment.

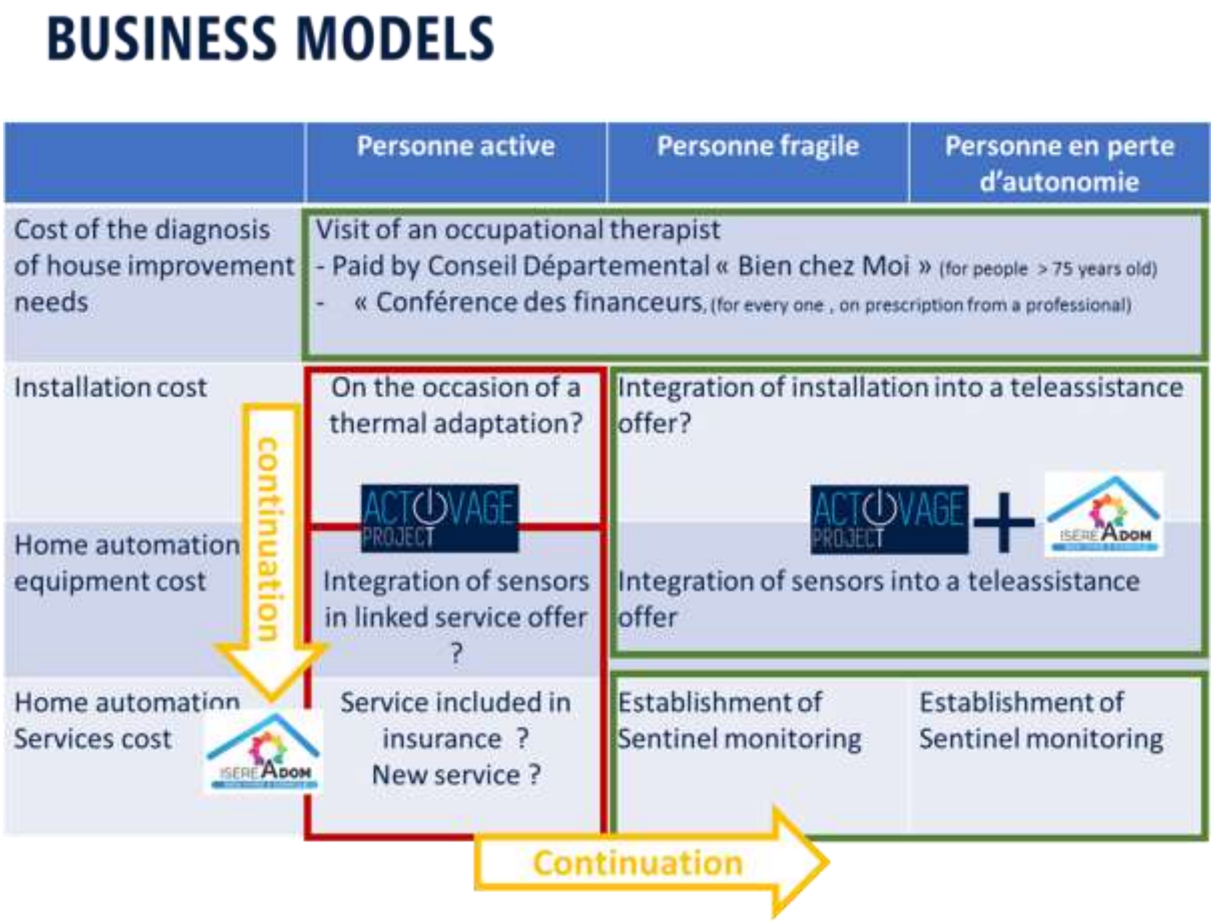


Figure 126 DS ISE Continuation of the continuum of care model in Isère

This diagram shows the complementarity of different blocks to equip, finance and ensure the service of assistance to people either active or fragile or in loss of autonomy.

Green blocks exist and are funded. Red blocks do not exist yet.

It is the part of Panel 1 that needs to be strengthened: the prevention of active persons. The AIOTES principle, if it allows home automation equipment at a lower cost, would be a factor facilitating equipment of this target. However, it remains to develop a service in addition to the human version (follow-up, advice, assistance, etc.). In connection with the territory, it will be a question of giving support… a personification of the digital!

8.3.5.5 Visions on Home care service evolution from DS Isère

Conseil Départemental and TASDA vision

- **Digital innovation must complement human aid.** It is therefore necessary to work on operating procedures to link human observation to data collection.
- Eventually, the connected object will enter homes of elderly people and will be used daily. However, to date, priority has been given to information on home interventions (data transmitted by professional caregivers on the digital link booklet) and to the de-compartmentalization of actors (particularly between medico-social and health actors, but also between private and public actors).
- A local policy, but also a national policy, is needed to support these innovations (which prove to be more socially oriented than technologically oriented), within the framework of public policies. The aim is to benefit both from national funding and from a continuity of

the health paths supported by national organizations (health insurance, CNSA), regional organizations (pension funds) and departmental organization.

IMA vision

What solutions can be found to the problem of satisfactory home support for the elderly as well as for their relatives? Our experience feedback allows us to discuss the following points:

- The answer provided by the technological devices (IOT, actimetry, monitoring) does not match to the major problem. These devices can occasionally and in a targeted way provide valuable services (in emergency with detection and warning mechanisms; in the long term with behavioural trend analyses and detection of weak signals), but are resolutely not the definitive answer to the search for a virtuous circle on the scale of society. We note that they do indeed present various problems:
    - Problem of appropriation by users and relatives
    - Economic problem: logistical cost of installation and maintenance
    - Problem due to data management
- The answer provided by a range of services covering heterogeneous needs (food: meals; fall prevention: fall detector; need for small DIY: a light bulb to change, etc.) In turn, it raises the question of the coherence and coordination of tenders in a context where aid is often poorly known, underused and fragmentary. There is a definite need for guidance in accessing services for the elderly to know what they are entitled to, what they can access, what could provide them with comfort, security and independence…). Be able to help you find your way through a range of services for dependent elderly people who wish to stay at home, depending on the personal context of each person (social support).
- Three major areas are to be promoted:
    - The local, or even the very local: the proximity of life and neighbourhood shops. Attachment to the home is also an attachment to the neighbourhood, to the community close to the place of life and to its daily activities. Access to the local press, for example, often appears as an essential primary service.
    - Supervision: the supervision function must be assumed to solve the problems of coordination, communication, personalization of the different contributions of the actors around the assisted person. In this respect, the use of digital solutions must allow the remote intervention of caregivers and their networking, that is to say their good coordination. Support is a recurring need.
    - The competence of home workers and their level of responsibility.

KORIAN vision

Within healthcare institutions, ACTIVAGE did not prove the effectiveness of the technology tested in terms of improving patient monitoring: the technology deployed in ACTIVAGE for collecting individual data and transmitting it to healthcare teams was not identified as a relevant element due to the technical complexity of setting up such systems. In this context, the production of additional data transmitted by the chamber does not offer any improvement in the medical follow-up of the patient.

On the other hand, the technology deployed to improve comfort and communication in the room and the improvement in the quality of life perceived by the patient is a real gain for the entire ecosystem. This is therefore where the added value of technology lies. In addition to being easy to install and use, the technology must improve the daily life of all those who use it: namely, the patient, his family and the medical team. The technology selected by Korian will focus on communication and social interaction. The technology must also promote the evolution of the patient's autonomy by making him/her more autonomous in controlling his/her environment.

Finally, the technology will have to be perceived by the patient and his family as a positive differentiating element in terms of cost.

Korian therefore intends to work on :

- the room that can be remotely controlled by the patient, thanks to home automation.
- communication and social links by continuing the installation of Technosens' e-lio box.

Finally, the most important thing is not the choice of technology, but the human action linked to it. Indeed, the coordination of the actions implemented by the ecosystem around the patient, before and after leaving the health establishment, are essential for the patient to accept and use technology.

2019 Korian launch Oriane, an offer that aims to be "global" by associating the intervention of home care workers with a "digital" platform allowing exchanges between the person being cared for or his or her relatives, health professionals and the reference teams of this new service. https://www.ticsante.com/story/4774/

Korian announced at the end of December 2019 in a press release that it had acquired a 70% stake in Omedys, a company specialising in telemedicine, "in order to roll out local teleconsulting services throughout France from this year 2020".

2020 Korian has announced several digital investments to continue to "integrate establishments into digital ecosystems".

Korian take a majority stake in the start-up Technosens, a Grenoble-based start-up created in 2017 also partner in ACTIVAGE DS Isère.

Technosens has designed E-Lio, "a platform enabling triple interaction between residents/patients - families - employees through a box installed in each room and connected to the television", describes Korian, adding that the solution "has been tested and developed for over a year" in three of its establishments in France.

The group now wants to extend the solution to its entire workforce, first in France and then in Europe. "It can also be adapted for use at home”

https://www.ticsante.com/story/5248/korian-annonce-plusieurs-investissements-dans-le-numerique.html

https://e-lio.fr/

Figure 127 E-Lio Form Technosens tested in DS Isère Adopted by Korian

TECHNOSENS Vision

On a technical side, 2 main learnings from ACTIVAGE :

- ACTIVAGE helped us confirm that the more stakeholders we have, the more interconnected the system is, the more complex it is to configure, install, run and support. ACTIVAGE was very ambitious in terms of number of sensors to be installed and way the different solutions (internet box / Sensinact box / sensors / Technosens tablet) were connected.
- Second confirmation brought by the project : in term of IoT, keeping local data is key. Internet can be used as a datastore, but the local system should be able to work whatever the internet connectivity conditions.

On a market side, Technosens is more used to work with nursing homes and hospital: private housing is different.

- Connectivity changes for each user
- Uses of internet is different (someone will set off the wifi box every night before going to bed, some other will keep the box on all day long)
- Changes in terms of building configuration
- Changes in the way we can install the sensors and system as we cannot install these at the construction time.

⇒ Private homes market is different from what we know and installation and support processes must be re-built completely to match the ground reality.

ACTIVAGE project contribution Technosens activity

Technosens offers a wide range of solutions to enhance the social link between the elderlies, their families and the professionals who interact with them. Our e-lio solution allow senior persons to do video calls directly from their personal TV sets, and give tools to the professional to improve the elderly quality of life and communication between families and senior housings. Our customers are nursing homes or hospitals.

We are proud to announce that the Korian group, who was part of the ACTIVAGE project, and the VYV group have recently invested jointly in Technosens to take a step forward towards better solutions for our seniors.

During the COVID crisis, Technosens developed a specific solution to respond to the isolation crisis within the nursing homes and we were proud to partner with the Isère Department who was part of the ACTIVAGE project, to equip the public nursing homes of the department with the Technosens e-lio solution.

The ACTIVAGE project has contributed to give visibility to our structure, and to reach the appropriate people, because, obviously, in the very end, senior care giving is all about people.

Figure 128 DS ISE E-lio from Technosens Service offer

SBA - FFD vision representing the installers

SBA (Smart Building Alliance – FFD – Fédération Française de Domotique)

Independent installer do not envisage to propose home automation solutions directly to elderly persons in a B2C model, as domotic is not sustainable on its own but complementary with human assistance.

The foreseen model for installers is to act as referenced subcontractors for Home Care service providers. The model will be B2B with a group proposing the whole service to the beneficiary.

- For panel 1 , active senior this could be through insurance (like IMA , ENGIE also launch a new service offer dedicated to seniors ENGIE CARE)
- For Panel 2 Frail people: this could be through teleassistance companies or nursing home companies (like Korian) who are building new service at home(like Korian Solution and Oriane).

It could also be a partnership between installers and occupational therapist, to propose a common offer : diagnostic, prescription, installation. This model is developed in France by MERCI JULIE https://www.merci-julie.fr/

An important segment for the installer is the "new collective building", the advantage is then to install during the construction a basic radio domotic solution through a "starter kit" that can benefit all users regardless of their age or level of dependence.

This solution is meant to be enriched with the right sensors and products in the case of elderly people living in the dwelling. The range of sensors selected can also evolve over time in case of deterioration of the health condition of the person and be easy removed or rearranged in case of change of tenant/owner.

Various stakeholders push this approach nationally in France:

- Some intermediaries push smart home solutions with a strong focus on property developers and act as facilitators between installers and developers. A first example is LONO (https://getlono.io/). They solicitate developers, provide the specifications for the smart works, pointing out interfaces with other works such as electricity and heating, find the installer with appropriate experience and assist the collaboration between all parties from the contract to the invoicing. Their role is to guarantee the successful implementation of smart home solutions. These dwellings can be considered future proof and offer a wide range of possibilities in the event of an elderly person moving in, provided that the information of the possibilities of the smart home are properly communicated.

9 DS7 WOQ final report

9.1 DS Experiment report

9.1.1 User engagement report

The DS-WQZ has been piloted in 102 homes and 71 nursing rooms with 179 users (161 older adults, 8 informal caregivers and 10 formal caregiver). The installation of 4253 sensors and devices, has led to the creation of the first socio-health ecosystem in the society, in Weiterstadt (Germany).

The DS-WQZ has been evaluating the impact of the new model incorporated in ACTIVAGE, for the provision of social, health services and nursing houses.

The DS-WQZ has very successfully developed the following areas in ACTIVAGE based on the monitoring in assisted living:

1. The passive alarm in assisted living:
2. The verification of alarms by the user in the house emergency call
3. The evaluation of call systems in the stationary area through differentiated forwarding of alarm situations to the nursing staff

These developments were targeted to

- capture and transfer the specific alarm situation: no monitoring, no alarm suspicions, no wasting time on interpretations
- relieve and support the staff, relatives, neighbours and house emergency services
- give a high level of security to the user (except in the nursing home and in the dementia shared apartment) through direct communication by the system.

Assistance, as we understand and develop, is characterized by the recognition of a defined and concrete situation, on which a previously defined action takes place, beside the involvement of the user.

In the nursing home and the dementia shared apartment, the user was not involved, but the staff was immediately informed. Our system impressed and convinced the people particularly in the nursing home through its simplicity and real work relief.

Flexibility and acceptance are the other essential goals of our programme. That is the reason that the failure in Türkheim and Stuttgart was an important point in our new development.

Our valuable experience led us to the fact that optimized communication and alarm management in the nursing home are the essential parts of the success.

Through involving more and more users and operators, now we have created a system which can be accepted even by home emergency call service providers, the ones that we didn't consider in the first steps of our project.

Today we know that we can significantly improve and simplify the processes in the nursing home and in the emergency call system for the operator. - See protocol v. March 5th, 2020 Treuchtlingen.

During the development of ACTIVAGE we tried and tested a large number of devices, sensors and wireless protocols. We tested the interchangeability and, of course, the improvement of the sensors. Today we can offer even more individual systems in terms of price and scope. Today we have systems that can detect a fall within a few seconds, or in another situation, react after 3-5 hours in order not to constantly recognize the "normal case" as an emergency.

It is important that we supervise without monitoring. Nobody should worry about the systems - it works completely unnoticed in the background and only reports when a critical situation is recognized.

9.1.1.1 DS WoQ Users

Our users are elderly people who live independently in residential complexes, such as in Stuttgart, Weiterstadt, Rodgau (Nieder-Roden) or Türkheim. Some of these residential complexes are supervised like in Rodgau, others completely unsupervised like in Türkheim or partly supervised like in Weiterstadt or Stuttgart have been (bevor leaving the project). The residents of the dementia shared flats and the residents of the nursing home in Treuchtlingen are taken care 24 hours a day; in some cases, around one third of them are in bed all the time.

A picture from us and the users, breakfast is still to serve

Pilots:

WOQUAZ Weiterstadt: 22 apartments with 25 residents, 11 dementia residents, 18 carers

Rodgau Nieder-Roden Johanniterquartier: 48 apartments with 53 residents and 7 carers

Türkheim: 26 apartments with 30 residents and 4 carers

Treuchtlingen: 6 apartments with 6 residents and 60 stationary residents and 4 carers

(Stuttgart: 30 apartments planned, but left at the beginning of the project)

9.1.1.2 Recruitment

In DS7, user recruitment was handled in terms of attracting new sites interested in the deployment of our solution. The sites themselves already had their inhabitants so that there was no need for recruiting individual users. The capacity of the sites is naturally physically limited to the capacity of the related buildings.

Table 164. DS WOQ total users recruited

RUC	Elderly	Informal caregiver	Formal caregiver	Other stakeholder
RUC 01	161	7	10	1

RUC 04	161	7	10	1
TOTAL	**161**	**7**	**10**	**1**

(but not all have participated to the evaluation)

Figure 129: DS WOQ Overview of the socio-demographic profiles of WoQuaZ users

Table 165. DS WOQ total number of facilities confirmed:

RUC	Private homes	Personal environments	Shared room in senior facility	Healthcare/Daycare facility	Other spaces
RUC 01	102	71	3		
RUC 04	102	71	3		
TOTAL	**102**	**71**	**3**		

9.1.1.3 Legal & Ethical

The DS-WQZ worked on the ethical and legal aspects. It complies with the GDPR. All older adults were informed and signed their consents.

Regarding the shared homes in dementia areas, there exist agreements with the operators, the BRK in Treuchtlingen and the care service in Weiterstadt, in which the regulations of the DSGVO are considered. However, no changes were made for the most part, as no data was shared anywhere out of the apartments and all representations were anonymized.

9.1.1.4 Examples of Support by local authorities


Neues Seniorenzentrum besucht

Sabine Leutheusser-Schnarrenberger in Treuchtlingen

Vorreiter in Europa: Beispielhafte Seniorenanlage in Weiterstadt

Staatsminister Axel Wintermeyer hat das neue Wohn- und Quartierzentrum in Weiterstadt besucht. Die Wohnanlage für Senioren ist mit ihrem technikbasierten Betreuungs-Konzept Vorreiter in Europa.

Hessische Landesregierung

HESSEN


DEMOGRAFIE

Wintermeyer besucht Europas beispielhafte Seniorenanlage in Weiterstadt

19.05.2017 | Pressestelle: Hessische Staatskanzlei

Staatsminister Axel Wintermeyer: „Eine Zukunft des betreuten Wohnens, die heute schon Realität ist."


Strategie Digitales Hessen

Intelligent. Vernetzt. Für Alle

Innovationsprojekte initiieren und fördern

Das Land fördert die Entwicklung und Umsetzung nachhaltiger Innovationsprojekte. Schwerpunkte sind der Nutzen für die Anwender, die Einbettung in regionale und soziale Strukturen und die Initiierung nachhaltiger Geschäftsmodelle. Angestrebt wird eine technische Basisplattform, die Anwendungen und Dienste verschiedener Anbieter modular integrieren kann (wie z.B. die Plattform UniversAAL).

5 Anwendungsbereich | 5.7 Wohnen und Leben

In Hessen existieren zahlreiche Forschungszentren, Projekte und Einrichtungen, die sich mit Assistenzsystemen im Wohnumfeld beschäftigen. Beispiele sind ...

- das Fraunhofer-Institut für Grafische Datenverarbeitung in Darmstadt, welches das Leitprojekt der Europäischen Union „ReAAL" mit über 6.000 Nutzern in 13 europäischen Regionen koordiniert,
- das hochinnovative Wohn- und Quartierzentrum WoQuaZ in Weiterstadt,

9.1.2 IoT infrastructure deployment

9.1.2.1 The ACTIVAGE Solution at DS7

The system always includes a controller per apartment or room.

The controller is equipped with a Z-Wave, ZigBee or ELDAT stick, depending on its protocol. The controller itself always has WLAN and Bluetooth. Any system and device can then be connected. The following devices can be connected:

Bed sensor from Wissner & Bosserhoff and Texibel

Motor lock from NUKI

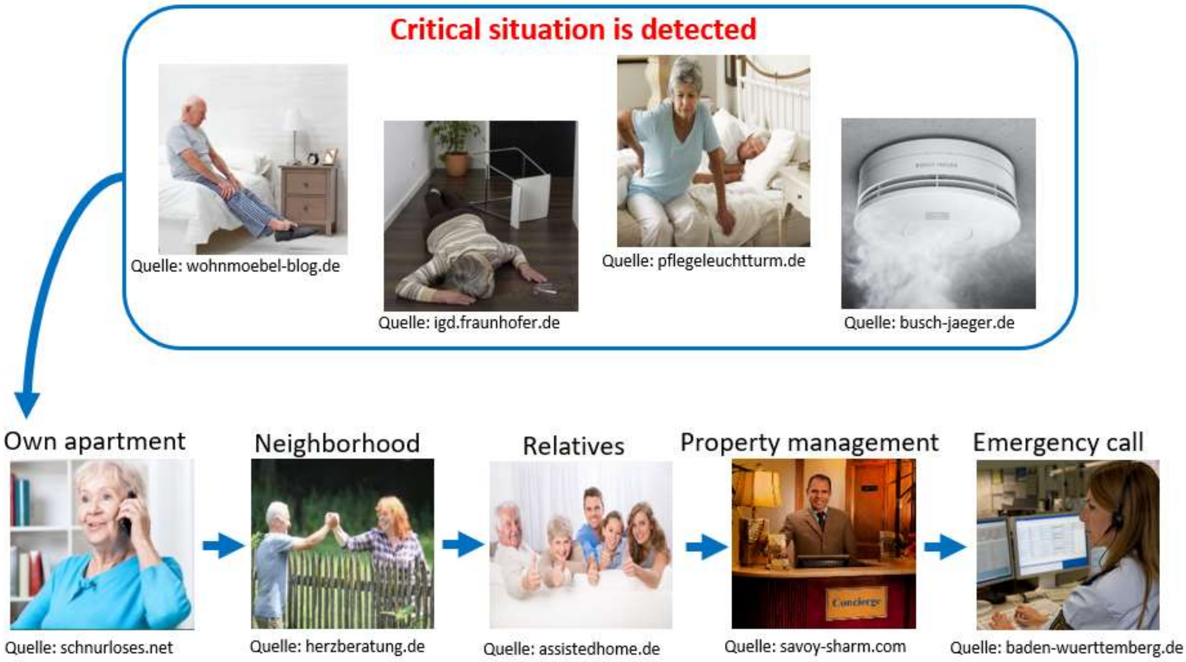
Fall sensor from COGVIS and Pikkerton

Smarthome components from ZigBee, IKEA, Z-Wave, ELDAT, MI, HUE, Homematik, XIAOMI, AQUARA, Wired systems: WAGO PLC

All DS-WQZ installations have been carried out in **private homes and care rooms**.

Following functionality was implemented in a first step at Weiterstadt and had been rolled out to the other facilities.

If an emergency situation has been detected an alarm chain by telephone is trigger.



9.1.2.2 Supported device types

- motion detector
- Door contacts
- smoke detector
- Switchable sockets
- Switching relay for light

- Switching relay for roller shutters
- Switching relay for 380V contactors - stove shutdown
- Motor lock
- Fall sensors
- Emergency buttons
- Emergency wristbands
- Speakerphone
- Humidity sensors
- Temperature sensors
- CO² sensors
- light switch
- Alarm switch - in the nursing home to turn alarms on and off
- ESPA-X server
- Call system according to DIN 0834

9.1.2.3 The IoT Platform and Architecture

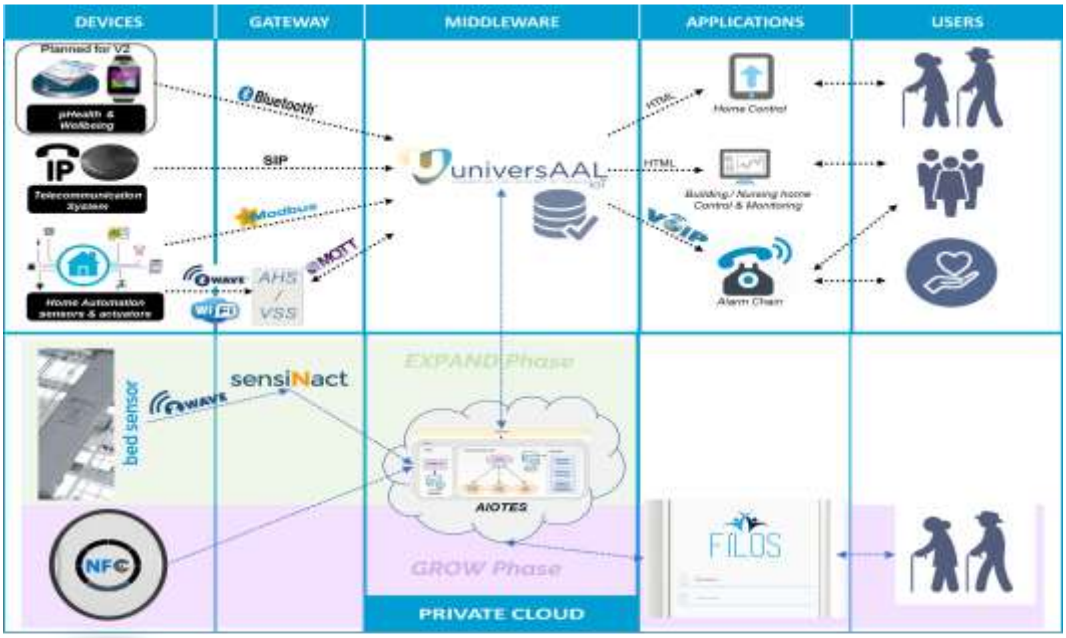
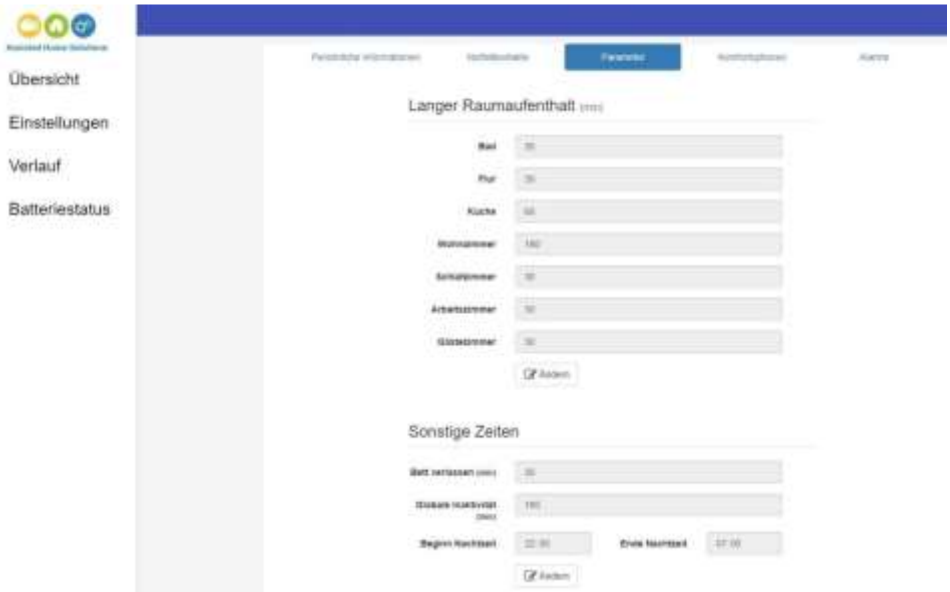
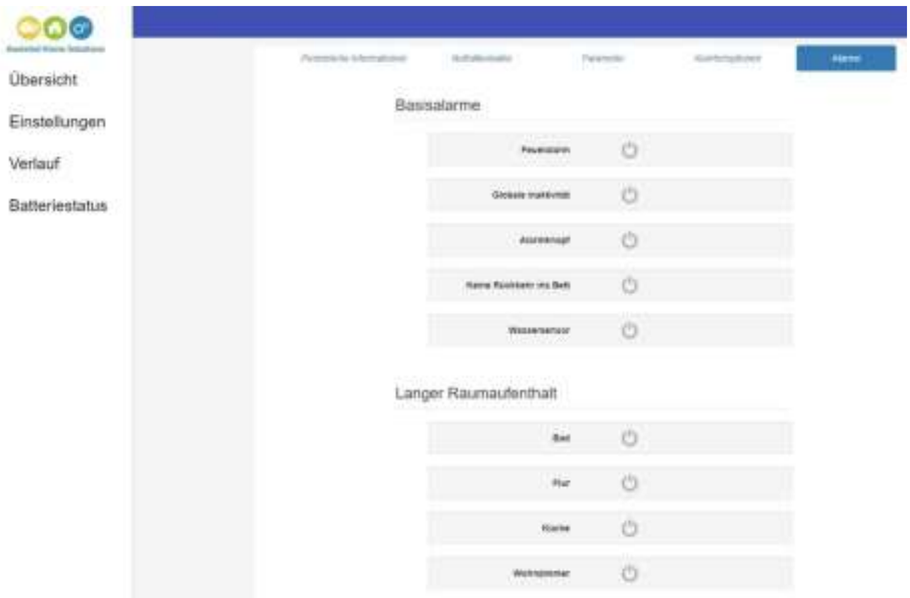
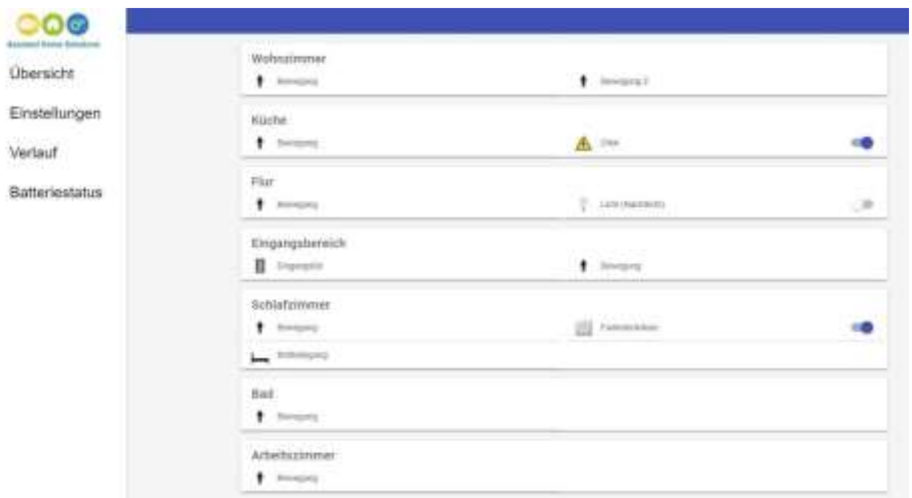


Figure 130: DS WOQ IoT solution architecture

9.1.2.4 User Views







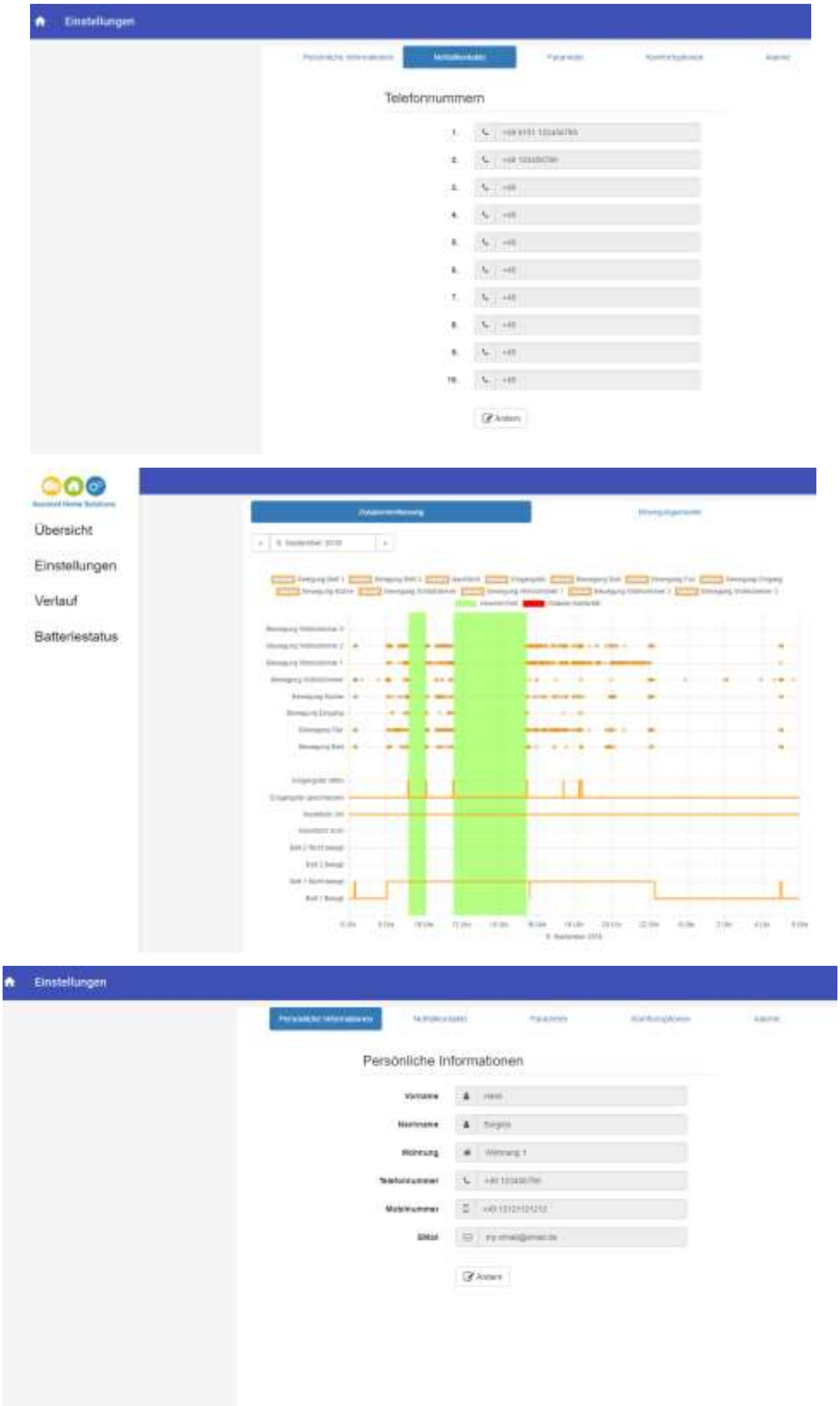


Figure 131: DS WOQ User dashboard screenshoots

9.1.2.5 Installations

The first installation took place on January 12, 2018.

The installations sites were as follows:

- 48 apartments in Nieder-Roden
- apartments in Stuttgart
- 26 apartments in Türkheim
- 60 nursing rooms and 6 apartments in Türkheim
- 22 apartments and 11 dementia rooms in Weiterstadt

The DS-WQZ pilot has been maintained as the date of this document while the sustainability of the solution is being studied with the service providers.

The number of drop-offs mostly goes back to death of the older adults or because they were admitted to residential care homes.

Table 166.DS WOQ Total number installations

RUC	Private homes	Personal environments	Shared room in senior facility	Healthcare/Daycare facility	Other spaces
RUC 01	102	71	2		3
RUC 04	102	71	2		3
TOTAL	**102**	**71**	**2**		**3**

(concierge and further common rooms are shared rooms)

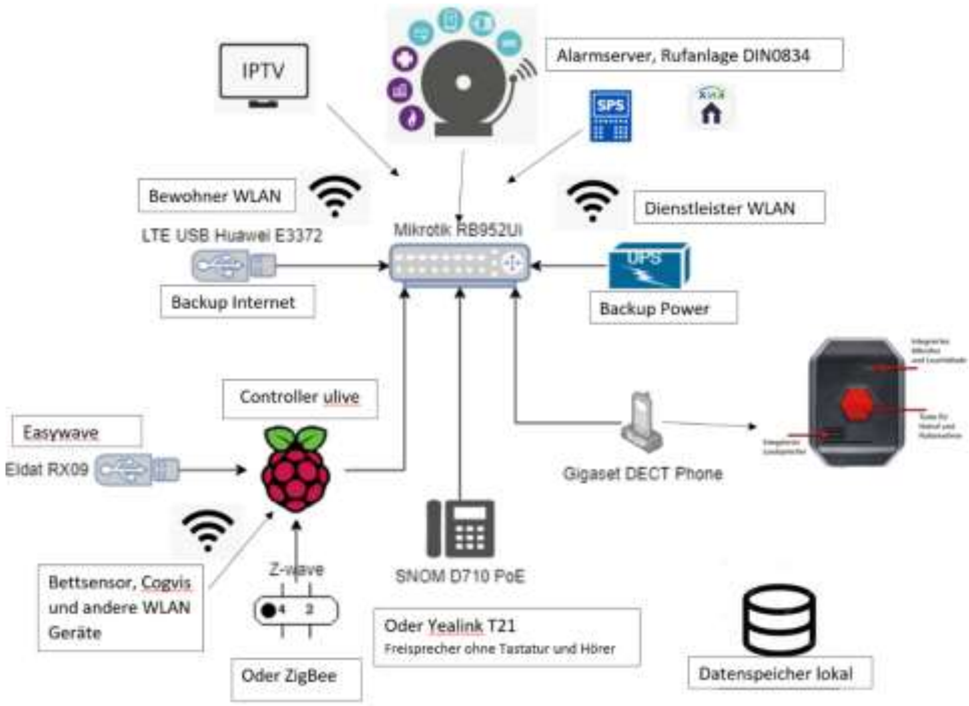


Figure 132: DS WOQ IoT ecosystem

The time for deployment of the motion and door opening sensors was 2 hours per household in the first project: Nieder-Roden. The time for deployment of the technical alarm sensors was 10 minutes per household.

The pairing of devices (motion sensor, door opening sensor, technical alarm sensors, panic button, medical devices) with the gateway and the element, the log in into the server and the software updates prior to the installation, reduced the installation time by -35 ± 10 minutes.

Setting up the controller took about 30 minutes per apartment.

The installation on site took one hour per apartment. After that, the system had to be individually adjusted to the residents' needs; it took also ca. an hour per apartment.

So we can say: to create an assisted living environment, we need approx. ten minutes of preparation per apartment, one hour for setting of the controller and the integration of the sensors, then one hour for the installation and one hour for the matching.

That means, it took 3 hours and 10 minutes per apartment in the WOQUAZ, Türkheim, Stuttgart and Nieder-Roden as well as in the 6 apartments in Treuchtlingen. In the nursing home and in the dementia sharing flats, the one hour for the individual settings was reduced. This can be done centrally by the nursing staff.

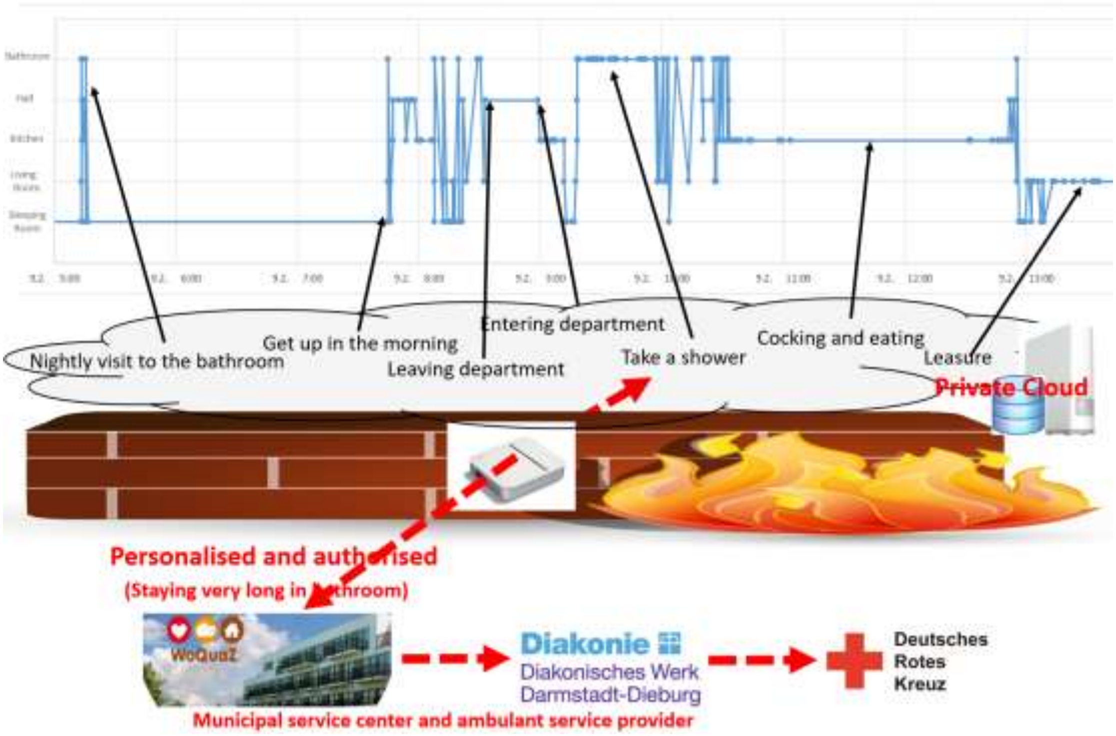


Figure 133: DS WOQ First installation in Weiterstadt

Figure 134: DS WOQ The uLive controller serving as gateway

An IoT based system was installed in each participant's home and each nursing room.

All sensors are connected to the controller where all of the data is evaluated. If an alarm situation is detected in the site, the controller sends information to the hands-free speaker in the apartment or a text message to the nursing staff.

The data of the sensors existing in the apartment can be called up via a tablet or smartphone to check the functionality of the sensors. Processes and alarms can also be checked in the monitoring. The main purpose of monitoring is to analyze errors. Administrators or operators can use a concierge interface to control the system, fine-tune it to needs of the resident or monitor battery levels.

The system does not collect data in order to monitor the resident. Such data like how often someone opens the door, how often someone goes into the bathroom or when someone goes to bed or gets up is not recorded.

In the nursing home, however, the nightly inspection tour can be monitored. Whereby the monitoring only refers to the possibility of the monitoring itself. That means it is not actually done, but shown at random on request. This can be used to prove that patrols are taking place.

However, it was found that the patrols woke up the residents and provoked the use of the toilet, which in turn could lead to falls.

To prevent the Falls, the number of patrols in Treuchtlingen was reduced and replaced by the “bed abandoned” alarm in our system. This means if a resident wanted to get up, this was recognized and immediately reported to the nursing staff.

This resulted in a significant psychological relief of the nursing staff and a qualitative improvement in the sleep of the residents because they were no longer disturbed.

In the approach of assisted living by some staff, the inactivity, no return to bed and a long whereabouts of the bathroom are monitored.

In Nieder-Roden and Türkheim these alarms were sent directly to the relatives, which led to great resentment. In Weiterstadt, due to the better infrastructure, the alarms could first be sent to the resident, who then verified and stopped the alarm himself by accepting the call. In Nieder-Roden, an alarm management system was installed which verified the alarms by monitoring. That was why an acceptance of the systems could be achieved.

In Türkheim, however, it led to the termination. Relatives and residents could and would no longer accept the false alarms. The system could not be accepted without a speakerphone and the verified alarms,

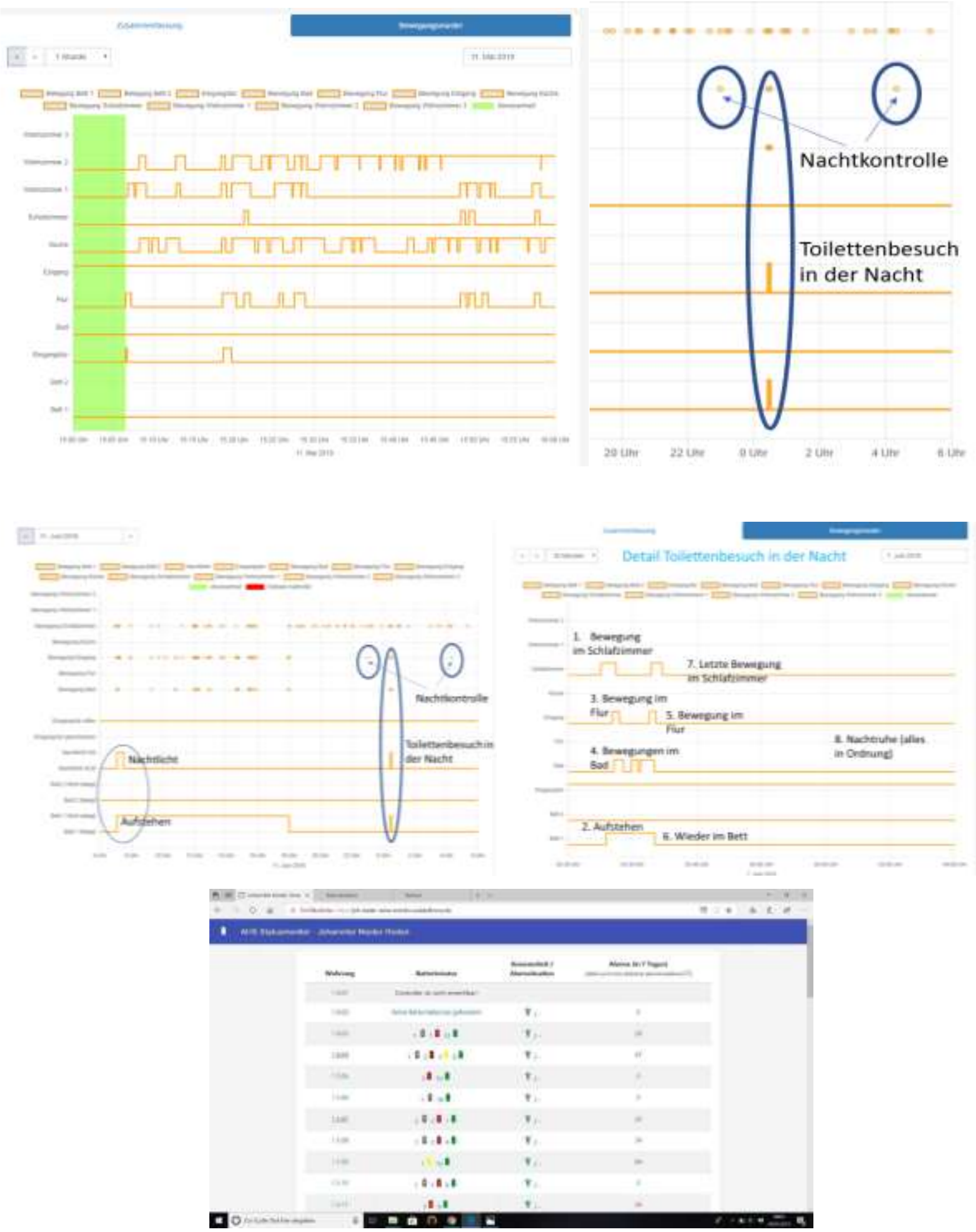


Figure 135: DS WOQ details of monitoring system

Table 167. DS WOQ Devices per categories installed *(multi-sensors are count as four sensors)*

RUC	Gateways	Environment sensors	Wearables	Health / Alarm devices	Communication devices	User interface devices
RUC_01	233	3842		178	55	
RUC_04	233	3842		178	55	
TOTAL	**233**	**3842**		**178**	**55**	

9.1.3 Experiment running report

9.1.3.1 Users participation

Table 168. DS WOQ Drop-offs by 30th of June

Reasons for drop-offs	Number of drop-offs
Death	4
Moved out	4
Denied further participation	18
No access due to COVID	25
TOTAL	51

Table 169. DS WOQ Users in operation

RUC	Elderly	Informal caregiver	Formal caregiver	Other stakeholder
RUC_01	161	7	10	1
RUC_04	161	7	10	1
TOTAL	161	7	10	1

9.1.3.2 Services & Apps in use

Actual available handling of alarm situations:

#	Situation recognised	Announcement and control call	Action in the home
1	Active Emergency Call	The emergency call button was pressed	--
2	Suspicion of a fall	Unusual lying position discovered	--
3	Unusually long periods of inactivity (including bathroom)	No physical activity for a long time	--
4	Leaving bed	if defined in care centres as alarm: Resident in room xx leaves the bed	Night light is switched on
5	No return to bed	The bed stayed empty for an unusually long time	--
6	Not getting up in the morning	No physical activity for a long time	Light is switched on
7	Not going to bed in the evening	You are up for an unusually long time	--
8	Smoke alarm	Smoke detected	Electricity / stove will be turned off, but lights will be turned on the shutters are raised and the door is opened
9	Entrance door open	The entrance door is open for an unusually long time	--
10	Unusually long water consumption	The water has been running for an unusually long time	The water was therefore turned off
11	Window is open	The window is open for an unusually long time	--
12	High humidity / CO^2 values	--	Fan turns on
13	The apartment is heated by the sun	--	The roller shutter goes down - but only when nobody is in the apartment or on the balcony
14	Reminder function	Announcement text freely selectable	--
15	Problematic blood sugar level	Your blood sugar is out of the desired range	--
16	Problematic blood pressure value	Your blood pressure is outside the desired range	--
17	Oxygen saturation problematic	Your oxygen saturation is outside the desired range	--
18	Incoming calls from the inhabitant's (or an authorized carer's) phone	This is your apartment speaking	Press zero: alarms are reset Press one: door can be opened Press five: you can speak into the home through the speakerphone ... further actions are possible

	realized functions	**in development**	**available soon**

9.2 Local evaluation report

The main goal was the aim of finding an optimal set for our solution to increase the health situation and evaluating the usefulness by an experimental process. After several months of study and analysis of the data and information obtained through surveys and interviews we are able to summarize the outcome of our experimental journey.

The evaluation process has been of high importance for DS WOQ since it was planned from the beginning to take the results of the project for a product placement in the coming months after the project. Therefor DS WOQ has seen this evaluation process not only to get direct feedback of the prototype as a passive indoor monitoring system for the detection of emergency cases of the elderly through sensors in their own homes, but also to continuously improve the weak points and additionally to know how to address which customer.

The DS WOQ had a very difficult start, since only Weiterstadt and Rodgau were fixed as pilot sites and after the leaving of Stuttgart pilot site there had been a lot of effort in acquiring new pilots to fulfil the promised number of end users. On the other side it was a very good test in gaining experience in searching for customer on the market for the future business.

Finally, by winning Treuchtlingen and Türkheim DS WOQ was able to reach the promised numbers. With the very good help of WP6 and WP9 DS WOQ has been able to manage the tasks of analysing the questionnaires and to review and share the results between the partners. With this help a continuous and dynamic process of quantitative and qualitative measurement has been possible.

Within the three evaluation phases the information collected from the different questionnaires and interviews with older adults Ds WOQ has been able to report the actual state to WP6 and WP9 in the biweekly phone conferences. After each phase the data has been uploaded to the ACTIVAGE DS evaluation LSP dashboard and the data analysis was carried out so that the results could be included in a continuous improvement process for a future business.

9.2.1 Goal of local evaluation: primary and secondary endpoints

The primary goal of DS WOQ was to prepare the pathway for a product placement after the project. Consequently, the necessity was given to demonstrate the need and feasibility for smart living environments based on Internet of Things (IoT) technologies during the project and to show positive effects in quality of life for the people 60+.

Consequently, the gaol was to reach following outcomes for our secondary endpoints:

- The use of the IoT-based solution for monitoring can provide substantial support to people over 60 years enhancing their quality of life by feeling safer at home and to allow older people to stay longer at home
- The use of the system brings great advantages for formal caregivers for the management and monitoring the status of the users and reaches to save time / money
- The use of the system helps to ease the care for caregivers can have a positive impact on the burden perceived by them
- The use of the IoT-based solution is respecting the privacy and security of user and therefor all data remains in the user's private network, there should be no uncontrolled data transfer
- The system is able to link various sensors and components from different manufacturers by numerous communication channels and protocols to enable a flexible interplay between the components
- The passive emergency call is being revolutionised by intelligent sets of rules and multiple verification of situations in order to convert computed conjecture to higher levels of certitude

This evaluation phase also made a number of recommendations aimed at finding a marketing solution that primarily increases the length of stay at home and thus increase the quality of life. Furthermore, the business model could be specified more precisely. This also resulted in recommendations for the composition of the hardware and the setting of the rules, installation, maintenance and ongoing operation. Finally, a more specific way was found how new customers can be addressed.

9.2.2 Local KPI collected

To collect the necessary information apart from the GLOCAL questionnaires (demographic data, EQ5D3L, Self-Assessment Questionnaire, UTAUT, and Carerqol7d), we also carried out a data analysis with local specific questions in order to be able to find a niche in the market (LKPIs and marketing questionnaire). In order to achieve the overall objective a set a of data has been collected to reinforce the outcomes and the analysis of our primary goal. In this sense the following specific objectives have been identified:

Impact on QoL

- to increase the quality of life to a great extent
- to increase the safety at home
- to increase the independence of the elderly
- to show that the support from the system is evident for elderly but also caregivers
- to reduce the workload for the caregiver

Innovation

- to reach an increased acceptance and low rejection rate by the end users
- to find a setting where users are not disturbed by the system by a conspicuous way
- to get a highly satisfaction, an increased level of approval for use and high recommendation rate to other people
- to get high privacy protection with the goal that data will not be passed on without the permission of the users
- to build a system which is easy to use, self-explanatory where no outside help is required

Sustainability

- to find an ideal setting of sensors and actuators to reach a minimal price level, since there are many different possibilities to combine the hardware
- to detect almost all emergency cases by an accurate behaviour recognition and to have a high detection accuracy close to 100% to get almost no false positives
- to find an inexpensive way which users are willing to pay
- to find a process for easy installation and a good scalability when replicating the system
- to get low running costs such as maintenance
- to find an easy integration of new devices into the existing setting
- to enable a maximum of compatibility due to its modular structure and to cover a wide variety of needs and applications

9.2.3 Local Evaluation Protocol

To measure the impact of the assessment an experimental method has been used, which compare the effects of the situation before and after the test phase at the four German pilot sites. The evaluation focuses on the impacts of older people and their informal carers. The implementation process of the evaluation observes where the barriers are and what is the margin for improvement to be scaled up and replicated to other future sites.

For this reason, information has been collected from the different questionnaires of the three phases and in parallel by evaluating the data from different sensors, actuators and devices and the reasoning of these sensor information for behavioural analysis to support the objectives (KPIs) mentioned above. To achieve this, the local evaluation protocol in DS-WOQ was as follows:

Since the users in Weiterstadt had yet participated to the ReAAL project the DS-WOQ started with the initial system at this site. During the project duration further sites had been acquired and the role out from the tested system in Weiterstadt to the other sites had been possible. After joining to the ACTIVAGE project each pilot had to look that the participants filled out the consent forms and a questionnaire to translate the behavior of living to the used rules of the system by parameters. During the project runtime the users had some time (3-6 months) to make experience with the system between each phase of evaluation, to find the advantages or the weak points by using it 24/7. At each phase the users had been interviewed personally in their apartments while filling the questionnaires. In case of Treuchtlingen the care persons filled out the questionnaires due to the bad health conditions of the end users (most of them suffering from dementia).

Following data has been collected:

- Demographic data
- Quality of Live Questionnaire for formal and informal care giver (QoL-7D)
- Global KPIs
- Quality of Life Questionnaire for elderly (EQ-5D-3L)
- Furthermore, local KPIs has been collected to see it the satisfaction changes over time

For the further product development additional questions had been asked in the final evaluation about the strengths and weaknesses of the system in the areas of:

- privacy
- IT protection
- inconspicuousness
- maintainability
- costs
- interoperability
- reusability
- expandability

and additional questions for the satisfaction of the system.

Since the pilots Treuchtlingen and Türkheim started later during the project, each evaluation phase always started in Weiterstadt and Rodgau.

To avoid to disturb the elderly all the questionnaires of a phase had been done together.

Due to some expected drop-offs at DS-WOQ more questionnaires have been planned in the three phases. All questionnaires have been filled by the end users themselves except the 59 elderly at Care level 5 in Treuchtlingen, which have been done by the care personnel.

In more detail:

- 479 sociodemographic data have been collected from older adults and caregivers
- 33 questionnaires for quality of live (CarerQoL7D) have been completed from caregivers

- 423 Quality of Life (QOL) questionnaires (EQ-5D-3L) have been completed from users
- 296 Acceptance and Use of Technology (UTAUT) questionnaires have been filled by users (274 by older adults, 22 by caregivers)

In summery a total of 1,231 questionnaires have been completed in the DS-WOQ for older adults and caregivers.

LSP Dashboard – DS-WOQ:

DS7 Woquaz - Questionnaries and surveys

Questionnaire name	Baseline	Intermediate	Final
Quality of life cares (QOLD7)	15	12	6
Techonology acceptance (UTAUT)	0	168	128
Quality of life eldery (EQ5D3L)	140	161	122
Sociodemographic data	179	172	128
Self Perception Questionnaire (SQP)	140	161	122
Loneliness scale (UCLA)	0	0	0

This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No 732679

Figure 136: DS WOQ LSP dashboard view

The evaluation starts with the definition of the KPIs and the planning, execution and analysis of the results. The set of KPIs have been used to adapt the system in iteration processes according to the needs of the elderly and the caregivers and for proofing the sustainability of the health services.

The information has been collected using the following procedure → conducting questionnaires in three phases: at the beginning, middle and end of the project:

- April – May 2019:

  Baseline questionnaire (Global questionnaire, EQ5D3L, Local KPI Questionnaire) for the, at this time, existing pilots Weiterstadt and Rodgau
- May – September 2019:

  Using the feedback to adapt the system by changing the set of rules and some hardware components like the bed sensor and roll out in Weiterstadt and Rodgau
- September – October 2019:

  Baseline questionnaire (Global questionnaire, EQ5D3L, Local KPI Questionnaire) for the new pilots Treuchtlingen and Türkheim, parallel role out of the enhanced system with bed sensor
- October 2019:

  Intermediate questionnaire (Global questionnaire, EQ5D3L, UTAUT, Local KPI Questionnaire) for the first pilots Weiterstadt and Rodgau after 6 months experience
- November 2019:

Intermediate questionnaire (Global questionnaire, EQ5D3L, UTAUT, Local KPI Questionnaire) for the new pilots Treuchtlingen and Türkheim after 2 months experience

- November – April 2020:

  Using the feedback of the intermediate evaluation to adapt the system by adding new hardware components like hands free phones or fall detector, switching to new protocols like DECT and roll out in Weiterstadt for testing the new system

- May – July 2020:

  Final Questionnaire (Global questionnaire, EQ5D3L, UTAUT, Local KPI Questionnaire) in all four pilots

Data from the same person has been used over the three phases to compare if the KPIs are changing like the personal situation of the users is getting better or worse, if the acceptance increases or if a lower rejection rate by the end users could be reached, if the system is easier to use and if a higher privacy protection could be achieved.

Limitations

During the process of the project implementation a number of circumstances have arisen:

1. Start of the evaluation process

   Since the pilot site of Stuttgart left the project in the first phase of the project the evaluation started only with the two sites Weiterstadt and Rodgau. After many efforts in finding new sites the start of evaluation in Treuchtlingen and Türkheim could start not before September 2019 with a delay of 5 months

2. Change in residents of the apartments

   Due to changing health conditions four persons died and four elderly moved out. Since the detection accuracy with many false positives appeared in the first months, 18 persons denied the further participation to the project. As consequence the hardware configuration has been changed in the next iteration

3. Restriction for the evaluation due to COVID-19

   Türkheim was unfortunately not able to participate for the final evaluation due to COVID-19. Here no access has been allowed to all the 25 end users. The other three care centres had been opened with restricted access. Additionally, the roll-out of the final version was delayed due to COVID which had implications to the final evaluation.

9.2.4 Analysis of results

The German DS7 has participated to the project with four pilot regions: Weiterstadt, Rodgau, Treuchtlingen and Türkheim with together 175 installed systems. Therefor the DS reached the goal of 123 systems (+42,3% more than planned). Except from Treuchtlingen all end users are participants from assisted accommodations in flats. Treuchtlingen itself is a care center with care rooms where people are living which need care and often have dementia. Following table show the state of installation at different dates.

In operation	Weiterstadt	Rodgau	Treuchtlingen	Türkheim	TOTAL
01.07.2018	2 flats 11 care rooms		2 care rooms		15
01.01.2019	3 flats 11 care rooms		4 care rooms		18
01.04.2019	5 flats 11 care rooms	48 flats 2 rooms	6 flats 60 care rooms		132
01.07.2019	7 flats 11 care rooms	48 flats 2 rooms	6 flats 60 care rooms	26 flats	160
01.01.2020	22 flats 11 care rooms	48 flats 2 romos	6 flats 60 care rooms	26 flats	175

Figure 137: DS WOQ progress of installation

At the different sites following sensors and devices had been installed:

668	Multi-sensors with motion, temperature, humidity, light
233	Controllers (Raspberry-Pis)
203	Door contact
178	Panic button
152	Bed sensors
148	Relays for Light
114	Relays roller shutter
105	Motion sensors for balcony
92	Switch and router for SIP
88	Socket 230 V
82	Smoke Sensor
56	Switch for 400 V
55	Hands-free Telephones
48	COGVIS fall detection systems
27	Motor key for door

If the multi sensor will be count as four sensors, altogether 4253 sensors have been installed at the four sites. In Weiterstadt 765 other devices already installed before ACTIVAGE started, which have also been used to collect information, derive behaviour from them and provide assisted services to the end users. During the runtime of ACTIVAGE 33.321.578 events from movement detectors, 7.887.965 room changes, 344.311 absence and presence interpretations, 335.005 bed occupancy detections, 57.695 absence detections with more than two hours and 642 alarms had been sent. In Weiterstadt with all the additional sensor installed before project start 179.791.226 events detected including 418.296 water flow events, 1.899.064 CO2 events or 3.153.952 humidity measurements. If a critical situation was detected an alarm was sent to the phones into an escalating alarm chain (see left: mobile phone interface with the alarms “Smoke alarm”, “Unusual long period in living room” and “Unusual long leave from bed in the night”).

Socio-demographic information

	Weiterstadt	Rodgau	Treuchtlingen	Türkheim	TOTAL
Elderly	24	53	59	25	161
Infomal	5	3	-	-	8
Formal	5	4	1	-	10
Real	**34**	**60**	**60**	**25**	**179**
Target	23	40	40	20	**123**
Achieved	147,8%	150,0%	150,5%	125,0%	**145,5%**

Figure 138: DS WOQ details on sociodemographic data collected

As one of the smallest DS at ACTIVAGE we got 179 socio demographic questionnaires at the beginning of the evaluation (see LSP Dashboard in chapter 9.2.3). The target we had to reach had been 123, which we surpassed by 45,5%. Due to death and people moved away the participants had been reduced to 172 in the intermediate state.

A few persons did not want to answer the Socio Demographic Questionnaire, others not the GKPI or the UTAUT questionnaires. As a result, we got 153 complete profiles from elderly out of all questionnaires (128 full profiles in the final evaluation due to COVID-19).

Distribution by age:

The average age of the participants in all sites is 81,8 years, where most of the participants are between 80 and 90 (39,2%), followed by the age between 70 and 80 (31,4%). 38,6% of the elderly at DS7 are living in care centres. At the group beyond 90 we had 20,3% and only a few younger below 70 (9,2%). The average age in the care centre is around 5 years higher than in the apartments, while around 2/3 of the 90+ people are in the care centre. The oldest participant is celebrating her 100th birthday this year, the youngest is 51 years. Thus, the physical and social health state is very different between the end users.

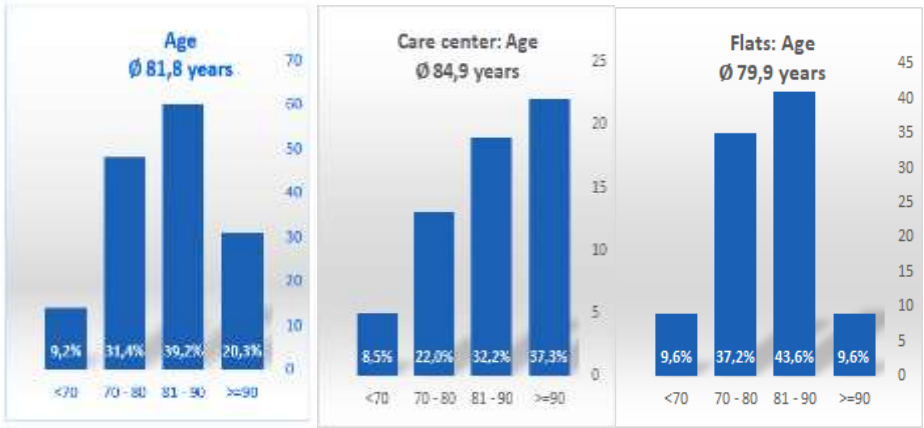


Figure 139: DS WOQ participants distribution by age

Distribution by gender:

At the four pilots the distribution is in the normal range, which is 66,7% women and 33,3% men, due to the higher life expectation of women which is very similar in the care centre and the flats.

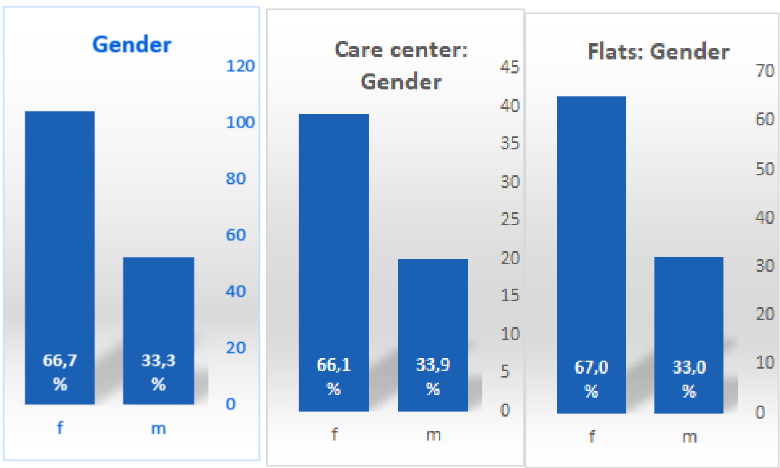


Figure 140: DS WOQ participants distribution by gender

Distribution by education:

Most of the participants have an education at ISCED level 3 (40,0%). Only 2,9% are in ISCED level 1. The highest degree of education has been a PhD of one participant and 7 have a master degree. The education level at the care centre is much lower than in the flats. The reason might lay in the years of the second world war and after, since the age in the care centre is higher (see above) and there had been less possibilities to get a good education at this time.

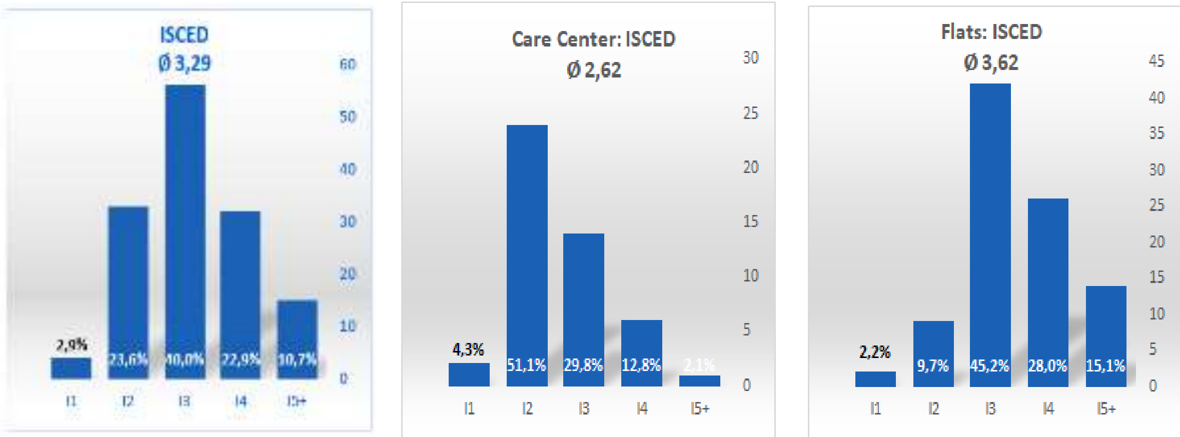


Figure 141: DS WOQ participants distribution by education level

Distribution by technology knowledge:

The technology knowledge is also in average of the population 60+. 58,6% have only basic and only 1,3% excellent knowledge. In the care centre is the technology level a bit lower which also may be caused by the higher age.

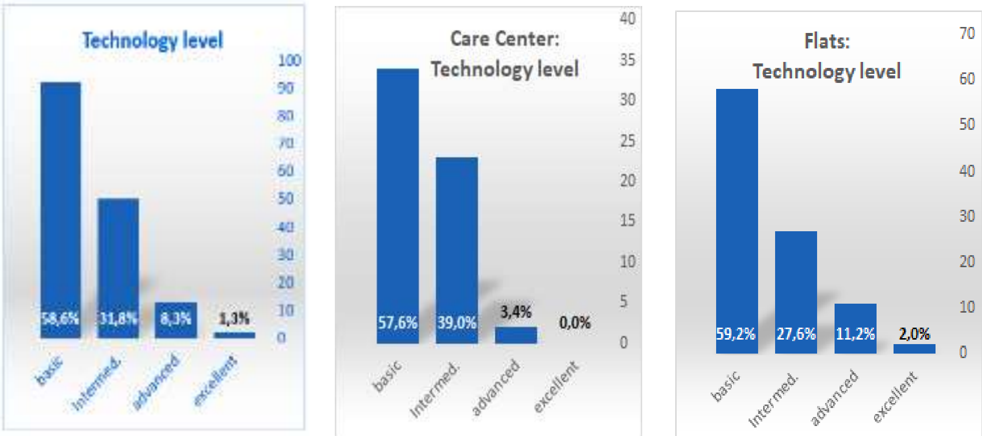
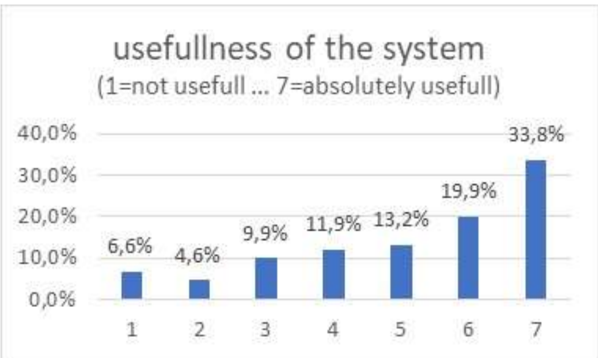
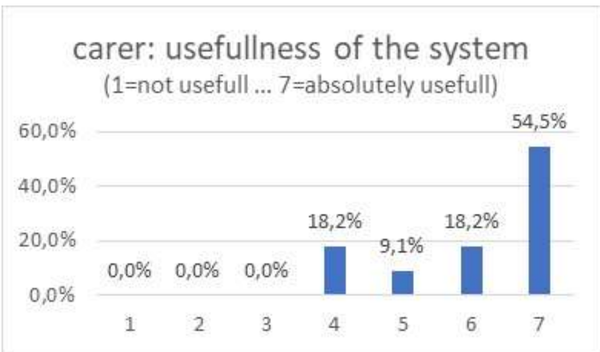


Figure 142: DS WOQ participants distribution by technology knowledge

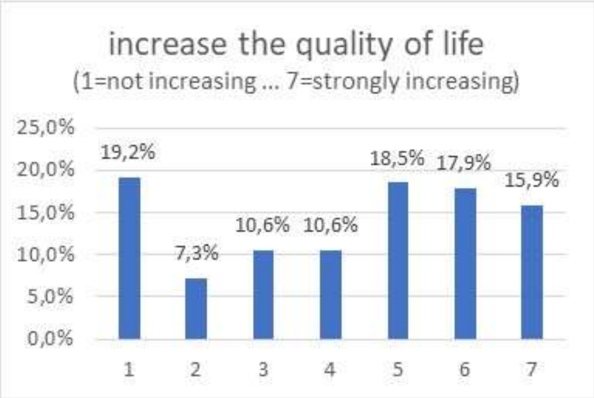
UTAUT and GKPIs

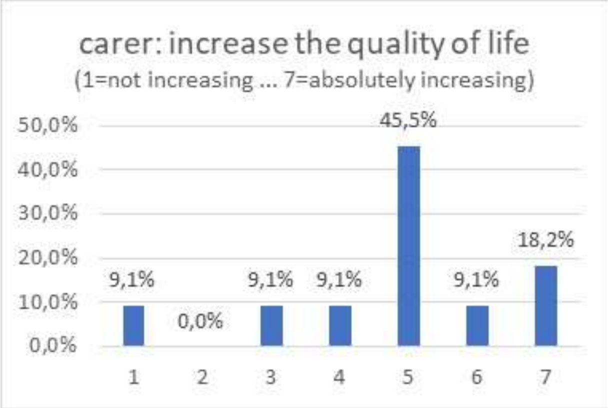
In order to achieve the mentioned objectives in chapter 9.2.2 following questions had been asked to the end users (elderly, family members and formal carers):



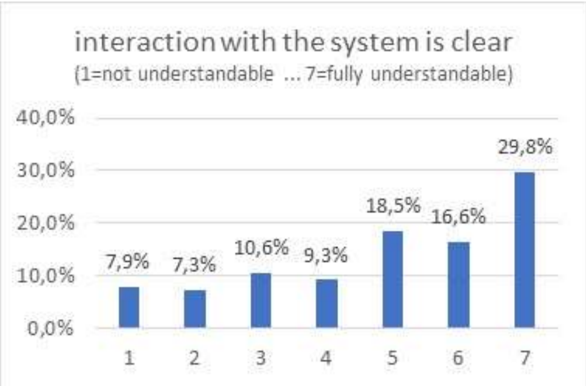


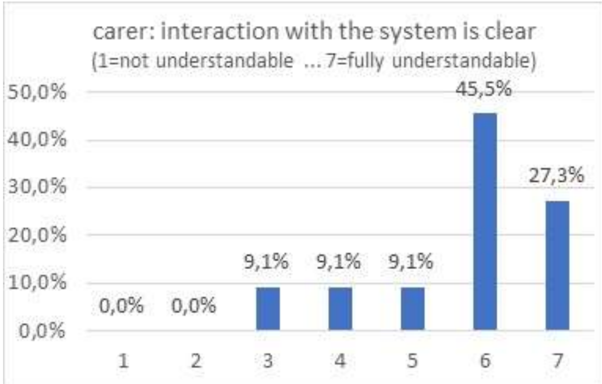
All together the participants see the system as useful. More than 50% see it as absolutely useful (33,8%) or very useful (19,9%). Especially for the care personnel the system helps a lot at their daily work.



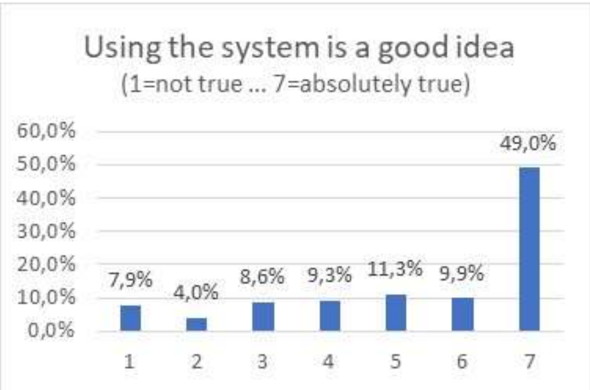


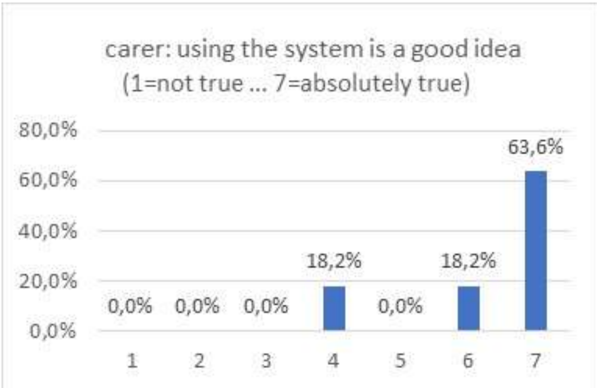
The increase of quality of life is seen very distributed between all users. Hopefully a higher advantage could be seen after the roll out of the new system in all other pilots. But the care personnel are even very satisfied by the old version of the system, which will increase additionally with the new system. Thus, the objective “increase the quality of life to a great extent” partly was met for the carers.



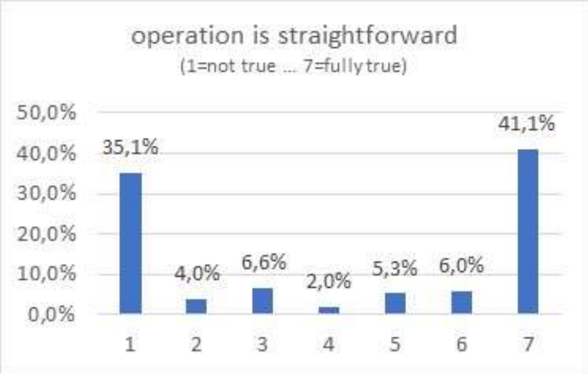


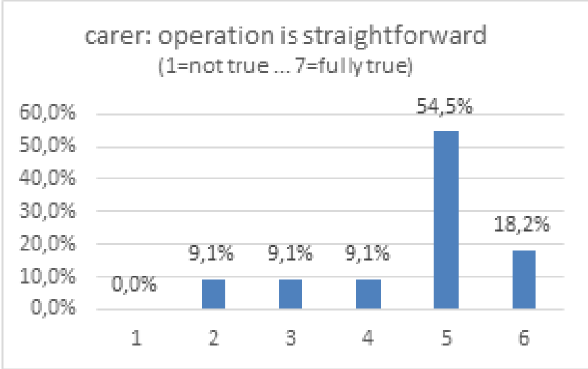
For most of the participants is fully understandable (or close to it) how the users must interact with the system. Especially the care personnel find it very understandable.



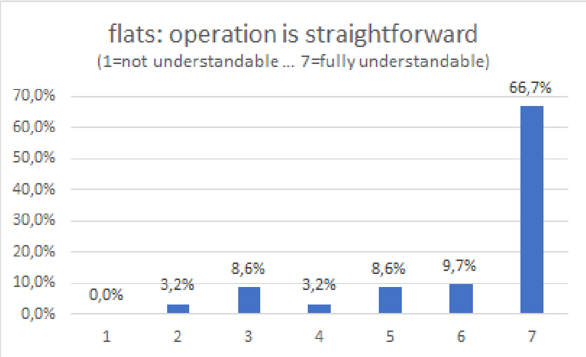


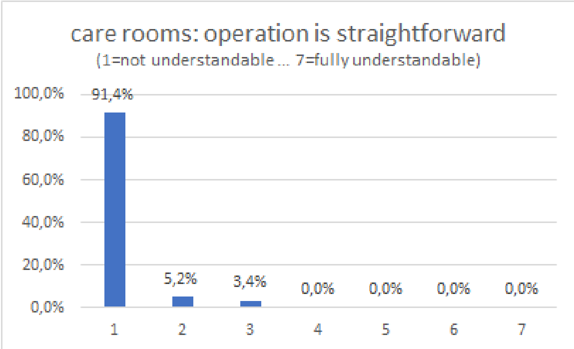
A very good result has also been, that half of the users see the use of the system as a very good idea. Also here, the care personnel find the use absolutely a good idea (63,6%).



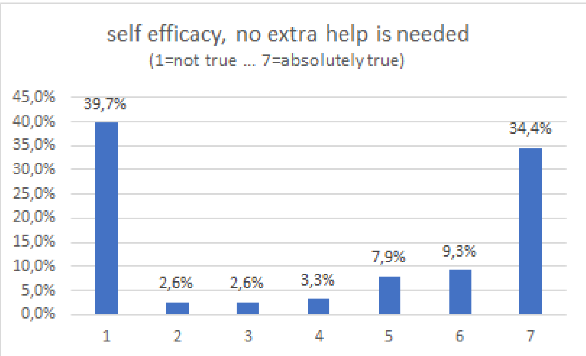


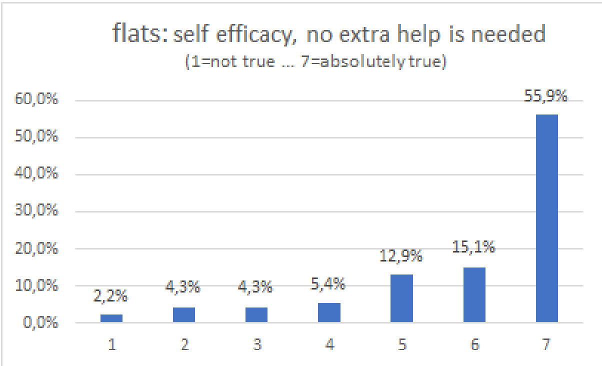
The care personnel understand very good the operation of the system (see right side). The overall view on the straightforwardness of the operation of all users is a bit surprising, but when splitting the result into flats and care rooms it gets explainable (see below).



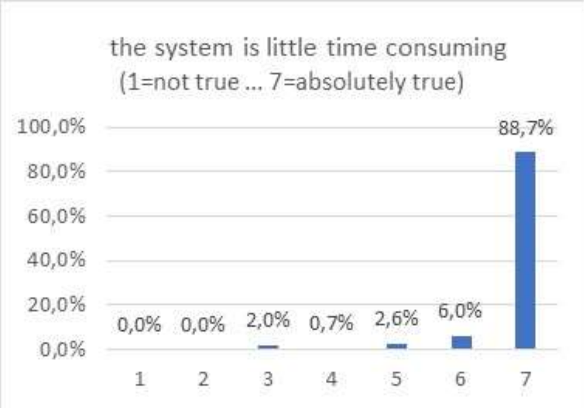


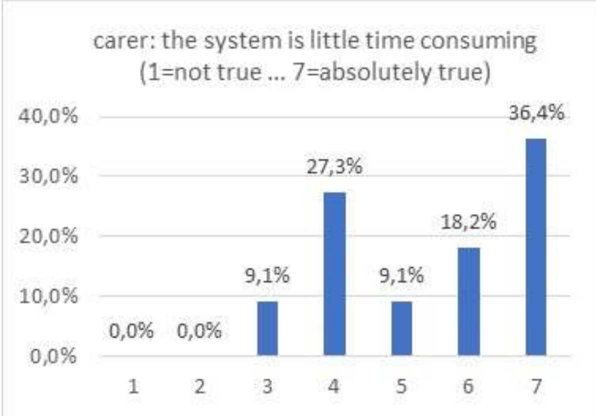
The users of the flats fully understand the system how it works and what they have to do. The people in care are often suffering from dementia and could no more understand the technology. Therefor we have to address the care centres themselves since the care personnel see the system as very useful (see above). Here we have seen the need of a completely different marketing strategy. Thus, we have now developed different concepts with own flyers and marketing material for the two different approaches.



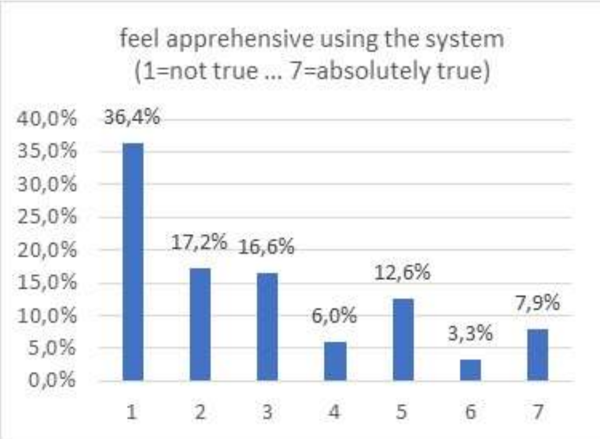


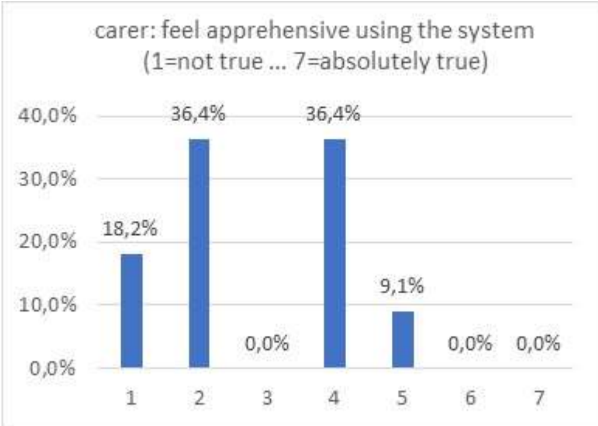
The same situation appeared when asking the end users if they can handle the system without outside help. Here 55,9% the end users of the flats absolutely agree and additional 15,1% full and 12,9 slightly agree to it. Here the objective of an "easy to use system, self-explanatory where no outside help is required" was totally met.



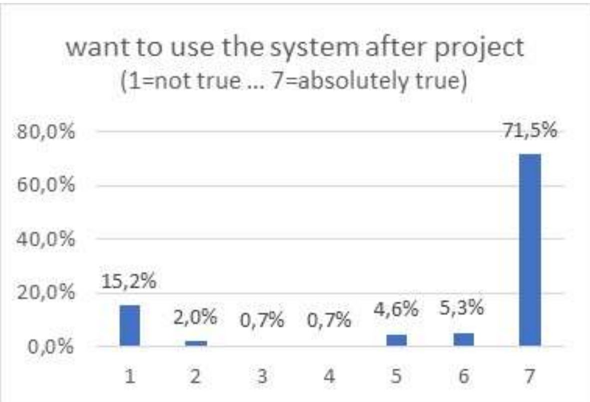


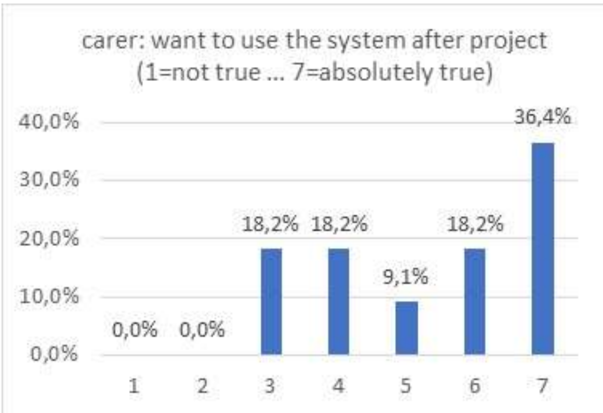
The end users have the opinion, that the system is very little time consuming (88,7%). For the care personnel a bit time is needed to control the state of the users every morning, but on the other hand time is saved due to less inspection routines.



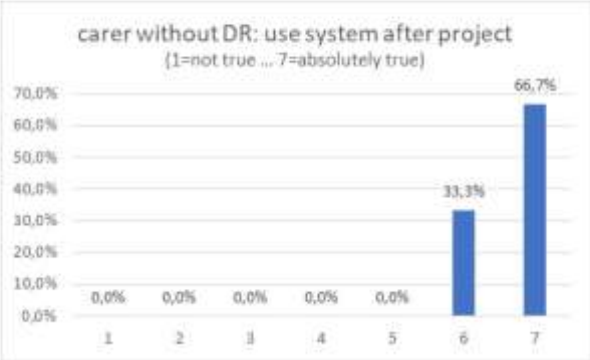


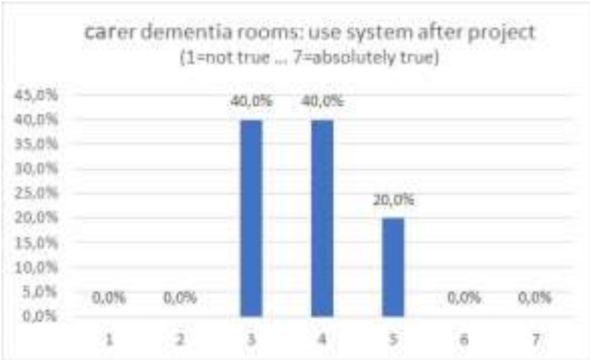
Another positive outcome of the evaluation had been, if the users feel apprehensive about using the system. Here answered more than half of the participants with "not true" or "almost not". Since the picture of the care personnel is a bit more sceptical we have asked further questions to the carer: the result is, that they are not afraid to use the system and make uncorrectable mistakes and also not feel intimidated / unsettled by the technology but they are afraid that information will be lost through incorrect operation. Therefore, we will have to put more emphasis on the graphical user interfaces (GUIs) to reduce their fears.





A very important result was whether the users would like to continue using the system after the end of the project. Here **71,5% of the users want to continue using it**. Therefor we firmly believe in a strong market opportunity for our system. Here too, the care staff was a bit more sceptical.





When we asked them for the reason, we received very positive feedback from the care personnel from Rodgau, Treuchtlingen and from the carers for the apartments in Weiterstadt without the carer of the dementia rooms (DR) with an average of 6.7 points (see left image above). However, the carers of the dementia rooms are not sure if they want to use the system in the future (3.2 points, right image above) which pushed the average down. Here we have to analyse the reasons for the bad review form the carer of the dementia rooms.

Local KPI

Local KPI Residents

The local KPIs questionnaires have been collected in all three phases. Here questions on requirements and functionality of the system have been addressed. For each question a KPI has been planned as target to be reached at the end of the project. Q1.1 and Q2.4 will be addressed below in more detail due to its importance.

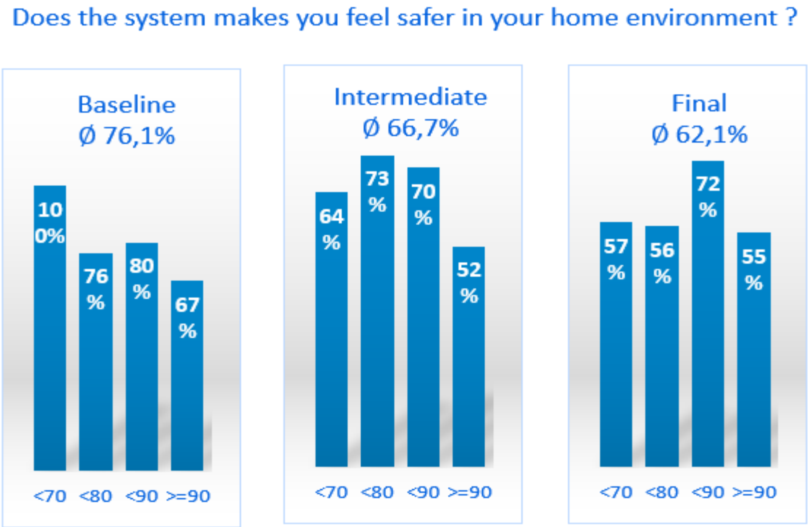
		% of participants who feel safer at their habitual living environment	% of participants who feel assisted by the system	% of participants predic-ting a prolon-gation in autonomy / domestic independence	% of participants who appreciate the flexibility of the rules/system	Number of apartments with full functionality of all rules	% of participants who refuse the complete system	Number of correct positive alerts	% of participants who see a long-lasting benefit comparing with clasical emergency call
Phase	Participants	Q1.1	Q1.2	Q1.3	Q2.1	Q2.3	Q2.4	Q3.1	Q3.4
DS7 LKPIs		1. Impact on QoL			2. Sustainability			3. Innovation	
Target		at least 75%	at least 75%	at least 75%	at least 75%	at least 60%	less than 20%	at least 75%	at least 60%
Baseline	140	75,93%	77,78%	68,52%	75,93%	61,11%	---	---	53,70%
Intermediate	161	66,67%	70,59%	56,86%	77,12%	77,78%	24,18%	44,44%	62,75%
Final	122	62,09%	64,05%	53,59%	72,55%	77,12%	22,22%	45,00%	58,17%

Figure 143: DS WOQ local KPI results for residents

Q1.2 address the objective "increase the safety at home", where we had asked the users, if the system give enough assistance to them. Here the goal of 75% had been reached with 77,8% in the baseline questionnaire, where the users only stated their opinion how the system will work. After the installation of the systems the approval to the system decreases to 70,6% in the intermediate evaluation and to 64% in the final evaluation due to the high rate of false alarms in the first phase. This could also be seen directly in the low number of correct alarms in Q3.1, where the target was failed strongly (45% instead of 75%). Therefor a new system with a higher recognition rate had been developed and integrated in a few flats at Weiterstadt until the final evaluation, where this disadvantage could be eliminated. This effect was unfortunately only measurable after the final evaluation due to the small number of new installed system at this time.

Q1.3 had the scope, if the system enables a better independence. Here also the results decreased due to the same situation from 68,5% to 56,9% and 53,9%. In both cases the target had not been reached. The question of the flexibility of the system (Q2.1) had been answered very close to the target in all three evaluations. Q2.3 was asking about the use of the full functionality where much more users agreed as expected. A long-lasting benefit was seen very close to the target.

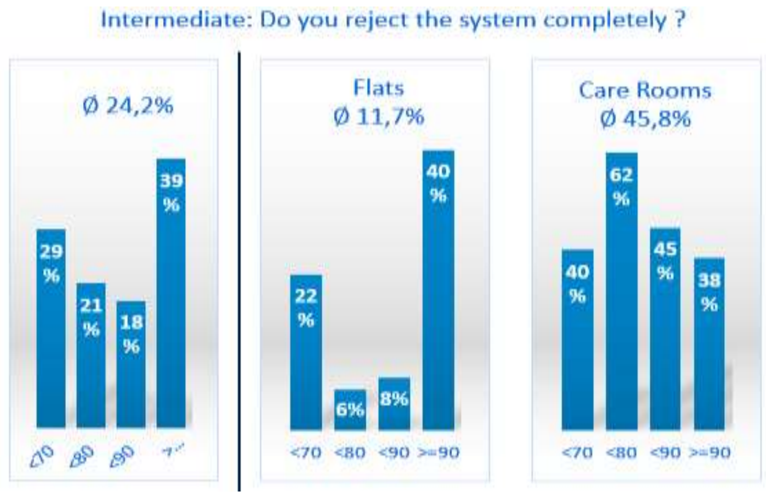
From the marketing perspective Q1.1 is very important for DS7 WOQ:



In the case of the objective "feeling safer at home" we evaluate with the baseline questionnaires if persons expect to feel safer at home with the system: while at the project start 76,1% feel safer at home without the system, in the intermediate phase it decreased to 66,7% with the system.

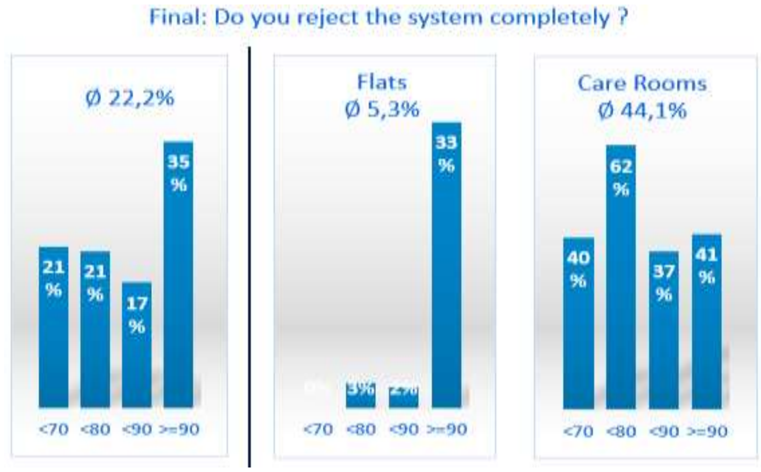
Due to some false positives the rate decreased to 62,1% in the final evaluation. During the runtime of the project we have taken this into account by the integration of new more accurate sensors and a change in the behaviour recognition. Unfortunately, we could manage to port the new system only in Weiterstadt until the final evaluation. Therefore, even this influenced the results of Weiterstadt positively, but the effect over all pilots has been still negative. We strongly believe, that with the role out of the new system in the other three pilots this will increase the approval strongly. Therefor for the first system we failed the objective to "detect almost all emergency cases by an accurate behaviour recognition and to have a high detection accuracy close to 100% to get almost no false positives". For the new systems it looks much better, but we have to evaluate it after the project again.

It was also interesting to see that user below 70 had believed in the system before they had made experience with (100%), which decreased dramatically to 64% in the intermediate evaluation, while the elderly between 70 and 80 years had nearly the same trust in the system in the intermediate evaluation. Between the intermediate and final evaluation, the people over 80 get back trust in the system, while younger lost again trust. This means, that we might have to think about to provide a test environment of the new system for the "younger" people to convince them to use the system. But it also can be seen, that our system is more appropriate between 80 and 90 years.



The first prototype which was evaluated in the intermediate evaluation had been rejected by 24,2%. After the improvements of the system to get a higher accuracy the rejection rate went down to 22,2% (see below). A very positive result was that the rejection rate of residents at the apartments decreased strongly from 11,7% in the intermediate phase to 5,3% in the final evaluation (see below). Here especially the younger residents see the system very positive (0% rejection rate at the age of younger than 70). But there is still the group of beyond 90 years where we have to put on more emphasis to convince them.

Thus, the reimplementation of the system had very positive effects for the acceptance. Our focus for marketing of the system should lay especially for people below 90 years living in apartments.



Since the high rejection rate of assisted persons in care homes (44,1%) we have to address the care personnel instead of the people need help. Here the care personal answered this question with 0% rejecting rate (see below LKPI Care Personnel Q2.4)! Here the objectives “reach an increased acceptance and low rejection rate by the end users" have been achieved in a very good manner.

Local KPI Care Personnel

		% of participants who feel safer at their habitual work environment	% of participants who feel assisted by the system	% of participants predic-ting a prolon-gation in autonomy / domestic independence	% of participants who appreciate the flexibility of the rules/system	Number of apartments with full functionality of all rules	% of participants who refuse the complete system	Number of correct positive alerts	% of participants who see a long-lasting benefit comparing with clasical emergency call
Phase	Participants	Q1.1	Q1.2	Q1.3	Q2.1	Q2.3	Q2.4	Q3.1	Q3.4
DS7 LKPIs		1. Impact on QoL			2. Sustainability			3. Innovation	
Target		at least 75%	at least 75%	at least 75%	at least 75%	at least 60%	less than 20%	at least 75%	at least 60%
Baseline	12	100,00%	91,67%	91,67%	83,33%	91,67%	---	---	83,33%
Intermediate	12	100,00%	91,67%	91,67%	91,67%	91,67%	0,00%	90,91%	83,33%
Final	11	100,00%	81,82%	90,91%	90,91%	90,91%	0,00%	66,67%	90,91%

Figure 144: DS WOQ local KPI results for carers

Even the results of the residents for the LKPIs have to be improved, the results of the care personnel are very positive. Especially Q1.1 if the carers are **feeling safer in their environment with the system had been answered with 100%!** Therefor the objective "increase the safety at home" was fully met. With Q1.3 the objective "increase the independence of the elderly" was also reached with the system from the carer view (90,9%). **Q2.4 with no person who refuses the system** was surprising. The other questions were also answered very positively. The only question where we have to do additional work is Q3.1. Here only 66,7% had correct positive alerts. We have to ask the carers later again, when the new system has been running long enough to draw conclusions.

Results of a study of the system for care by external experts

DS7 also carried out a study in March 2020 from two external professors Prof. Wießner, kath. Universität Eichstätt (sociologist) and Prof. Gerner, Technische Hochschule Nürnberg (Business and Economics) to evaluate the results at the care centre of Treuchtlingen. The aim of the study was to find out whether the workload for the staff in nursing homes could be relieved. For this purpose, a statement should be made about success and failure, costs and benefits. This should now serve as a basis for decision-makers as to whether additional investments in care are worthwhile, also from the point of view of relieving the staff.

The summary of the study was: To the surprise of the experts, the system was a "smart home" surface in which monitoring provides clear information about the respective resident behaviour without revealing behavioural patterns. Here, specific settings and alarms could be switched on and off in a simple manner. The impression of everyone is, that the system is for "fall prevention". Nothing unnecessary like automation or unclear rules that evaluate data. The nursing staff informs the nursing management of their need for alarm types for a specific resident and the care personnel sets the resident-specific alarms, which enable faster, more targeted help. "Out of bed" is an important alarm that now makes work easier since it is reliably displayed to the staff via the normal care telephone, and the staff can immediately contact the resident via the voice connection. The other important alarm is "No return to bed", where the return time is individually adjustable. This is used for residents who are less at risk of falling, often people with dementia who sometimes leave the room at night - this is now noticed much better. There are no more surprises for the staff at night. Time is saved, even if it cannot be directly proven in money, so it is "improvements in everyday work" and "increase the quality of work". Today the work situation in Treuchtlingen is perceived as easier, more pleasant and, above all, more satisfactory, since help is made much easier. This means less stress in Treuchtlingen and the work is seen as much more satisfying. There are significantly fewer falls and therefore much less stress. All in all, there is now a better quality of care available. Here the objectives “show that the support from the system is evident for elderly but also caregivers” and “reduce the workload for the caregiver” have been achieved very well.

Marketing Questionnaire

DS WOQ also made a marketing questionnaire in parallel to the final evaluation. Its intention was to find the importance of different quality characteristics the system has on the one side (in blue), and how these characteristics have been solved by the system (in red).

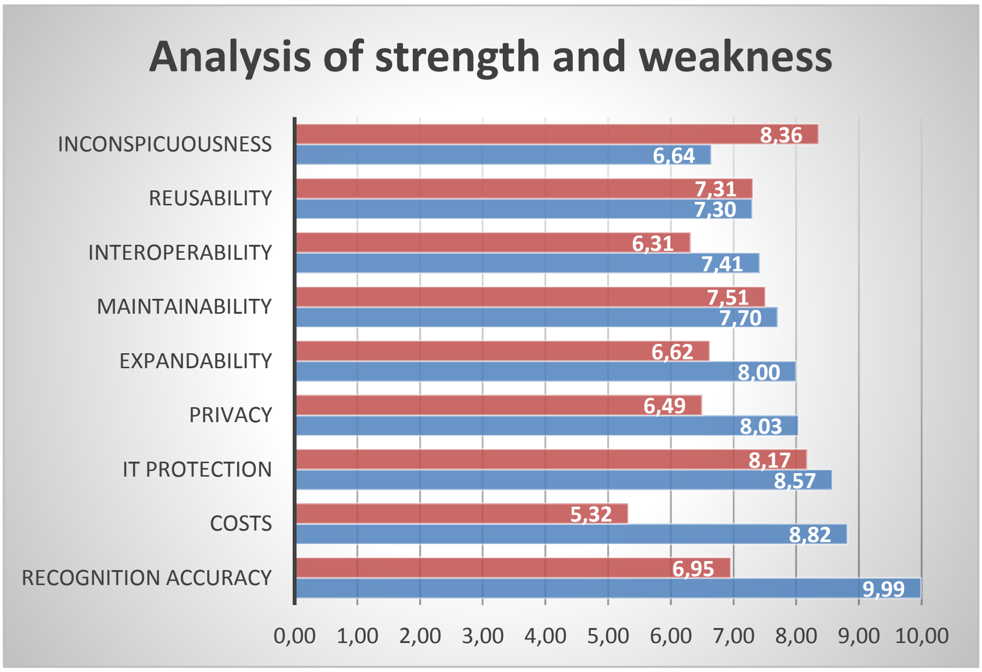


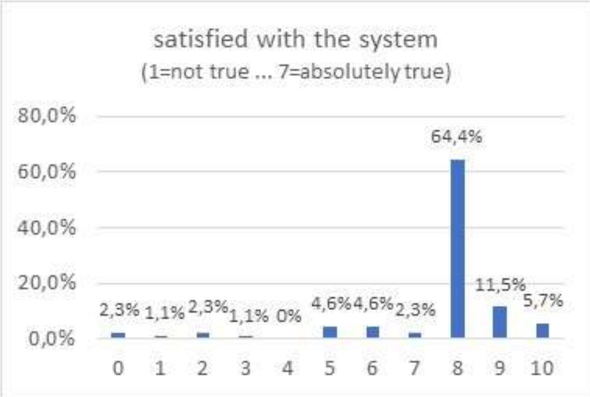
Figure 145: DS WOQ marketing questionnaire results

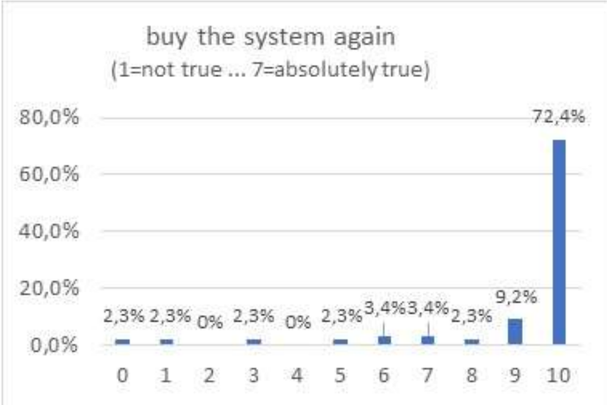
This evaluation showed us, that users rate the recognition of a specific situation as the most important property (9,99 of 10), followed by the cost of the system (8,82) and IT Security / Privacy. Therefor our selling points should lay on these properties. On the other hand, it showed us also where we have to put more emphasis for the future development: especially the recognition accuracy was rated much lower in the implementation of our system (6,95 / 9,99). The costs (objective “find an ideal setting of sensors and actuators to reach a minimal price”) are rated as to high (5,32 / 8,82). Since both points had been recognized after the intermediate evaluation, we have adapted the system for both points (e.g. by integrating other sensors with higher accuracy), but since the roll out of the final system had only been done in Weiterstadt, this effect was not really seen in the final evaluation as yet mentioned above.

Additionally, in the direction of privacy we have to enhance our marketing, since we have implemented the system as most restrictive as possible, but it seems that this is not seen by the end users (6,49 / 8,03). Therefor it is difficult to argue that the objective “get high privacy protection with the goal that data will not be passed on without the permission” have not been met, since it is impossible to do it in a more restrictive way. The same situation appeared with the objectives “find an easy integration of new devices into the existing setting” and “enable a maximum of compatibility“, since these are especially the key features of the platform universAAL, which is the basis of the system. But since it also cannot be seen by the end users we have to find a better marketing strategy for it.

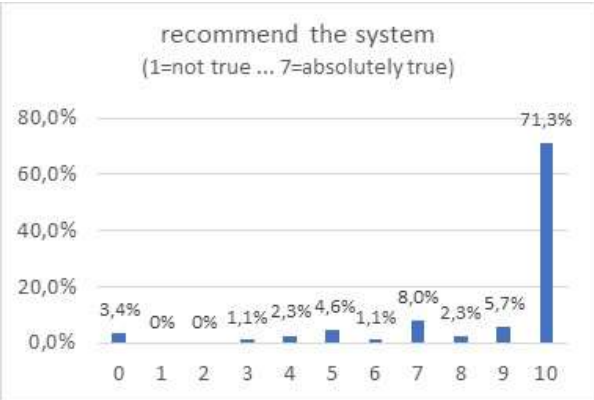
Since the expected value of maintainability (7,70) is almost the same value as with the implemented system (7,51), we are on a good way to meet the requirement “get low running costs such as maintenance”.

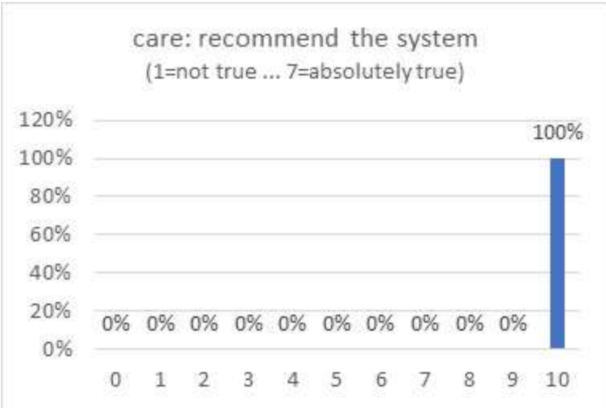
Surprisingly for us had been, that inconspicuousness is not that important as we thought (6,64) and were we laid a lot of effort in the past (8,36) and consequently the objective "users are not disturbed by the system by a conspicuous way" was reached from the beginning.





In the context of the marketing questionnaire we also asked questions about the satisfaction with the system. In a range from 0 to 10 the end users answered this question with an average of 7,52 (64,4% of them with 8). Even better was the result of the question, if they want to buy the system again. It had been answered with an average of 8,91 (here 72,4% of them voted with 10).





The recommendation of the system to others was rated with an average of 8,82 where 71,3% see it as absolutely recommendable (10). In the care sector it even laid at 100% with 10. Consequently, the objective to "get a highly satisfaction, an increased level of approval for use and a high recommendation rate to other people" was very successfully fulfilled.

9.2.5 Conclusions

With help of the evaluation and of the analysis, the project enables now DS WOQ to improve the actual system. The goal to prepare the pathway for a product placement after the project has been reached which is a next step and make business out of the results done in ACTIVAGE.

Additionally, our secondary endpoints have been achieved by providing substantial support to people over 60 years, enhancing their quality of life by feeling safer at home, and to have great advantages for formal caregivers for the management and monitoring by easing the care for caregivers.

When adding new sensors and devices from different manufacturers a flexible interplay between the components of the former system and the new components could be implemented easily. Thus the declared goal of the DS partners to increase the functionality of the Smart Living solution in Weiterstadt before the project could be reached and the variety of communication channels and protocols has been expanded. Additionally, the focus on defining the unique selling points of the solution has been reached. We had also been able to split the solution in two prototypes for „Independent Living“ and for “Care Centres”. Finally, we reached to have a verification of the alarm situations that are recognized by various sensors via immediate data evaluations and reasoning in real time. Thanks to the evaluation analysis, we are now on a good way to an applicable innovation with a clear business chance and business plan and we are keen to convince new customers where we can sell our project results as a product in the near future.

We managed to connect the IoT world to the telephony world. As consequence the old systems such as emergency call centers and alarm servers can continue to be operated as usual. We also had been able to have no uncontrolled data transfer, which means not only data security, but also device security. Furthermore, we managed to have no direct connections between devices and other internal sources of data with the external systems – data exchange with external systems is primarily done via IP telephony, unless the system is explicitly configured differently by the data owner and we also support now a wide range of device protocols and types so that a large number of manufacturers and products can be networked. With help of ACTIVAGE the passive emergency call is now being revolutionized by an extended intelligent set of rules and multiple verification of situations in order to convert computed conjecture to higher levels of certitude. Almost all objectives have been achieved. As future work we have to find a cheaper way or a better marketing since the marketing questionnaire showed us, that the costs are the second important property for the end users, but the worst rated implementation.

All these results enable us to fix now our new unique selling points, which differentiate us from competitors:

1. IoT world is connected to the telephony world. As consequence the old systems such as emergency call centers and alarm servers can continue to be operated as usual.
2. All data remains in the operator / user's private network and is operated according to the preferences of the operator / user. There is no uncontrolled data transfer. That means not only data security, but also device security. The security function works externally (data security) and internally (device security).
3. There are no direct connections between devices and other internal sources of data with the external systems – data exchange with external systems is primarily done via IP telephony, unless the system is explicitly configured differently by the data owner.
4. The semantic platform enables multiple use cases for the same data, no matter from which source. This means that one device can be used for several functions at the same time. It can be seen as complex realization of networked IoT.
5. We support a wide range of device protocols and types so that a large number of manufacturers and products can be networked.
6. The passive emergency call is being revolutionized by intelligent sets of rules and multiple verification of situations in order to convert computed conjecture to higher levels of certitude.

All this reached milestones helped us to have now a prototype which is close to the market. This brought us in a close contact with new potential clients where we want to sell this solution with help of the company Assisted Home Solutions and the new planned company uCore. During the project we found potential customers like Bavarian Red Cross in Augsburg where in a 1st step installations for 100 users are planned and a framework agreement for 1000 users is in discussion. At Lincoln in Darmstadt we have just signed a contract for 18 apartments, in Rüsselsheim with GeWoBau we are in discussion to equip 5 blocks with at least 40 apartments and with the City of Darmstadt are 132 apartments in discussion. Few other related acquisition activities are still ongoing and new ones will start in near future. As a next step for our business we have now to find a process for an easy installation and a scaling up process for the replication of the system, what would have gone beyond the possibilities of the project.

9.3 Local sustainability plan

9.3.1 Product/Service Definition

uLive assistance system for homes and care centres with the uLive Concierge

uLive provides for assistance at home and monitoring in nursing homes, with automatic (emergency) situation recognition and handling, including alarms.

The uLive Concierge is a Web application for configuration and personalization of uLive installations in homes, monitoring the homes and controlling home devices.

Running on top of universAAL IoT <www.universaal.info>, uLive is

(1) a truly open system which is extensible with third-party universAALized technologies and solutions, and

(2) part of the federated ecosystem of ACTIVAGE and even extensible by non-universAALized technologies and solutions that belong to the ACTIVAGE ecosystem!

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uLive Main Features

Indications of emergency with alarm processing: unusual long inactivity or sleep, no return to bed during night, protracted stay in bathroom, entrance door left open, fall alarm, active help request, smoke alarm and prolonged water consumption.

Safety & Comfort: night light, auto-ventilation depending on air quality (CO_2 & humidity), home leaving (depending on the duration of absence, switch off the lights, the stove & other dangerous appliances, water and the whole electricity if necessary, and close the window blinds in warm days), home entering (undo actions taken when leaving the home) and protective measures upon smoke alarm (power off, blinds up & door open).

Behaviour in emergency situations: triggering personal alarm escalation chains using IP telephony, optionally preceded by an announcement of the recognized situation (over a speakerphone) and a control call to the home phone to assess the recognized situation, and succeeded by feedback (over a speakerphone) if no helper could be reached and the system has to repeat the alarming; a called helper who confirms to take care of the emergency situation will be connected to the speakerphone.

Prerequisites

Technical, per home: One raspberry pi and one speakerphone (included), sensors and actuators as detailed for the different packages below (mainly motion, door contact, and bed sensors as well as light controls & switches), one SIP account, and VPN connection for technical system admin

Technical, per concierge: One mini-pc (included), building-level private network that gives the mini-pc access to the homes in the building, end devices with a browser for accessing the Web application

HR & organizational per home: Emergency contact persons, a two-hours training session for the inhabitants and these emergency contact persons, technicians for sensor installation, system configuration, personalization and launch

HR & organizational per concierge: Residential care and /or building management personnel, a six-hours training session, ca. 2 hours for installing and launching the uLive Concierge

uLive Alternative Packages

uLive night assistant

Comfort and wellbeing: automatic nightlight

Control of domestic risks, alert on risky or emergency situations:

– No nocturnal return to bed
– Active emergency call (panic button)
– Long stay in bathroom
– Alarm with personalized escalation chain

Package prerequisites: SIP account and Internet connection for IP telephony + a home phone with a dedicated phone number + emergency contact persons in the escalation chain who are reachable under a phone number

Package content: uLive-night Controller with 32GB Micro-SD card and uLive assistance software, two motion detectors, one bed sensor, one LED strip (1m), and one emergency button

Package pricing: for orders with a minimum of 20 installations

– 990 € per installation, including devices, but excluding installation

  (estimated effort for installation and launch of each system: 2 hours)

– 500 € for the uLive Admin, Monitor, Use (the uLive Concierge Web application)

– 99 € yearly for the maintenance and updates

uLive everyday guard

Comfort and wellbeing:

– Presence / absence detection
– Automatic nightlight
– Deactivation of stove after leaving home
– Reactivation of stove upon entering home

Control of domestic risks, alert on risky or emergency situations:

– Inactivity recognition
– No nocturnal return to bed
– Long stay in individual rooms / home
– Long stay in bathroom at night

– Active emergency call (panic button)
– Alarm with personalized escalation chain

Package prerequisites: SIP account and Internet connection for IP telephony + a home phone with a dedicated phone number + emergency contact persons in the escalation chain who are reachable under a phone number

Package content: uLive Controller with 128GB Micro-SD card and uLive assistance software, five to eight motion detectors, one to three door contact sensors, one to two bed sensors, one to two LED strips (each 1m), one emergency button, one relay, one smoke detector

Package pricing: for orders with a minimum of 20 installations

- minimum 2,000 € per installation, including devices, but excluding installation

  (estimated effort for installation and launch of each system: 4 hours)

- 500 € for the uLive Admin, Monitor, Use (the uLive Concierge Web application)
- 119 € yearly for the maintenance and updates

uLive add-ons

Special fall detectors for uLive night assistant / everyday guard

A must for both private homes and care centres

Specialized sensors for fall detection can dramatically shorten the time for recognizing emergency situations.

Add-on pricing: 900 €

Automatic door control for uLive night assistant / everyday guard

A must for private homes (as opposed to care centres)

When in emergency help comes without having access to the home, uLive will be able to open the door in a secure way and on demand.

Add-on pricing: 300 €

Monitoring air quality / water consumption for uLive everyday guard

Automatic ventilation control depending on co_2 and humidity

Unusually long water consumption as an additional indication of an emergency situation

Add-on pricing: 150 € for each of the two features (excluding the ventilator / water meter)

uLive reusable components for ACTIVAGE ecosystem

universAALized sensors & actuators, such as bed sensor, fall sensor and door lock

Integrate seamlessly ready-to-use sensors and actuators into your AIoTES-enabled solution

Component pricing: depends on the underlying device

universAAL controller

A Raspberry Pi 4 model B readily installed with universAAL and related (1) communication gateways for Modbus, MQTT, ZigBee and ZWave, (2) component integrators for 10 different device types, and the uLive Concierge Admin, hence appropriate for the integration (including commissioning) of 30 different types of sensors and actuators

Component pricing: 1,400 €

9.3.2 Market Analysis[58]

With "uLive" as the main product line, uCORE will target, ultimately even worldwide, companies such as "Assisted Home Solutions (AHS)", which are active on the market as a regional provider of services and products in the care, assisted living and home emergency segments. It should therefore be clear that uCORE will not be directly active as a system provider in this market, because experience shows that the definition and packaging of the concrete systems based on customer-specific requirements and preferences as well as the installation, adaptation and commissioning of these systems in individual residential units are complex projects in themselves that can only be carried out by regional service providers. uCORE, on the other hand, has to concentrate on the product and its adaptability in order to combine global quality with regional flexibility and to secure the future of the product.

In order to estimate the market volume for uLive as a product line in uCORE, one has to consider the customers of service providers like AHS; these are in Germany primarily (1) organizations such as the German Red Cross and the Johanniter with their care and home emergency call centres, (2) residential construction enterprises and cooperatives, such as Bauverein AG and WBG Mindelheim with their projects for age-friendly homes, and (3) associations, such as Sozialverband VdK Deutschland e.V. and Arbeiterwohlfahrt Bundesverband e.V. with activities partly at the intersection of the activities of the former two types of organizations. Certain wards in hospitals are also among the customers of companies like AHS.

According to the Federal Statistical Office, there are 14,500 nursing homes, 14,100 outpatient nursing services and 3.4 million people in need of care in Germany. Hospitals and care centres usually make use of a "nurse call system" without any voice connection. About 1 Mio of people in need of care use the classic emergency call systems. Not least due to the challenges of the aging society, this industry is currently on the threshold of the renewal of the systems and has high hopes for digitization. So far, however, there is a lack of effectively beneficial solutions that are practical and go beyond laboratory and model apartment installations. uLive fills exactly this gap.

Since uLive is generally used per household and per care room, it can potentially be used 3.4 million times in Germany alone. With uLive, AHS considers an estimated market share of 20% of the current market of the classic emergency call systems, i.e. the selling of 200,000 instances of uLive, to be realistic within five years. As a matter of fact, uCORE is very well networked at the European level and can also gain market shares in the EU beyond Germany. So, from a global perspective, we expect that uCORE would indeed be able to achieve the number 200,000 for uLive within five years.

9.3.3 Competition/sector Analysis

The dominant product on this market is certainly the classic home emergency call, which consists of a call button and a base station as a hands-free speaker[59]. In Germany, this system is used by around 1 million people in need of care[60]. The system connects individual people in their

58 This market analysis is written from the viewpoint of the planned spin-off, called "uCORE Systems GmbH". More on uCORE will follow in the next subsections.

59 In care centres and hospitals there is the nurse call system, which normally does not contain a hands-free speaker, but is considered in this analysis as a subset of the classic home emergency call.

60 https://hilfsmittel.mitpflegeleben.de/hausnotruf-systeme-im-ueberblick/

apartments with the so-called "call centers"[61], which receive calls for help and initiate any assistance that may be required. That is why the home emergency call systems are offered by service providers with call centers and outpatient nursing staff – in Germany mainly by the DRK / BRK, the Johanniter and ASB. The technology for home emergency call systems (with the base station as the main component) has been manufactured in Germany since 1980, for many years now mainly by "Bosch Security Systems" and "TUNSTALL GmbH". Further useful information can be found e.g. at http://hausnotruf-magazin.de/.

For about 10 years there has been increasing criticism of home emergency call systems, especially with regard to the following points:

- The fixed emergency buttons can be out of reach at the time they are needed; the wearable version, on the other hand, is hardly compatible with forgetfulness.
- The more sensitive people in need feel stigmatized by wearing an emergency button and try to hide it from visitors and later forget to wear it again.
- The number of emergencies that go unnoticed is not negligibly small, be it for the above reasons or because the person in need had a black-out in the accident or the call button was lost in the course of falling. That is why the requirement for the possibility of passive detection of emergencies (compared to active calls for help) are getting stronger, especially when considering that the state of the art allows this.
- The dominance by only few successful manufacturers on this market has resulted in them reselling almost the same technology for 30 years without special investment in improvement.

In order to reduce the number of unnoticed emergencies, the idea of "a day button" was initially used, with which the person in need actively confirms that he is doing well. If this confirmation is not received within 24 hours after the last time, the service provider should then initiate verification measures, if necessary, with an outpatient intervention up to breaking the apartment door. Over time, however, this became too expensive for the service providers and is now mostly only offered at an additional cost.

However, the demographic change in an aging society has increased the pressure on service providers in this industry[62] to improve the efficiency of their services with the help of digital technologies. In the first few years, these organizations hoped that the old manufacturers would replace the technologies; but when it became clear how complex the implementation of the passive detection of emergency situations can be, they finally started to evaluate innovative offers from new system providers.

As a matter of fact, however, none of the new systems has passed the tests so far because

- many sensors do not have the necessary quality for the implementation of critical actions,
- the situation recognition has not been realized in several stages of semantic abstraction but rather directly on the basis of sensor reports, and the result of the situation recognition is not verified before the action is initiated.

As a result, they end up with very weak assumptions that generate too many false positives and therefore again cause unnecessary costs. Some system providers try to circumvent this problem through monitoring: instead of generating an alarm directly, they send a notification that there is a presumption to be checked. Then the plausibility must be checked in an app and, if necessary,

61 In the case of care centres and hospitals, rooms and beds are connected to ward nurses on a stationary basis.

62 Both internally through the shrinking of staff and an increase in customers, and externally through social policy in order to prepare for an even more difficult situation in the future.

the situation must be clarified directly with the person in need by phone. However, this is rejected by the service providers as too costly.

Since the derivation of situations from the analysis of the sensor data has proven to be rather complicated, there is also the approach of developing more complex specialized sensors, especially for the purpose of reliable fall detection, which make sense as participants in a larger distributed system of systems. Attempts to push such devices themselves to become the controller for smart living, however, often fail because of the resulting complexity.

In the following, the few products that are more relevant for uLive are examined in more detail.

Climax Controller (https://climax-deutschland.com/)

Climax acts primarily as a hardware supplier in the market; in particular, the central controller of Climax is of interest for uCORE and its uLive product line. The equipment of the controller is considerable in some models, e.g. with integrated microphone and loudspeaker and support for Bluetooth / BLE, ZigBee, ZWave, SIP and a type of speech recognition. The controller does not come with a reasoning module that recognizes certain situations and reacts to them. Only the handling of an active emergency call by pressing a button or by voice is pre-programmed as a useful function. In addition, Climax offers (Web) apps for configuring the system, controlling actuators and visualizing sensor data, actually like a classic smart home system.

The functions of Climax controllers are therefore not sufficient to classify Climax as a competitor for uLive. However, since uLive is to be marketed by uCORE as pure software without hardware, a partnership with Climax in terms of using uLive as an alternative “operating system” for Climax controllers can be very beneficial for both parties.

Dosch & Amand DECT Pendants (https://www.da-products.de/dect-pendants)

D&A is a DECT specialist. The relevant DECT Pendant product line, with an award-winning variant, functions as an extended home emergency call device: in addition to an emergency button, the small companion device also integrates a fully configurable DECT speakerphone with voice recognition. It can also detect falls (via integrated sensors) and smoke alarms (via acoustics) via on-device processing. If an emergency is detected (emergency button / fall / smoke alarm), individually configured contact persons are called who can then speak directly to the person wearing the device via the speakerphone. The device can also be used for normal telephony by voice commands. The main weak point of the device is that it has to be charged after a maximum of eight hours, which makes it difficult to be used by elderly people living alone.

Despite the astonishingly successful realisation of the concept, the DECT Pendants from D&A are no real competitors for uLive because with the underlying utility-device-centric approach, they have limited capacity for extensibility and can hardly be equipped with situation recognition capabilities.

Thanks to support for IP telephony, however, uLive integrates these devices as a possible participant in the system and can benefit from their capabilities, both as a speakerphone and as a triple emergency detector.

easierLife (https://www.easierlife.de/)

easierLife uses a Climax home emergency call device as base station. Only active help request with the armband is classified as reliable and covered by the care insurance. The rest of the easierLife offer is not part of it and may not be connected to the home emergency call centres. Basically easierLife tries to send information about the behaviour of older people to their relatives with motion detectors, door contact sensors and other devices such as smoke detectors. The family member receives push notifications such as "Movement, door open, door closed, smoke detected." This means that he receives information in an app that he then has to interpret himself. However, he can then contact his relatives in need via the app.

In the background, easierLife saves all data on an own server in the Cloud, in which an attempt is then made to recognize patterns based on the movement profiles using algorithms. This leads to further messages such as "did not get up", "unusually little movement" etc.

easierLife tries to convince professional care service providers on the market of the system with the vision of early detection of danger based on monitoring. In the bottom line, however, the false positives become annoying at some point and lead to dulling. Real dangers are recognized only by chance and dealing with the multitude of information requires a lot of patience from the relatives and those in need of care.

VSS (https://ahs.digital/)

The company VSS developed the product, now known as ALWA, based on the uLive concepts. This process began after a proof of concept by Fraunhofer IGD to automatically recognize certain situations in everyday life on the basis of universAAL-IoT (2015). However, VSS relied on openHAB as an alternative for universAAL and put the first installations into operation as early as 2017. In 2018 the company name was changed from VSS to "Assisted Home Services" based on the name of "Assisted Home Solutions" (a spin-off from Fraunhofer IGD).

As a result, pre-set situations are recognized with this system. The problem with this system is that it cannot verify the guesswork in the system – i.e. the system does not involve the user. This leads to false alarms that the service providers cannot accept. The false alarms additionally increase the alarm management effort. The consequence is that this company is thinking about its own alarm management in order to at least make an additional estimate via monitoring. In addition, handling alarms Is not based on IP telephony with the SIP protocol, but a telephony service is used, so that no differentiation based on the system's call number is possible; as a result, the integration with emergency call centres can only be implemented with extra effort, which is why the requirement is still open.

Conclusion

Many new systems do not have any passive mechanism for recognizing emergency situations, but invest on other new features, such as benefiting from new communication technologies. The GSM emergency call devices, for example, can also locate the device by GPS, but must be charged daily. As a wearable connected to mobile network, however, they are not bound to a fixed place, as opposed to home emergency call systems.

All others try to expand their features by integrating new types of sensors and / or eHealth products. In the end, however, they only increase the false alarm rate, which is not acceptable for home emergency call centres. In addition, often poor quality is masked by low system prices. Therefore, so far there are no solutions that manage to prevail, only ideas and attempts. This shows that the pressure to offer something new is increasing.

Cell phones, wearables and voice assistants are succeeding more easily because they have many synergies in everyday life and thus make the actual emergency appear like a simple add-on. Dealing with people's lives based on typifying as well as the careless handling of privacy will increasingly be confronted with acceptance problems. The data protection problem is rather insurmountable for professional service providers. Accessing own information via an app may also face more acceptance problems.

Cloud providers like Verklizan, who connect many devices to home emergency call service providers via their platform, may also succeed in improving emergency call systems and reducing false alarms. However, apart from issues concerning data protection, the approach has so far been limited to monitoring instead of recognizing the specific situation, verifying it and finally initiating suitable actions.

In the end, only systems that can recognize the specific verified emergency cases will succeed to prevail – at this point, uLive is unrivaled.

9.3.4 Value proposition

System integrators and providers in the care, independent living and home emergency sectors, such as AHS, have not been able to convince their customers with the first generation of "digital products" due to different deficits, such as too many false positives or negatives, low degree of practicability in the sense of readiness for practical use in daily life, trifling with privacy, typifying end users instead of individualizing the system, this way becoming domineering in the eyes of the end users.

uLive is the first product that has proven its practicality in real life, while not making hidden business with people's private data. **uLive will increase the efficiency of care** to the benefit of both carers and cared people by going beyond pure monitoring and resolving the concrete cases of concern based on a future-proof combination of individualisation with the minimisation of uncertainty in situation recognition.

9.3.5 Strategy for local sustainability

The main strategy for sustainability of the DS7 ecosystem is based on launching a new company in charge of maintenance and further development of uLive as its initial software product. Some different aspects of this strategy will be elaborated in this section.

9.3.5.1 Open Data strategy

DS7 is currently lacking any open data strategy. Only evaluation data contributed to WP6 may be involved in the related ACTIVAGE overall strategy.

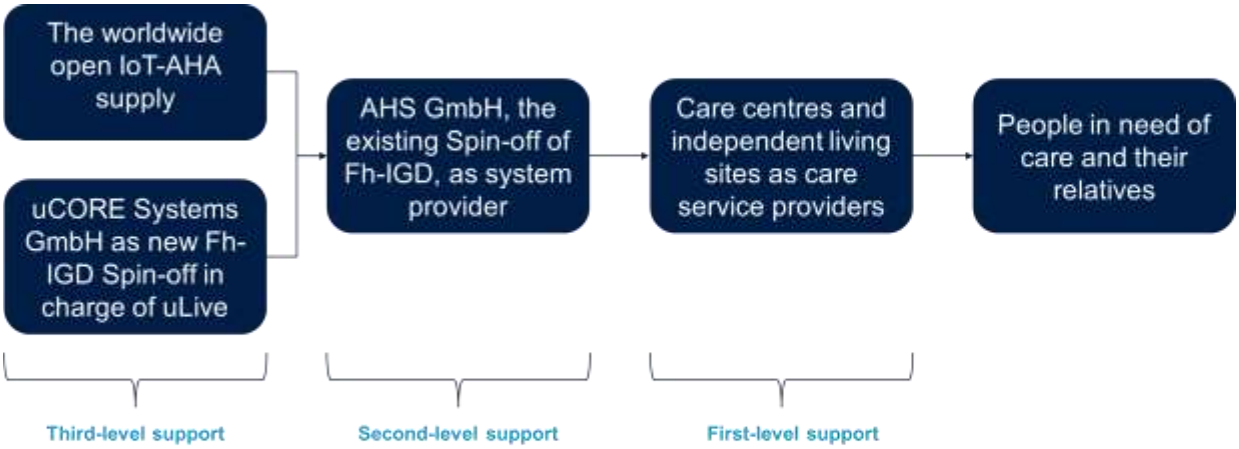
Data in the IoT-AHA system remains absolutely private in DS7, currently with no possibility for sharing any portion of it in its digital representation. Merely, authorized people (usually the end users and their formal and informal carers) can benefit from a Web application to get access to the history of data of single flats / care rooms in terms of diagrams. Data can be exported as PDF in its visualized form, but the visualizations do not include any identity indications. This Web application will be enhanced in future versions with possibilities for dynamic queries including aggregation facilities over several flats / care rooms in the same building, later even over several buildings of the same service provider.

Being based on universAAL IoT, data can be shared in its digital form in future with external entities according to the universAAL mechanisms for remote interoperability and the related security specifications. If this will be used in future for contributing to certain open data initiatives cannot be asserted at this point in time.

9.3.5.2 Continuation strategy

All of the four sites in DS7 participated in ACTIVAGE LSP in real operation, from the beginning with the intention of uninterrupted usage and possibly extending to further sites, unless the deployed system would prove not to hold its promise or make more problems than it is able to solve. Although the DS needed to provide a few updates for improving the system, but eventually the experience has been evaluated positively and hence all sites are assuming to continue using the installed systems and hence make pressure in the direction of sustainability of the system and well-defined support and update strategies.

In the meanwhile, the concepts for both the sustainability and the support procedures are now clear, as depicted in the following figure:



There is only one missing element in the realization of this concept, namely the launch of uCORE Systems GmbH to take care of the maintenance and further development of uLive as the actual solution. The plan is to resolve this issue by the end of Q1/2021, at the latest; Fraunhofer-IGD is supposed to fill the gap until this process concludes.

The open issue in the creation of uCORE is related to its ambition to act as the business arm of the universAAL IoT Coalition (uIC) and start to address further domains beyond the AHA domain. However, for some time it was not clear if it would be better to directly start with a larger invest or first keep the focus on uLive to eliminate the burden of larger invest and grow later based on reinvest. Finally, the second strategy has been chosen as the more feasible option. Currently, the founders are working on the detailed business plan and preparing the pitch to address investors (deadline: 30-Nov-2020). This is why end of Q1/2021 has been set as deadline for the transfer of responsibility from Fh-IGD to uCORE.

9.3.5.3 Replication strategy

Also the replication strategy is obviously based on the launch of uCORE. In the context of replication, however, it is important to highlight that from the viewpoint of uCORE, the role played by AHS is a regional one. This means that uCORE will try to attract further companies with similar role in other regions in order to extend its presence on the market to other European countries and beyond.

9.3.5.4 Scaling-up strategy

In DS7, user recruitment was handled in terms of attracting new sites interested in uLive deployment. The sites themselves already had their inhabitants so that there was no need for recruiting individual users. The capacity of the sites is naturally limited physically to the capacity of the related buildings. Therefore, scaling up in terms increasing the number of users can only be achieved by replication, which has already been addressed in the previous section.

Scaling up in terms of the number of devices deployed at each site, has been ongoing to some extent. For example, Weiterstadt, as one of the four sites, was originally only focused on passive emergency recognition; in 2019, however, we added both “fearless”, a product of the Austrian company “cogvis” as a complex sensor specialized in fall detection, and the panic button as means for active help request to all homes in Weiterstadt. In Türkheim, we added “Nuki”, the smart lock from Austria, to all homes in order to be able to open the doors automatically in case of emergency. In Treuchtlingen, we added a “visitor button” so that alarms can be deactivated easily whenever the inhabitant of a given care room is not alone in his/her room. Similarly, any of the sites may decide also in future to add further new types of devices based on new requirements that may arise with the time.

Scaling up in terms of ecosystem was practiced in DS7 in the first place in the context of the first open call. In one of the two use cases, namely in case of User Authentication Hub (UAH), we came to the conclusion to be able to offer the UAH as a meaningful and more sophisticated alternative for the simple “visitor button” that is used just for switching alarms on and off, if the vendor get back to us with a new version considering our requirements. In addition, we effectively enhanced our ecosystem by already having added to our offer the above-mentioned “fearless” sensor as a recommended option.

One of the main plans for scaling up at the ecosystem level is related to linkage with providers of tele-health services. This, however, necessitates the provision of a technical framework that is easily adaptable to the regional requirements of each site and their local health service providers.

10 DS 8 LEE final report

10.1 DS Experiment report

10.1.1 User engagement report

"We" refers to all those involved in carrying out the project, not just those included in the list of authors.

Where not otherwise stated, data presented in section 1 are derived from the spreadsheet titled "ActivAge Participant info July 2020" provided by Leeds City Council (LCC) (dated 06/07/20).

273 total elderly users signed up to the project between November 2017 and December 2019. Eighteen users who signed up did not proceed with installation for various reasons (e.g., no longer interested, illness, logistical constraints). The mean age of the elderly users was 74 ± 8 years (range: 56-106 years), and the distribution of male and female participants was 43.9 and 56.1%, respectively. All users participated in the following ACTIVAGE use cases (AUCs):

- AUC1 – Daily Activity Monitoring
- AUC4 – Emergency Trigger
- AUC7 – Prevention of Social Isolation

104 total informal carers signed up to the project, although only 30 remained operational.

Confirmed user count data are also available on the ACTIVAGE Admin Dashboard using the "All (Not demo)" trial filter. These data are summarised in the table below.

Table 170. DS LEE User counts from the ACTIVAGE Admin Dashboard (date accessed 03/08/20).

Elderly	Informal caregiver	Formal caregiver	Other stakeholder
357	94		5

The majority of users lived in private homes, some situated within sheltered accommodation. Precise numbers for each living facility are unavailable, as we did not collect this data during the sign-up process. It was initially planned that people living in extra-care housing (e.g., private rooms with communal living space and flexible support provided depending on need); however, as these facilities use a shared Wi-Fi network and people do not have individual Ethernet connections in their room, it was not possible for the equipment to be installed.

We collected living status data for 244 participants only. Living status data are summarised in the table below.

Table 171. DS LEE Living status data for elderly users (data from Leeds City Council; n = 244).

RUC	Alone	Not alone	Missing data
AUC1/ AUC4/ AUC7*	11	88	145
TOTAL	**11**	**88**	**145**

10.1.2 IoT infrastructure deployment

255 total installations were completed at private homes between July 2018 and December 2019. The mean age of those who had equipment installed was 76 ± 7 years (range: 56-106 years), and the distribution of male and female participants was 43.8 and 56.2%, respectively.

The two locations Staines and Milton Keynes also received 39 total installations for private homes.

We provide the number of devices installed at the Leeds deployment site and their specific locations in the table below.

Table 172. DS LEE Summary of sensor installation data for all users (data from Leeds City Council; *n* = 255).

Device type	Quantity installed
Appliance plugs	**331**
Television	85
Kettle	199
Computer	20
Microwave	19
Toaster	1
Cooker	2
Washing machine	4
Lamp	1
Door sensors	**278**
Front door/main entrance	171
Back door/rear entrance	45
Side door/side entrance	14
Fridge door	48
Motion sensors	**400**
Bedroom	50
Hallway/landing	87
Lounge/living room/sitting room	113
Dining room	4
Kitchen	100
Bathroom	46
TOTAL	**1009**

A similar Sensor Installation Data Summary is available from Samsung on 05/08/20 and supplements "Hub Sensors" and "Home Monitor Sensors" for the following:

Table 173 DS LEE Summary of sensor installation data for all users

Device type	Quantity installed	Device type	Quantity installed
Appliance Plugs	**376**	**Motion sensors**	**438**
whole house monitor power	17	motion (living room)	1
living room lamp power	1	conservatory motion	1
energy monitor power	1	sitting room motion	1
house monitor power	12	kitchen room motion	1
phone charger power	1	dining room motion	3
bedroom lamp power	2	living room motion	29
bedside lamp power	2	new device motion	4
lounge lamp power	1	bathroom motion	46
television power	88	hall way motion	1
food mixer power	2	workshop motion	1
new device power	6	sun room motion	1
microwave power	19	cat room motion	1
mini oven power	1	entrance motion	2
computer power	11	motion (office)	1
toaster power	2	kitchen motion	99
kettle power	195	bedroom motion	65
fridge power	2	hallway motion	114
heater power	1	landing motion	1
laptop power	1	TV room motion	2
freezer power	1	lounge motion	60
house power	1	stairs motion	1
lamp power	6	study motion	2
pc power	2	Unknown motion	1
Open sensors	**353**	**Hubs sensors**	**281**
living room door	5	**House monitor sensors**	**155**
dining room door	1		
new device door	4		
cloakroom door	1		
bathroom door	24		
bedroom door	7		
Unknown door	29		
balcony door	1		
kitchen door	2		
fridge door	59		
lounge door	3		
garden door	4		
front door	134		
patio door	2		
main door	11		
side door	66		
TOTAL	**1603**		

Installation data for confirmed users are also available on the ACTIVAGE Admin Dashboard using the "All (Not demo") trial filter. These notably supplement values for "Wearables" and "Phones". When these are subtracted from the total, it leaves a total 1624 installations, more or less congruent with the above sensor data update. These data are summarised in the table below.

Table 174. DS LEE Summary of sensor installation data according to the ACTIVAGE Admin Dashboard (date accessed: 03/08/20).

Device type	Quantity installed
Gateways	284
Motion sensors	444
Door sensors	355
Wearables	357
Phones	357
House monitors	161
Power monitors	380
TOTAL	**2338**

ACTIVAGE Proposal Document B assigns DS8 Leeds 1000 target users of 7200 ACTIVAGE total target users, 13.9% of the total project target. The Proposal Document B also provides 43,000 total target devices for the project, 13.9% of which requires Leeds to install 6000 devices.

Leeds trialled a population of 456 of 1000 target users, 45.6% of the target. 45.6% of 6000 target devices requires the trial to detect at least 2736 device installations.

The above table shows at least 2178 installations detected (section 1.3 details the inconsistency in reported Phones and Wearables and number of installed device versions) out of the required 2736, the project achieved **79.6**% of total target device installations.

Distribution of ACTIVAGE Use Cases (AUC) deployed: Any gateway installations indicate the operation of AUC 1, 4 and 7. Any installations of phone and watch without gateways indicate the operation of AUC 4 and 7 only. The number of gateways installed are less than the number of phone and watch pairs distributed. There is a minimum 284 instances of AUC 1, 4 and 7 in operation.

10.1.3 Experiment running report

10.1.3.1 Users participation

Out of the 357 participants who had an installation, 242 participants remained operational.

We report thirteen participants to have withdrawn from the study. The reasons for withdrawal are summarised in the table below. There are a further 6 that withdrew for unknown reasons.

Table 175. DS LEE Reasons for withdrawal from the study (data from Leeds City Council and the Web Portal).

Reasons for drop-offs	Number of drop-offs
Did not like the equipment	2
Found the equipment difficult to use	5
Overwhelmed by the equipment	4
Sickness	2
Unknown	6
TOTAL	**19**

Average daily usage of wearables for AUC 1 and 4 the past 30 days on 12/08/20 is 4.8 hours.

10.1.3.2 Operational effectiveness

We provide a summary of the reported technical and/or operational issues in the table below to provide indication on how the project is working.

Table 176. DS LEE Summary of technical and operational issues reported to Leeds City Council between July 2019 and November 2019.

Issue experienced	Number of issues
Faulty watch (not quantifying physical activity)	4
Faulty watch (hardware-related, failure to power on or charge)	7
Faulty motion sensors (hardware-related)	5
Connectivity issues (phone and watch)	3
TOTAL	19

The mean response time to reported faults was 195.8 ± 119.7 hours (range: 24-384 hours, median: 192 hours).

Additional data from ZenDesk states that, as of 03/08/20, users reported 302 new issues, and 116 issues were resolved between July 2018 and December 2019. The average first reply-time for all 302 reported issues was 159.9 hours (range: 31.8-488.3 hours), and the overall average satisfaction rating was 55.6%. The exact details of all issues documented by ZenDesk are currently unavailable; however, we collated data from 49 separate tickets to provide insight into some of the technical and/or operational issues experienced by users. We provide a summary of these issues in the table below.

Table 177. DS LEE Summary of technical and operational issues documented by ZenDesk (date accessed: 03/08/20).

Issue experienced	Number of issues
App-related issues	**17**
Installation	2

Entering information	5
Design and usability	2
Activity monitoring	4
Logging in	3
Connectivity	1
Phone-related issues	**7**
Software updates	1
Locked phone	1
Connectivity	1
Not working (no explanation provided)	3
Other	1
Watch-related issues	**19**
Fall detection	4
Activity monitoring	4
Battery	3
Design and usability	2
Not working (no explanation provided)	5
Other	1
Sensor-related issues	**6**
Data collection	3
Sensor placement	2
Sensor mapping	1
TOTAL	**49**

241 of 307 phones are currently operating on version 1.0.31 and are able to be supported up to version 1.0.41.

146 of 222 wearables are currently operating on version 1.0.12 and are able to be supported up to version 1.0.12.

10.1.3.3 Use case exchange report

Summary of Use Case from other Deployment Site imported and exported

1. Deployment Site Leeds imported Deployment Site Madrid Cognitive Stimulation. Leeds City Council (LCC) conducted main import.
    a. Four test accounts were used by testers to prepare communications to on-boarded users. Eleven ACTIVAGE participants registered interest in trialling the app, 10 of whom proceeded with consent to the trial. The 1 that did not was no longer using the phone they received from Samsung and only used an apple phone (the app is not available through apple store). Upon review with the 10 participants, 7 had been using the application and 3 had not yet set up. For 2 of these this was because they were struggling to download the app without help from relatives and the other one has Alzheimer's, and the family member who is their point of contact decided that it would be too complex for them to use. Of the 7 participants who have used the app over the past 2-3 weeks, their feedback relating to the app was collected. Of these, 6 plan to continue using the app, 1 found it too frustrating and is going to delete it.
    b. Feedback

i. Positive
    1. Like the idea of brain training to keep the brain working
    2. Good stimulation for the brain
    3. Good way to have to concentrate
    4. Good range of puzzles and games
    5. Liked the options for easy, hard, etc.
    6. Found the evaluation similar to the 11 plus exam – Enjoys intelligence tests, etc. so liked this
    7. One person said they enjoy the evaluation even more than the games and puzzles

ii. Issues / required improvements
    1. Struggled to hear and understand the voiceover in evaluation
    2. List 3 animals beginning with [letter …] didn't seem to recognise a lot of answers, so even if this was completed it would say that it was wrong
    3. Some instructions were difficult to understand
    4. Eyes were getting tired before being able to complete some games
    5. Some parts of the app would have some parts of the screen off the edge
    6. Some spelling/translation mistakes – October/Octobre.
    7. One person stated that although they like to keep the brain working, they prefer to do it by doing DIY projects that require strategy as well as physical strength – rather than using a app like this

2. Deployment Site Region Emilia Romagna (RER) wanted to import the measurement of step counts using a smartwatch from Deployment Site Leeds. The following comments are from DS RER.
    a. We consider mobility an important indicator of the health status after a stroke event. The monitoring of the daily step was of great interest for the health professional and we intended it to increase the level of knowledge of the status of the end users. It was also very interesting to test the usage of a complex but friendly device as the Samsung smartwatch on elderly people with chronic conditions. We needed to amend the protocol submitted to ethical committee to include the new Use Case, including Deployment Site Leeds service. The procedure can be long and we concluded it in February 2020.
    b. Only a test of installation in the Deployment Site Leeds portal was possible. We did not distribute any smart watch and smartphone (intended to function only as a gateway) due to coronavirus emergency. Deployment Site Region Emilia Romagna received some smartwatches. The Integration with ACTIVAGE Internet Of Things Ecosystem Suite was harder than expected and Corona Virus emergency reduced sensibly the available resources. This increased the delays and determined the impossibility to proceed with full import of Deployment Site Leeds service.

3. Deployment Site Valencia importing ACTIVAGE Use Case 1, Daily Activity Monitoring:
    a. When we tried to install the solution on energy consumption, we realized that the way in which electricity enters the houses in Spain, (mostly apartments), is different from that of houses in the United Kingdom. Electricity reaches homes from inside the walls, from an electrical cabinet to which the electric company does not allow access. Therefore, the installation must occur inside the house

and this implied having to leave the electrical panel open for the entire duration of the project. Older people actually refused to have a solution installed that required keeping the electrical panel open. Therefore, we were only able to put one of the facilities in a house that agreed to have the panel open during the entire time of the experiment.

- Number of new services/RUC deployed
  1. Deployment Site Leeds tried to import 1 Use Case from Deployment Site Madrid
  2. Deployment Site Region Emilia Romagna tried to import 1 Use Case from Deployment Site Leeds.
  3. Deployment Site Valencia tried to import 1 Service from Deployment Site Leeds.
- Number of new users / devices / data integrated in DS as consequence of expand phase
  1. Deployment Site Leeds reports:
     a. Six users continuing for remainder of trial using their phones providing participation data including evaluation attempts and successful game completion.
  2. Deployment Site Region Emilia Romagna Reports:
     a. One attempted import remained in pending status due to Covid19 related restructuring.
  3. Deployment Site Valencia Reports:
     a. Number of devices: One magnetic (refrigerator). Two motion sensor: Living room and kitchen. One electrical clamp, (electrical panel).
     b. One User remains using the installation.

10.2 Local evaluation report

10.2.1 Goal of local evaluation: primary and secondary endpoints

The purpose of providing technical, economic, scheduling and operational descriptions of the project, the evaluation aims to assess three characteristics reflected by the gathered data:

1. Feasibility (state of being easily or conveniently done)

   The Feasibility is suggestive as this was a trial implementation of ACTIVAGE. The study of its feasibility in the conclusion makes recommendations of Falls Algorithm improvement as significantly improving the feasibility and this is pending update.

2. Acceptability (How well an intervention will be received by the target population and the extent to which the new intervention meets the needs of the target population and organizational setting)

   Describes the success of component interoperability for delivering the customer interface.

3. Success of the project (serving the project's aims) in relation to meeting its KPI targets.

   Closely related to feasibility, aims at having ACTIVAGE as the preferred provider of the solution.

There are 16 Key Performance Indicators (KPIs) detailed in section 10.2.2.

Many of these KPIs will be evaluated through a comparison of pre and post-intervention scores on questionnaires, relating to health and wellbeing (SF-36 and EQ-5D), fear of falling (FES-I), loneliness (UCLA loneliness scale), and acceptability of technology (adapted UTAUT). Sensor data will measure usage.

Limitations: In response to unavailable data or evaluation methods, it was necessary to make justifiable substitutions, e.g. we intended the completion of a satisfaction survey at the end of the project to assess engagement with the technology and support services (adapted patient satisfaction survey). This did not occur; instead, a study of five questionnaire responses from the UTAUT and SPQ questionnaires attempts a reasonable substitution for user satisfaction.

The full account of justifiable substitutions for KPI evaluation methods detailed in Section 10.2.3 follows:

- KPI_REQ_007: We intended the completion of a satisfaction survey at the end of the project to assess engagement with the technology and support services (adapted patient satisfaction survey). This did not occur.
    - Instead, a study of five questionnaire responses from the UTAUT and SPQ questionnaires attempts a reasonable substitution for user satisfaction.
- KPI_REQ_008: We intended the comparison of cost to NHS spending. The note of analytical barriers due to market segmentation is common and therefore remains in R&D.
    - Instead, a qualitative response from Leeds City Council is detailed in the Appendix Table "KPI Measurements Availability and Substitutions with Results".
- KPI_REQ_013: No data is available
    - Instead, a qualitative response from Leeds City Council is detailed in the Appendix Table "KPI Measurements Availability and Substitutions with Results".
- KPI_REQ_014: We intended the completion of a satisfaction survey at the end of the project to assess engagement with the technology and support services (adapted patient satisfaction survey). This did not occur.
    - Instead, we offer ZenDesk support statistics seen in Section 1.3.2 as a substitution.
- KPI_REQ_016: We intended the measurement of attendance to fall prevention activities such as strength and balance classes. This did not occur.
    - Instead, a qualitative response from Leeds City Council is detailed in the Appendix Table "KPI Measurements Availability and Substitutions with Results".

10.2.2 Local KPI collected

The project includes 16 KPIs relating to the triple win strategy adopted by the project (impact on Quality of Life, sustainability, innovation and growth). As per the 3 characteristics described in Section 10.2.1, each category contains technical, economic, scheduling and operational sub-criteria describing the project, for example social isolation or physical wellbeing.

Table 178 DS LEE Quality of Life KPIs

KPI ID	Description
KPI_REQ_001	Improvement in physical wellbeing of participants
KPI_REQ_002	Improved sense of safety in the home
KPI_REQ_004	Decrease social isolation
KPI_REQ_009	Increased physical activity in participants

Table 179 DS LEE Sustainability KPIs

KPI ID	Description
KPI_REQ_008	Demonstrable savings to Health and Social care system
KPI_REQ_010	Creation of business case for use of IoT solutions for healthy ageing
KPI_REQ_011	Usage / acceptability of wearable
KPI_REQ_012	Usage / acceptability of stationary sensor
KPI_REQ_014	Support service (helpline/email/forum) provides a prompt and useful response
KPI_REQ_015	Reduce cost of fall risk screening

Table 180 DS LEE Innovation and growth KPIs

KPI ID	Description
KPI_REQ_003	Increased access of community and social facilities & services
KPI_REQ_005	Decrease in referrals to telecare service
KPI_REQ_006	Number of visits to primary care facilities
KPI_REQ_007	Number of participants engaging positively with technology
KPI_REQ_013	Be more accurate than current service provision on fall detection rates
KPI_REQ_016	Increased detection of people who would benefit from fall prevention activities

For every user recruited there will be one consent form to be signed. Once this is done we will have the minimal data set as below.

Table 181 DS LEE Minimum Data Set

	Items
Minimal Data Set	Age, gender, start date, end data, role, reason end, userID(email address), initial frailty index

The targeted cohort for all of the KPIs listed below are an older person, aged 65 years old and over, with Clinical Frailty Scale (CFS) levels between 2 and 6, living alone or spending a considerable part of the day alone at home. We base the percentage distribution on the demographics of the Leeds.

10.2.3 Local evaluation protocol

Measurement tools, targets and systems for evaluation have been developed for each of these KPIs. Many of the KPIs will be assessed through questionnaire measures at baseline and post-intervention (some will only be assessed post-intervention, for example, acceptability of the technology). The rest of the KPIs will be assessed at the end of the data collection period when group data can be examined, e.g. comparing falls detection rate in the intervention group versus falls detection using current local systems.

Table 182 DS LEE KPI Evaluation Protocol

KPI	Measurement tool	Target	System for evaluation: when	System for evaluation: who
Quality of life				
KPI_REQ_001: Improvement in physical wellbeing of participants	SF-36 and EQ5D (health and overall wellbeing questionnaires)	15% increase (SF-36) and 20% increase (EQ-5D)	EQ-5D and SF-36 at baseline and immediately post-trial.	Collected by LCC via registration website or face to face.
KPI_REQ_002: Improved sense of safety in the home	FES-I (fear of falling questionnaire)	Reduce by 20%	FES-I at baseline and immediately post-trial.	Collected by LCC via registration website or face to face.
KPI_REQ_004: Decrease social isolation	UCLA loneliness scale	Decrease score on loneliness scale by 20%	UCLA loneliness scale at baseline and post-trial.	Collected by LCC via registration website or face to face.
KPI_REQ_009: Increased physical activity in participants	SF-36 (physical activity and health questionnaire)	15% increase in SF-36 scores	SF-36 will be administered at baseline and immediately post-trial.	Collected by LCC via registration website or face to face.
Sustainability				
KPI_REQ_008: Demonstrable savings to Health and Social care system	Compare intervention costs to NHS spending in older adult population	20% cost reduction to both health costs and social care costs	Comparison of figures to be done post intervention.	Collected by LCC or Samsung dependent upon who has access to figures
KPI_REQ_010: Creation of business case for use of IoT solutions for healthy ageing	Measured by overall success of the intervention as demonstrated by a business case created at month 36	Successful creation of a business case in month 36	Overall evaluation of success post-intervention.	Collected by Samsung based on overall data collected
KPI_REQ_011: Usage / acceptability of wearable	Sensor data (to measure usage) and an adaptation of the UTAUT questionnaire (to measure acceptability)	Continuous use of 70% of services (usage) and 75% high/very high (acceptability)	Evaluation of wearables data post-intervention.	Collected by Samsung
KPI_REQ_012: Usage / acceptability of stationary sensor	Sensor data (to measure usage) and an adaptation of the UTAUT questionnaire (to measure acceptability)	Continuous use of 70% of services (usage) and 75% high/very high (acceptability)	Evaluation of sensor data post-intervention.	Collected by Samsung
KPI_REQ_014: Support service (helpline/email/forum) provides a prompt and useful response	An adaptation of the Patient Satisfaction Survey used by Gellis et al (2012)	Post-intervention scores over 45 would suggest high satisfaction as scores can range from 6 to 60.	This survey can only be used post-intervention as it assesses how satisfied participants felt about the system.	Collected by LCC immediately post-intervention.

KPI_REQ_015: Reduce cost of fall risk screening	Compare intervention fall detection costs with current UK service provision costs	Decrease cost of fall detection by 20% compared to current UK provision	Comparison of figures to be done post intervention.	Collected by LCC or Samsung dependent upon who has access to figures
Innovation and growth				
KPI_REQ_003: Increased access of community and social facilities & services	Compare access to services pre and post intervention	Increase by 25%	Comparison of figures to be done post intervention.	Collected by LCC or Samsung dependent upon who has access to figures.
KPI_REQ_005: Decrease in referrals to telecare service	Compare participant referrals to control group referrals	25% decrease	Comparison of figures to be done post intervention.	Collected by LCC or Samsung dependent upon who has access to figures
KPI_REQ_006: Number of visits to primary care facilities	Compare participant primary care admission figures to UK average figures	25% decrease	Comparison of figures to be done post intervention.	Collected by LCC or Samsung dependent upon who has access to figures
KPI_REQ_007: Number of participants engaging positively with technology	An adaptation of the Patient Satisfaction Survey used by Gellis et al (2012)	Scores over 40 would be in line with those found by previous research (Gellis et al, 2012) so the target is 70% of participants with a score over 40	This survey can only be used post-intervention as it assesses how participants felt about the intervention.	Collected by LCC immediately post-intervention.
KPI_REQ_013: Be more accurate than current service provision on fall detection rates	Compare intervention fall detection rates with current local service provision	Increase detection of falls by 20% compared to local service provision	Comparison of figures to be done post intervention.	Collected by LCC or Samsung dependent upon who has access to figures
KPI_REQ_016: Increased detection of people who would benefit from fall prevention activities	Compare people accessing fall prevention activities pre and post-intervention	Increase in people participating in fall prevention activities delivered by LCC by 20%	Comparison of figures to be done post intervention.	Collected by LCC

In Appendix Table "KPI Measurements Availability and Substitutions with Results", all KPIs are shown in the order they appear in the above table, describing the substituted measurement tool if the specification cannot be satisfied. The Results have been colour coded among 4 colours (white (unsatisfied), pale green, light green, dark green (satisfied)) corresponding to scores [1 (lowest), 2, 3, 4 (highest)]. These have been summarised below the table of measures and results for a preliminary score describing the project's satisfaction of the KPI evaluation goals.

Table 183 DS LEE Reduced version of Appendix Table 20, *a)*Summary of KPI Measurements Availability, Specification and Substitution (163 / 192 = *83%*, minimum score = 25%), *b)*Summary of KPI Measurements Results Column (31 / 64 = 0.48 = *48%*, minimum score = 25%)

	Availability	Specification	Substitution	Results
KPI_REQ_001	4	4	4	3
KPI_REQ_002	4	4	4	1
KPI_REQ_004	4	4	4	1
KPI_REQ_009	4	4	4	4
KPI_REQ_008	2	2	3	1
KPI_REQ_010	3	3	3	2
KPI_REQ_011	4	4	4	4
KPI_REQ_012	3	3	4	4
KPI_REQ_014	2	2	3	2
KPI_REQ_015	4	4	4	1
KPI_REQ_003	4	4	4	2
KPI_REQ_005	4	4	4	1
KPI_REQ_006	4	4	4	1
KPI_REQ_007	2	2	3	2p
KPI_REQ_013	3	2	3	1
KPI_REQ_016	2	2	3	1

10.2.4 Analysis of results

QoL KPI improvement Applicability to Leeds Elderly Population:

Improvements should be applicable to the general Leeds Elderly population. We lack knowledge of the population's standard deviation and so use

$$S^2 = \frac{\sum X^2 - n\bar{X}^2}{n-1} = \frac{sum\ of\ squared\ sample\ elements - (sample\ size * square\ of\ sample\ mean)}{sample\ size - 1} = \frac{sample\ size * sample\ variance}{sample\ size - 1},$$

the theoretically unbiased estimator of variance to study the population as a t_{n-1} distribution subject to unknown standard deviation, which at large n tends toward a standardised normal Z-distribution which we originally assume Leeds to provide, of which the ACTIVAGE Trial sample serves as a random selection. We apply a series of improvement thresholds [20% improvement, 16% improvement …] and apply the Student's t-distribution to hypothesise these thresholds to, on average, describe the Leeds Elderly population, i.e. the trial suggests the broad application of the solution to have a 20%, 16%, 14% etc… improvement on the Leeds population for a particular use case.

The ACTIVAGE Trial sample describes the Leeds population by providing a confidence interval for the means and standard deviations of the improvement observed in participation in all questionnaires. We treated all questionnaires regardless of the mean improvement confidence interval falling below a certain percentage threshold. It is hypothesised using standardised normal distribution of combined differences $Z = \frac{(\bar{X}-\bar{Y})-(\mu_x-\mu_y)}{\sqrt{\frac{\sigma_x^2}{n_x}+\frac{\sigma_y^2}{n_y}}}$ whether the periodic samples' average differences $(\bar{X}-\bar{Y})$ are significantly different from the differences between averages of base and improvement threshold scores $(\mu_x-\mu_y)$.

We can prepare similar t-distribution methods for specific study of this trial against other independent populations, whether we repeat the study in the same city to reinforce the description of the city by successive trials or perform the study in a different location to hypothesise the ability to describe by using the trials differences between different populations. We should minimise excessive paired t-testing results in undesirable compounding type 1 error.

General Study of the Trial Sample's Questionnaire Responses:

With the study of more than 2 independent populations (in this case most desirable to be discernible time thresholds containing trial periods), Analysis Of Variance (ANOVA) prevents the compounding of type 1 error that occurs in repeated paired t-testing across the 2 pairs that occur in periodic sequence over 3 periods. ANOVA requires both greater variance between periodic sample means as well as a lower variance in each periodic samples. Box Plots below show that the samples serve neither of these (there is insufficient variance between the periodic samples' means and excessive variance within the periodic samples).

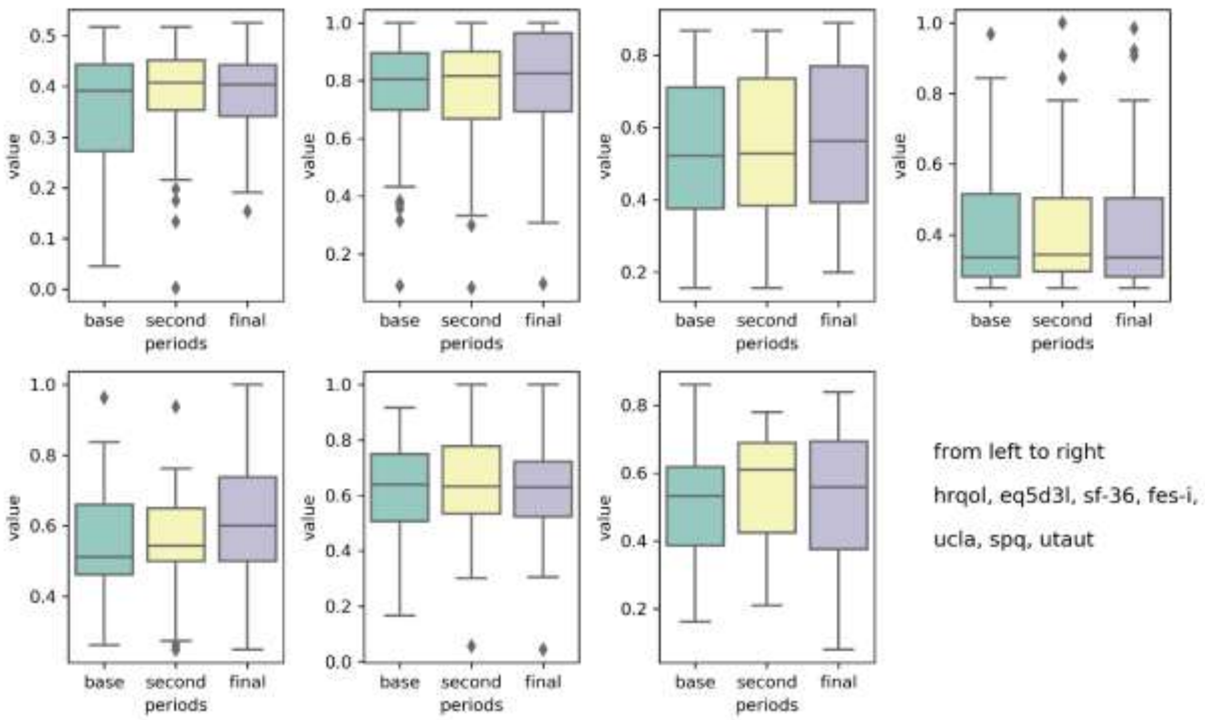


Figure 146 DS LEE Boxplots for ANOVA

In this trial (requiring stricter implementation/study of periodicity), ANOVA for each questionnaire prevent any periodic sample from being confidently represented as discernibly different over a three period treatment. This would require the final column in the ANOVA table below to follow

$$P(test > F) < 0.05.$$

The trial sample of the Leeds Elderly population did not sufficiently maintain low variability per period and they did not sufficiently vary over the duration of all periods. All ANOVA tables suggest an unchanging population has provided the mean scores of each questionnaire at each period.

Over the course of 3 periods, we cannot state any questionnaire to exhibit significant change.

Table 184 DS LEE ANOVA of responses to 7 Questionnaires in order: CDC-HRQOL-14, EQ5D3L, SF-36, FES-I, UCLA, SPQ, UTAUT

	df	sum_sq	mean_sq	F	PR(>F)
periods	2.0	0.02635	0.01318	0.96918	0.38308
Residual	96.0	1.30526	0.0136	nan	nan

	df	sum_sq	mean_sq	F	PR(>F)
periods	2.0	0.00711	0.00356	0.0977	0.90695
Residual	258.0	9.39308	0.03641	nan	nan

	df	sum_sq	mean_sq	F	PR(>F)
periods	2.0	0.01696	0.00848	0.22214	0.8011
Residual	134.0	5.11494	0.03817	nan	nan

	df	sum_sq	mean_sq	F	PR(>F)
periods	2.0	0.00115	0.00058	0.01905	0.98113
Residual	201.0	6.07331	0.03022	nan	nan

	df	sum_sq	mean_sq	F	PR(>F)
periods	2.0	0.08711	0.04355	1.40036	0.25121
Residual	102.0	3.17239	0.0311	nan	nan

	df	sum_sq	mean_sq	F	PR(>F)
periods	2.0	0.00389	0.00194	0.05888	0.94285
Residual	115.0	3.79832	0.03303	nan	nan

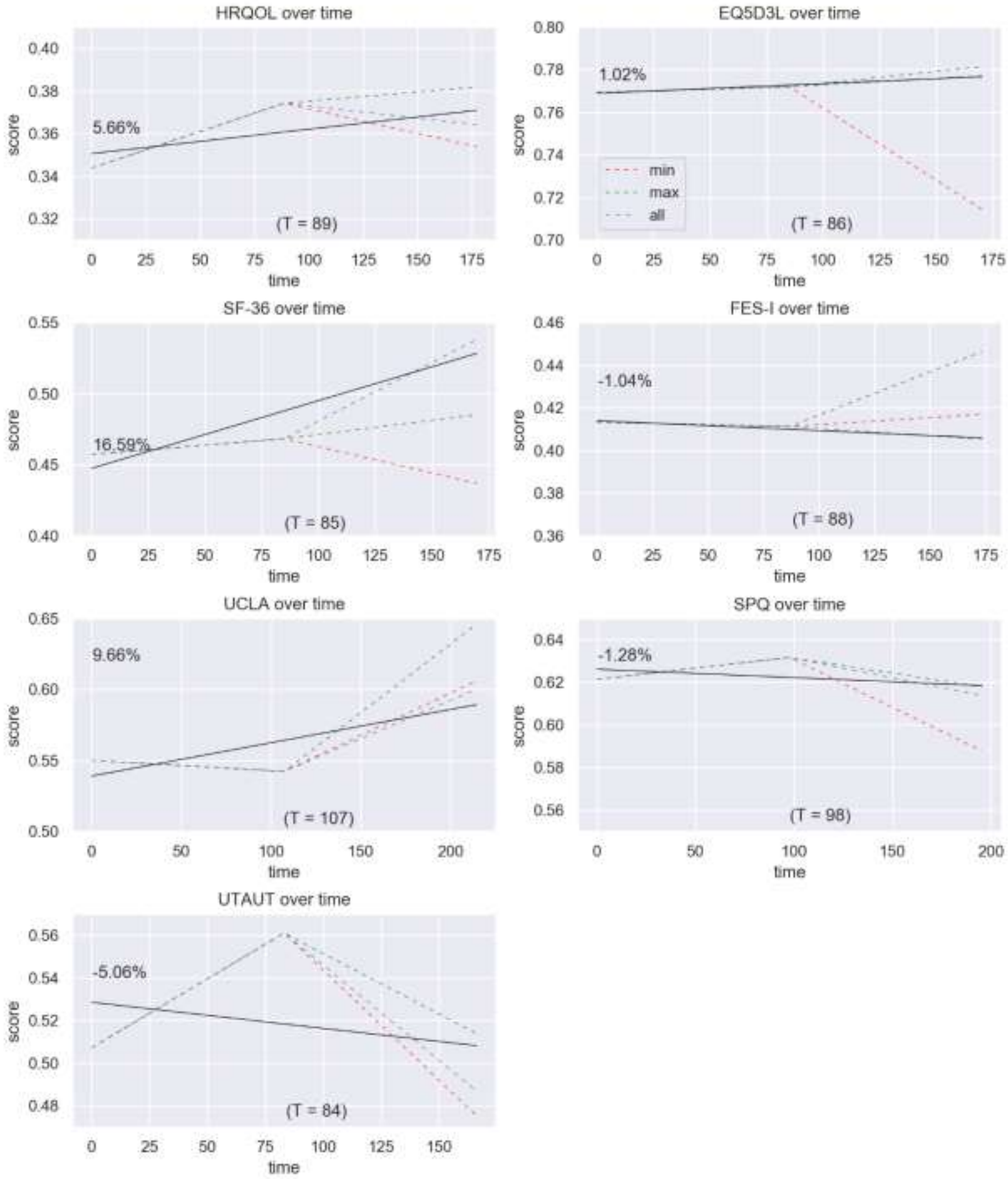
	df	sum_sq	mean_sq	F	PR(>F)
periods	2.0	0.02563	0.01282	0.33109	0.71987
Residual	45.0	1.74174	0.03871	nan	nan

We then estimate the likelihood that a random selection from the trial group will successfully satisfy the improvement threshold. Then, given the true number of successful cases in the set, we hypothesise whether we can accept the sample to demonstrate this change. The improvement Hypotheses indicate the likely effect on a specific sample of the trial's sample that we interpret as descriptive of the population from which the ACTIVAGE Trial is drawn. We note these improvement estimates as potentially concurrent to a decreasing trend throughout the trial sample, especially where the hypothetically improved set is a minority (less than 50%).

The below series of graphs show these trends. The un-bracketed number near the trend line specifies the percentage change over 2 periods of the questionnaire. The bracketed number is a weighted average period between response attempts.

Stratifying the sample for moderating effects allows greater specificity for the study – there are further interpretations for group specific improvements separating for age group, employment status, gender, living environment etc…

Figure 147 DS LEE Time correlations for questionnaires to identify what statements on proportions of the trial contradict the overall trend.



We can selectively implement the method for the maximum and minimum change per user and further selected for minimum periodicity given the undesirable extent of adjustment in response to insufficient sample size. We note again that solving for periodicity is concurrent with improving the completeness of data.

We treat the mean score using a Combination of mean scores of maxFinal and Base periods for improvements that expect positive change and minFinal and Base periods for improvements that expect negative change to demonstrate the greatest possible difference observed throughout the trial sample.

Hypotheses List

*The list follows the template for Hx as described in the Appendix.

1. H1: CDC-HRQOL improved on average by at least 20%
    a. $P(F > F_{3,n}) = 0.383$, there is no significant difference between the 3 periodic samples.
    b. $t_{33}(0.05) \cong -1.694$
        i. Provides μ_{Dhrqol} = 11.04% ± 4.76% (6.28%, 15.8%) improvement as the 95% confidence interval for the mean improvement experienced by the population (Leeds Elderly), on which the trial sample is normally distributed. Also provides Var(Dhrqol) = (1.76%, 4.66%) as the 95% confidence interval for the variance in improvement experienced by the population (Leeds Elderly), on which the trial sample is normally distributed.
        ii. Prevents rejection of hypothesis that there is an average 20% improvement in the Leeds Elderly population, on which the trial sample is normally distributed.
    c. *It cannot be rejected that 42% of the sample may improve by 20%,* $\alpha = 0.05, \beta = 0.84$
    d. $c_1 = 11, c_2 = 23$
        i. We cannot reject that a majority (51%) of the sample may improve by 10% or better.
2. H2: EQ5D3L improved on average by at least 20%
    a. $P(F > F_{3,n}) = 0.907$, there is no significant difference between the 3 periodic samples.
    b. $t_{86}(0.05) \cong -1.665$
        i. $\mu_{Deq5d3l}$ = 1.58% ±4.53% (-2.95%, 6.11%), Var(Deq5d3l) = (4.88%, 8.92%)
        ii. Prevents rejection of hypothesis that there is an average 7% improvement in the Leeds Elderly population, on which the trial sample is normally distributed.
    c. *It cannot be rejected that 36.3% of the sample may improve by 14%,* $\alpha = 0.05, \beta = 0.26$
    d. $c_1 = 34, c_2 = 53$
        i. We cannot reject that a majority of the sample experiences at least no improvement or better.
3. H3: SF-36 improved on average by 15%
    a. $P(F > F_{3,n}) = 0.801$, there is no significant difference between the 3 periodic samples.
    b. $t_{45}(0.05) \cong -1.684$
        i. $\mu_{Dsf\text{-}36}$ = 6.10% ±5.74% (0.36%, 11.84%), Var(Dsf-36) = (3.71%, 8.36%).
        ii. Prevents rejection of hypothesis that there is an average 18% improvement in the Leeds Elderly population.
    c. *It cannot be rejected that 44.4% of the sample may improve by 16%,* $\alpha = 0.05, \beta = 0.80$
    d. $c_1 = 16, c_2 = 30$
        i. We cannot reject that a majority of the sample may improve by 5% or better.
4. H4: FES-I reduced on average by 20%

   a. $P\left(F > F_{3,n}\right) = 0.981$, there is no significant difference between the 3 periodic samples.
   b. $t_{67}(0.05) \cong -1.669$
      i. $\mu_{Dfes\text{-}i}$ = -1.94% ±3.73% (-5.67%, 1.79%), Var(Dfes-i) = (4.39%, 8.68%).
      ii. Prevents rejection of hypothesis that there is an average 5% improvement in the Leeds Elderly population.
   c. *<u>It cannot be rejected that 34.8% of the sample may improve by 16%</u>*, $\alpha = 0.05, \beta = 0.23$
   d. $c_1 = 26, c_2 = 43$
      i. We cannot state that a majority will exhibit 0 or positive reduction.
5. H5: UCLA reduced on average by 20%
   a. $P\left(F > F_{3,n}\right) = 0.251$, there is no significant difference between the 3 periodic samples.
   b. $t_{36}(0.05) \cong -1.692$
      i. μ_{Ducla} = -12.46% ±7.44% (-19.9%%, -5.02%), Var(Ducla) = (4.74%, 12.06%).
      ii. Study does not support any improvement in the population on which the trial sample is normally distributed, UC7 highlight as requiring support.
   c. *<u>It cannot be rejected that 34.8% of the sample may improve by 10%</u>*, $\alpha = 0.05, \beta = 0.64$
   d. $c_1 = 12, c_2 = 25$
      i. We cannot state that a majority will exhibit 0 or positive reduction.
6. H6: SPQ improved on average by 20%
   a. $P\left(F > F_{3,n}\right) = 0.943$, there is no significant difference between the 3 periodic samples.
   b. $t_{40}(0.05) \cong -1.686$
      i. μ_{Dspq} = -0.58% ±6.08% (-6.66%, 5.5%), Var(Dspq) = (3.59%, 8.72%).
      ii. Prevents rejection of hypothesis that there is an average 8% improvement in the Leeds Elderly population.
   c. *<u>It cannot be rejected that 39.7% of the sample may improve by 10%,</u>* $\alpha = 0.05, \beta = 0.54$
   d. $c_1 = 14, c_2 = 27$
      i. We cannot state that a majority will exhibit 0 or positive change.
7. H7: UTAUT scored on average 75% (requires 48% improvement to base, instead we show for 20% improvement)
   a. $P\left(F > F_{3,n}\right) = 0.720$, there is no significant difference between the 3 periodic samples.
   b. $t_{16}(0.05) \cong -1.746$
      i. μ_{Dutaut} = 1.31% ±11.06% (-9.75%, 12.37%), Var(Dutaut) = (3.56%, 14.86%).
      ii. Prevents rejection of hypothesis that there is an average 20% improvement in the Leeds Elderly population.
   c. *<u>It cannot be rejected that 37.4% of the sample may improve by 20%</u>*, $\alpha = 0.05, \beta = 0.82$
   d. $c_1 = 4, c_2 = 13$
      i. We cannot reject that a majority of the sample experiences at least no improvement or better.

An example study of 1 questionnaire is provided below as was applied to each questionnaire.

CDC-HRQOL-14 Healthy Days Measure

Questionnaire Format

HRQOL reports on the impact on QoL using 14 questions of varying response ranges divided into 3 sections: 1. Healthy Days Core Module (Health conditions counting number of days for the past 30 days), 2. Activity Limitations Module (Limitations on QoL due to Pre-conditions) and 3. Healthy Days Symptoms Module (Symptoms potentially arising due to Pre-conditions counting number of days for the past 30 days).

Method and Limitations

HRQOL as required to improve by 20%. This study provides the conditions by which we can make this statement.

34 out of 177 users completed this questionnaire from base to final.

$$completeBase = cB \sim N(0.344, 0.0179)$$

$$maxFinal = mF \sim N(0.382, 0.0092)$$

$$\boldsymbol{Difference} = cB - mF, \boldsymbol{D} \sim N(0.0380, 0.1646^2)$$

Providing the Z-score for this difference statistic requires testing the hypothesis for the likelihood of at least 20% improvement. The likelihood of at least 20% improvement:

$$P\left(DZ > \frac{0.2 * \mu_{cB} - \mu_D}{\sigma_D}\right) = P(DZ > 0.1871) = \mathbf{0.425}$$

This estimation has emerged from a set of 34 complete responses for which a selection for 20% improvement returns 13 responses, fewer than suggested by the estimate:

$$H_0 : p = 0.198, H_1 : p < 0.198$$

$$X \sim B(34, 0.425), P(X \leq 13) = 0.376 \gg \mathbf{0.05}$$

13 participants are in the desired response range, given the binomial arguments, test the likelihood of no more than this number of occurrences of the success condition. With a 5% significance region, we cannot reject the original hypothesis that 42% of the sample are likely to improve by 20%.

Table 185 DS LEE Hypothesis (Improvement by x%) testing for P likelihood given present responses must be accepted with response probability greater than 0.05.

improve	present responses	P	Response Probability given P
20%	13	0.424655	0.3757
16%	18	0.460172	0.8370
14%	18	0.476078	0.7866
10%	22	0.507978	0.9645
7%	23	0.531881	0.9701
5%	23	0.551717	0.9508
0%	25	0.590954	0.9731

The results of this method applied to the hypothetical condition for scores improving 20% are applied to improvements of 16%, 14%, 10% and so on in the table above. The table also allows us to state that the trial demonstrated an acceptable representation of a majority case for improvement by 10% (row 4, column "P", value 0.507978) which is in the 95% confidence interval for improvement according to the t-distribution test statistic providing an unbiased estimate using the trial as descriptive of the Leeds Population.

10.2.5 Conclusions

Overall response

In response to the purpose of assessing feasibility, acceptability and success of the project in relation to meeting Key Performance Indicator (KPI) targets, we must interpret the current weighted average score as detailed below ((6*29.2 + 4*75 + 6*54.2)/16) of 50.025% as suggestion that only part of the of assessment is satisfactory.

If 60% is the threshold for satisfactory performance, taking a score of 61% as indicating satisfactory performance:

Table 186 DS LEE Feasibility, Acceptability and Success KPIs (refer to section 2.2 or 2.3 for KPI details)

Feasibility KPIs	KPI_REQ_008, KPI_REQ_010, KPI_REQ_015, KPI_REQ_005, KPI_REQ_013, KPI_REQ_016	Acceptability KPIs	KPI_REQ_011, KPI_REQ_012, KPI_REQ_014, KPI_REQ_007	Success KPIs	KPI_REQ_001, KPI_REQ_002, KPI_REQ_004, KPI_REQ_009, KPI_REQ_003, KPI_REQ_006
Scores as percentage	1 + 2 + 1 + 1 + 1 + 1 = 7 / 24 = **29.2%**	Scores as percentage	4 + 4 + 2 + 2 = 12 / 16 = **75%**	Scores as percentage	3 + 2 + 1 + 4 + 2 + 1 = 13 / 24 = **54.2%**

1. *(Section 10.2.1 notes that the feasibility for a trial is experimental in nature. The response to the requirement below for improving the Falls Algorithm has occurred, and is pending implementation of updated falls algorithm).* Feasibility score signifies improvement requirement to delivery of technical solution replacement (see appendix Table KPI Measurements Availability and Substitutions with Results). Improving the Falls Algorithm solution compared to the current solution would provide the following benefits:
    a. Aim to be performant and cost reducing to justify KPI_REQ_008 (Demonstrable savings to Health and Social care system)
    b. Provide inference to KPI_REQ_010 (Creation of business case for use of IoT solutions for healthy ageing)
    c. Directly improve KPI_REQ_015 (Reduce cost of fall risk screening)
    d. Directly improve KPI_REQ_005 (Decrease in referrals to telecare service)
    e. Directly improve KPI_REQ_013 (Be more accurate than current service provision on fall detection rates)
    f. Incorporate some improvement to KPI_REQ_016 (Increased detection of people who would benefit from fall prevention activities) to represent the solution as feasible at least to a satisfactory standard.
2. Signifying successful UI delivery, better than satisfactory Acceptability suggests the users are interfacing with the solution in a way they find better than satisfactory.
3. Success score given successful UI delivery suggests the quality of the solution requires improvement.
    a. Observing any KPIs scoring 2 or lower:
        i. KPI_REQ_002 (Improved sense of safety in the home) assurance of the solution's support by available staff would justify testing KPI_REQ_002 again to improve its partial satisfaction of conditions

ii. KPI_REQ_004 (Decrease social isolation) highlights the requirement of on-site staff and the requirement for alternative methodology appended to events recommendations e.g. journaling option for attended events with images linking to past event details
iii. KPI_REQ_009 (Increased physical activity in participants) scored well
iv. KPI_REQ_003 (Increased access of community and social facilities & services) is highlighted for alteration in Appendix Table "KPI Measurements Availability and Substitutions with Results" to improve specificity which may indicate improvement.
v. KPI_REQ_006 (Number of visits to primary care facilities) is similarly explained in the Appendix Table.

Analytical response

We can address inconclusive ANOVA study preventing identification of certain difference between any of the sample period thresholds and the inability to reject improvement hypotheses that occur contradictory to the overall trend combined with broad confidence intervals and very high Type 2 Error by suggesting improvement to data quality as specified below. As an example, the EQ5D3L Questionnaire with the highest number of complete responses has comparatively narrow statistical confidence intervals and Type 2 error against the UTAUT Questionnaire with the lowest number of complete responses.

It is necessary to note that all questionnaires suffer from insufficient sample size. Cochran's representative sample $n_0 = \frac{Z^2pq}{e^2}$ requires sample to be sized *385 complete sets* of questionnaire responses. This assumes maximum variability (p == q where p is the likelihood of a particular outcome and q is the likelihood of opposite outcome i.e. improvement or not), taking Z = 1.96 for standard normal distribution 2 tailed critical regions of 2.5% and e = 0.05 for the study's descriptive accuracy +/-5%.

There is an adjustment available to smaller populations. Taking N = the number of base responses per questionnaire, the adjustment follows: $n_a = \frac{n_0}{1+\frac{n_0-1}{N}}$. This adjustment presents a range of required sample sizes that the trial never satisfied with complete sets.

Table 187 DS LEE Proportions of number of complete responses against base responses and minimum sample size requirement.

Questionnaire	Base Responses	Adjusted Cochran Number	Number of Complete Responses	Complete Set / Base Responses (CB)	Complete Set / Adjusted Cochran Number (CC)	CB*CC General Participation Score
EQ5D3L	225	140	87	38.6%	62.1%	**24.0%**
SPQ	176	120	41	23.3%	34.2%	**8.0%**
UCLA	155	111	34	21.9%	30.7%	**7.2%**
UTAUT	114	89	17	14.9%	19.1%	**2.9%**
FES-I	203	131	68	33.5%	51.9%	**17.4%**
SF-36	191	132	46	24.1%	34.8%	**8.4%**
CDC-HRQOL-14	177	117	32	18.1%	27.4%	**5.0%**

The questionnaires with a general score below 15% have high Type 2 error β in the hypothesis list. Reducing this would require a greater sample size. The expected high β is due to proximity in sample size to neighbouring improvement conditions. The sample sizes for different improvement conditions would become more varied with more complete sets, reducing the likelihood of correct description by a neighbouring sample despite being unable to reject the null hypothesis.

With no score above 100% given the adjustments, there is emphasis on the requirement for improving, at least by a factor of three, strictness of co-ordination with on-site staff, perhaps according to a series of automated and manual notifications. This will concurrently improve periodicity consistency, not requiring weighted average periodicity to be representative of any final set. The trial's issue relating to periodicity is also severe.

We can address the requirement for satisfying data quality by increasing the cohort size, but the dependence on this alone does not account for the increased resource requirement for administration. Reducing dependence on increased cohort size is possible by an automated scheduling admin feature, its sub features aiming to improve formal engagement on a user basis with user initiated timeouts, and user initiated periodic completion requirement notifications, improving periodicity and restricting input. This implementation would be subject to feedback following a trial over a period sufficient for demonstrating enforcement by automation, shorter than the operating collection period of ACTIVAGE Leeds. The discussion for this design has been formalised separately.

10.3 Local sustainability plan

10.3.1 Product/Service Definition

Services provided:

- Home Monitoring to support users staying at home and remaining independent
- Emergency Trigger based on CSEM Falls detection algorithm.
- Reduce Social Isolation

ACTIVAGE uses: a set of sensors communicating to web portal through a data hub; a web app accessible by browsers; an android phone app; and a tizen watch app. ACTIVAGE combines these into a single product to provide home monitoring. ACTIVAGE applies Machine Learning to sensor data to personalise user behaviour patterns, alerting the carer of anomalies. An events section provides information about local events to encourage users to participate in communal activities.

We describe the service using three ACTIVAGE Use Cases (AUC) dependent on the above architecture.

1. AUC1 – Daily Activity Monitoring
    a. Use Context
        i. Sensors will monitor energy usage to build a picture of a person's daily life. We can attach sensors to doors or seats to check occupancy or could be energy plugs attached to home appliances to define normal patterns and timings of behaviour and send alerts to named individuals that the participant may require attention, not requiring any input from the participant, acting as a passive monitor.

ii. Carers and Family members can remotely access visualisations of data. Service or care providers would also be able to access this data if it would better support the participant.

b. Requirements

i. Environment sensors to acquire environment conditions and person behaviour; Gateway to collect sensor information and send it to IoT platform; Processing module for pattern recognition and behaviour detection and data mining; High level of personalization Communication capabilities toward relatives and professional; User friendly and natural interfaces to interact with user at home.

2. AUC4 – Emergency Trigger

a. Use Context

i. We can configure the home hub to alert any undesirable states, e.g. having a fall; when the solution detects the user to be immobile for too long, or not performing their usual daily routine.

b. Features

i. Falls Algorithm in Watch paired to a phone; a panic button on the watch phone pair; Environment sensors to acquire environment conditions and person's behaviour; Broadband/Wi-Fi access in the home; Gateway to collect sensor information and send it to IoT platform; Processing module for pattern recognition and behaviour detection and data mining; Communication capabilities toward relatives and professional; User friendly and natural interfaces to interact with user at home

3. AUC7 – Prevention of Social Isolation

a. Use Context

i. We use mobile technology connected to the internet to improve the user's communication from the home and make practical suggestions on activities they might like to engage with.

b. Features

i. Needs Wi-Fi access; High level of personalization - specifically with target setting on watch; User friendly and natural interfaces to interact with user; Using open data from Data Mill North can link to local services on offer

Relevance of ACTIVAGE's Value to the existing ecosystem of local services.

It is key to the target population (described below) that ACTIVAGE links closely with existing services they may be engaging with, not only to boost participation, but also to improve trust in this solution and improve the likelihood of delivery of intended benefits.

Mapping out the target population of this project would include:

- A total cohort size of 300 including carers
- Over 65s – people who want to maintain their physical health and independence
- Over 65s – people who are a little higher on the frailty scale and need the peace of mind able to be offered by technology
- Family members and people living in the same building
- Carers – family members and informal carers such as neighbours
- Carers – formal paid carers working for an independent agency
- Professional front line stakeholders – GP, OT, Social worker, Housing officer

- Professional involved stakeholders – service managers, project managers and TeleCare staff

The Leeds target population requires a project that is easy to access and understand rather than something they may see as a hassle or unnecessary – this will come from ensuring people understand the equipment they are given and what it is they can achieve. The city is committed to co-design as part of its user centred design. It already has a track record of direct engagement with user groups recruited from the community. We would extend and deploy these as part of ACTIVAGE Leeds.

ACTIVAGE intends to improve four current services:

1. Assisted Living Leeds – assistive technology equipment hire.
    a. Administrative assistance
2. TeleCare Service with Assisted Living Leeds 24hr call centre – fall detection and response.
    a. Innovate preventative elements that the current solution lacks
3. Carers Leeds – support service for people with a caring responsibility
    a. Direct advertisement of ACTIVAGE to carers to involve a wider demographic.
4. Neighbourhood Networks – Long running (20 years) local service aiming to reduce spending on social care.
    a. Connect users to activities and events in the local area to link them to neighbourhood networks, reducing social isolation.

ACTIVAGE intends to improve 4 background experiments:

1. Leeds Falls Project – successful fall recovery program by NHS and Leeds City Council (LCC).
    a. Device offering
2. Tablet Lending Scheme – Learning opportunities access by Leeds Libraries.
    a. Device offering
3. WIFI / Broadband in Social Housing – LCC 100% digital commitment.
    a. Targeted marketing and installation to affected sites
4. TIHM For Dementia Project – IoT & Big Data Analytics trial to improve home treatment, QoL and reduce hospital admissions.
    a. Prevention and early detection contribution.

Starting from the requirement on devices for value propagation, the value chain follows:

1. Device Provision (Samsung watches and phones, 3rd Party energy monitoring and home sensors)
2. Network Provision (working broadband connection and user SIM with data connection)
3. Platform Provision (3rd Party data storage and analytics)
4. Application Provision (CSEM and Samsung phone, wearables and PC apps)
5. Service Provision (LCC and 3rd Parties)
6. Payers (End User, Local Authority Procurement Teams)
7. Customers (Over 65s, Family / Friends, Formal Carer, GPs)

8. Society (Less reliance on statutory services, improved self-management, resources able to be deployed elsewhere).

Five home sensors will be provided to elderly trial users. These will monitor electricity usage of the house, high-energy consumption electrical items, opening and closing of windows or doors and movement activity.

A wearable device such as a Samsung Gear S3 watch will be constantly monitoring user activity and detect a fall. Two gateway devices will connect to the internet. These will send data from the sensors and in the case of the smartphone send and receive notifications. The middleware section stores user data, user settings, runs analytics & sends information about local activities and notifications. Web server will publicize local community events using open datasets such as Data Mill North. Trial participants may access ACTIVAGE data, settings and information through the application and Web portal. Primary users control access to their data and where notifications are sent. Friends/family can view health data, and receive notifications. Carers can monitor health and wellbeing of primary users with the view to provide better care.

10.3.2 Market Analysis

10.3.2.1 PESTEL analysis

Table 188 DS LEE PESTEL analysis

Element	Factor	Business Impact
Political	Heavy political focus on health as a core state responsibility. Government support for global convergence to a common medical technological format. Government promotion of digital technologies. Coronavirus (COVID-19) increase in use of digital tech.	Coordination can be focused for delivering the solution thanks to provision of funding eligibility criteria and data protection legal frameworks by the government as enablers of interoperability.
Economic	Maintenance of National Strategy for (2062) increase of healthcare expenditure to 20% of GDP from 9.7%. Compound Annual Growth Rate in Electronic Healthcare ranges between 12% - 35% for the EU. Continued economic development in emerging markets outside the EU and converging economies within the EU	2062 forecast defines the case for Project Continuation. The UK has a stable market providing opportunities for market penetration and growth. We target functional telehealth care provision at a lower cost across EU national health systems in response to an increasing number of healthcare providers adopting connected telemedicine technologies.
Sociological	81% of respondents to Eurobarometer 460 “Attitudes towards the impact of digitisation and automation on daily life” (2017) said they never used health and care services provided online	Significant opportunity for increasing use of internet for health related solutions. Improving collective consciousness of wellbeing.

	without having to go to the hospital or doctor's surgery. Adherence to interoperability to enable treatment of the patient in their home country.	Raising awareness of social isolation, providing technological solutions to tackle the issue. Providing peace of mind that when a person requires support a friend will be notified and quickly respond.
Technological	Installation communications and accompanying instructions must be kept complete and up to date in response to lagging process and information management infrastructure, which tends to slow down adoption. There is significant requirement on training IT personnel to receive a complicated, adequate solution on site.	We employ the most advanced AI technology. With remote monitoring 24 hours a day, 7 days a week, 365 days a year. The online platform is automated human interventions are not necessary.
Environmental	Weather reports should change behaviours ahead of time, e.g. indication of icy conditions on app could prevent a fall outside.	Our online platform reduces the need for unnecessary home visits. Due to the constant monitoring health and activity levels are always up to date, so interventions can be planned.
Legal	Lack of commonality in the way data is stored between concurrently developing solutions in the market hinders sharing of data further than the existing legal privacy restrictions.	We have produced the ACTIVAGE Restful API.

10.3.2.2 Market characterization

1. Market Size
    a. Which customers
        i. Particularly among the aging population prone to Alzheimers, Dementia, Diabetes, Chronic Obstructive Pulmonary Disorder, Cardiovascular Disease, Cancer, Sleep Disorders, several other co-morbidities
        ii. AUCs:
            1. AUC1 Daily Activity Monitoring – Remote Monitoring Technologies (RMT) Market
            2. AUC4 Falls Prevention – Telecare Market
            3. AUC7 Reduction of Social Isolation – Personal health systems in general including RMT, Telecare and mHealth
2. Growth Rate and EU potential market 2013 EC Personal Health Systems report.
    a. Remote Monitoring $1.1B at 12-13% Compound Annual Growth Rate (CAGR) to $1.8-2B for a 470M EU population by 2024
    b. Telecare market of $0.76B at 13% CAGR, this shouldn't be confused for telehealth involving delivery of consultation using ICT which has a larger market.
    c. mHealth market of $6.55B at 34.3% CAGR to $28B in 2024
3. Market Structure
    a. Market Segmentation

i. Overlapping solutions in healthcare and wellness makes it difficult to segment the Integrated Personal Health Services (IPHS) market. An approach recommended in Strategic Intelligence Monitor on Personal Health Systems (Peter Baum, 2013), Health Conditions (ranging Healthy to Chronic) and Product Sophistication (ranging Low to High) are presented as 2 dimensions inside which RMT, Telecare and Wellness hybridisation is contained as a chronic, mid to high-level sophistication product meaning that it is expected to be in maintained research where investment is high but commercialisation is, as of yet, low.

b. Profiling
   i. The Hybrid Product relies on the following participants
      1. Telcos and Mobile operators actively targeting healthcare for diversification from decreasing margins on traditional communications markets. Solution partnerships determine some customer loyalty, ensuring continuous cashflow, though the loading on bandwidth may be lower.
      2. ICT Vendors, Consultants and system integrators are attracted by the opportunity to apply their core competencies such as managing data, structuring work flows and integrating legacy systems. Complementary products may be developed by these groups to be coupled with the established solution.
      3. The delivery of value is ultimately dependent on Mobile Device use, requiring Mobile Device Manufacturers and developers for those mobile devices.
      4. Medical Engineering companies are expected to deliver products derived from quality Research & Development
      5. Manufacturers of Medical / Monitoring devices can provide similar service they do to institutions, broadening their range of products by modification for use by the layman. The products may be developed to improved software capabilities given the type of modification. These companies would stand to benefit greatly still following broad adoption of RMT.
      6. Original Equipment Manufacturers offer product components to third parties that can repackage and integrate into a separate product.
      7. Potential customers would include private and public hospitals, social and health care providers, practitioners, insurance companies, housing cooperatives and public health institutions.

4. Needs
   a. RPM
      i. Increasing incidence of chronic disease
      ii. Ageing populations
      iii. Increasing hospital expenses
   b. Telecare
      i. Need for continuous care
      ii. Alterations in family structures and demographic change decreasing the number of available carers
      iii. Affluent elderly demands
   c. mHealth
      i. Remote consultation
      ii. Health monitoring

iii. Record Keeping
iv. Planning Care provision
v. Education

10.3.3 Competition/sector Analysis

10.3.3.1 Competition profile analysis

In the table below, we have listed competitor's falls detector solutions, capabilities, service characteristics, and where the sensor is worn.

Table 189 DS LEE Table of falls detection products

Product	Capabilities	Sensor location	Service characteristics
Philips Lifeline	Fall detection	Chest (pendant)	Subscription-based
Apple watch	Fall detection, smartwatch features	Wrist	Standalone
MyNotifi	Fall detection	Wrist	Standalone (can be used with hub)
Tunstall Vibby	Fall detection	Wrist	Must be used with hub
Medical Guardian (mini guardian)	Fall detection	Chest (pendant)	Subscription
GoLive clip	Fall detection, activity features	Collar, bra, or belt	Subscription

The table below lists solutions that already have a market presence; the table lists the name of the company and provides a description of the service provided.

Table 190 DS LEE Table of service providers

Service Provider	Service
Assisted Living Leeds	Provides assistive technology equipment hire and recycling. Run jointly by the local authority and the NHS, basic equipment is delivered free of charge and then collected again once no longer needed to reduce waste and cost .
Telecare Service	Supplies pendants and alarms for in the home for people at risk of falling or who have had a recent fall, also enabling safe hospital discharge. Includes a 24 hour call centre and mobile response unit based at Assisted Living Leeds.
Carers Leeds	A third sector provider of support services for people with a caring responsibility.
Neighbourhood Networks	Local services running in Leeds for over 20 years and credited with reducing the social care spends. They provide signposting and social inclusion services for older people, specific to a local area.
Tunstall Healthcare	Provides technology to support those requiring care & health intervention to live independently in their chosen home setting.

Canary Care	Provides product for monitoring all the important rooms and doorways, plus activities like eating and drinking, and taking medication.

10.3.3.2 Porter's 5 forces analysis

Table 191 DS LEE Porter's 5 forces analysis.

Force	Analysis of potential factor
Competitive rivalry	• Existing care homes provide a high service at a cost. • Small number of online companies cater for this need. • Although limited number of companies cater for these market segment, rivalry is high. • Advertising is expected to be high to gain customers in an already competitive market.

Threat of new entrants	• Barriers to entry
	  • The UK has decreasing barriers to entry with significant public awareness of interconnected smart devices and their beneficial influence. (YouGov 2018 The dawn of the connected home)
	  • COVID19 has made on-site support difficult.
	  • Regulatory and policy conditions are emergent, the sector is considered sophisticated with high investment and low commercialisation. Commercialisation is expected to emerge at scale.
	  • An appropriate offering for the affluent elderly.
	• Emerging IoT technologies provide more opportunities for rivals. With off the shelf commodity items increasing the capability for economies of scale, companies will have to innovate to survive.
	• There is always a threat to brand equity by new entrants using low cost models to gain market share.

Threat of substitutes	• Buyers are likely to substitute a less performant, expensive solution with a better one that can be replaced for cheaper. There will likely be a trial to demonstrate the ease of substitution. • Majority of existing service providers focus on personal alarms, few provide home monitoring sensors. • None could be found that combine their services with prevention of social isolation.
Bargaining power of suppliers	• There is a modest amount of service suppliers such that bargaining power is to their advantage • Few industry suppliers. • The cost of switching suppliers may be prohibitive.
Bargaining power of customers	• Some services are so alike that users may decide to substitute with little change in cost or service. • Buyers can switch due to price sensitivities. • Buyers can exert pressure for higher quality solutions.

10.3.3.3 SWOT analysis

Table 192 DS LEE SWOT analysis

STRENGTHS	WEAKNESSES
Leeds deployment site partners includes large multinational companies. Leeds DS has strong management and engineering teams. Leeds commercial partners have proven technological excellence and reputation for quality with strong brand recognition. Structured network of 50 participants for good Innovation Configuration. Successful delivery of Innovation Experience via customer engagement on a trial basis. Successful Innovation Offering via a functioning product system and product performance support. Aims to establish mHealth compared to its current disruptive innovation status to enable integration with regulation and accelerate adoption.	Reliant on third party customer support and installation teams. Data quality issues reduce the theoretical case due to reduced comparability against other studies. User centric with little strictness for encouraging model behaviour, increased model centricity is difficult with a tech incompatible (older) target user base. More consideration for the environment of care for patient and their circle of care is necessary to render the research and resources not wasteful. Improve Patient engagement, administer pre and post processing more thoroughly. Lack of interoperability due to fragmentation.
OPPORTUNITIES	**THREATS**
2024 61M smartphone users in the UK. Target rural populations, far from town or city centres. Preparedness to complement traditional therapies – e.g. waiting lists. Successful cost reduction promotes the preventative self-care agenda against rising healthcare costs. New medical data relatively frequently supersedes itself, requiring periodic corrections and associated innovations. Improve cross platform compatibility, contribution to emergent interoperability frameworks. Incorporating social media elements (allowing the creation and exchange of user generated content, e.g. blogs, fora, gaming, image broadcasting).	eCare - https://cordis.europa.eu/project/id/856960 Behavioural change interventions may become de-prioritised. Is it the best policy making tool for others to demonstrate compliance? An expectation for 20% of UK GDP to be spent on NHS by 2062, targeted by competitors. AHA Scaling, Secure UK and NHS mHealth policy implementation and justify continued initiatives to stimulate innovation in mHealth, targeted by others. Target group Aging populations is shorter term and eventually includes everyone on this short cycle, the innovation is expected to improve rapidly.

10.3.4 Value proposition and Targeted Customers

Table 193 DS LEE Lean canvas RUC 1.

ACTIVAGE Use Case 1 Daily Activity Monitoring Lean Canvas				
Problem	**Solution**	**Unique Value Propositio**	**Unfair Advantage**	**Customer Segments**
There are significant and regular time periods during which the status of elderly people living in private is preferable to be known. This requires support for elderly people to live in their home should they wish to. The activities engaged in by the elderly increasingly require active support. Human care aids this well, which may be improved and which may not be always available. It is possible to improve connectivity between carers and relatives and support independent living and improve quality of life.	Provide home monitoring by installing a range of sensors around the home to monitor the user as they go about their daily activities. Provide a smart-phone and smart-watch which collect health data through health trackers. Allow family, friends and caregiver to monitor activity of users.	We employ behaviour monitoring through machine learning technologies to create specific user profiles which are unique to each person.	Through the use of highly sophisticated and complex technologies such as our machine learning we have technology that is unique to us. (protected IP?)	Our solution targets people with Clinical Frailty Scale (CFS) level between 3 and 6, living alone or spending a considerable part of the day alone at home.

Existing Alternatives	Key Metrics	High-Level Concept	Channels	Early Adopters
Assisted Living Leeds - encompasses assistive technology equipment hire and recycling. Run jointly by the local authority and the NHS, basic equipment is delivered free of charge and then collected again once no longer needed to reduce waste and cost.	We measure how mobile a person is around their home. Our passive IoT sensors record sensor actuations, which provide the status of the activity levels of the beneficiary.	Geolocation with extra, highly specific features. Having friends and family wherever they, know you are active, safe and well. Friends and family can visit, call over the telephone if they wish to talk about anything of importance to them.	Customers can be engaged directly through local community centres.. Through charities, such as Age UK	Customers should be digitally literate not fearful of technology, i.e. willing to embrace new technologies. They should be interested in their wellbeing and be actively monitoring their health. They want to share their data with friends, family etc., and like to have the benefits of someone who cares for them also having visibility of their activity levels.

Cost Structure	Revenue Structure
Fixed costs: • IoT sensors and hubs. • Smart-phones • Smart-watches • Licenses • Installation teams • Server infrastructure Variable costs: • Maintenance will vary on problem • Support teams will vary on number of customers	Upfront costs for equipment, followed by subscription. Subscription based model for a term of 12 months with option for renewal when term is about to expire.

Table 194 DS LEE Value proposition canvas RUC 1.

ACTIVAGE Use Case 1 Daily Activity Monitoring Value Proposition Canvas

Value map		FIT	Customer profile	
Gain creators Users will know how they have performed in the past for a behavioural change context, can set activity targets for the present, and can know that a friend or family member is always there to care for them.	**Product & Services** Our Internet of Things home monitoring technology provides a means of monitoring activity levels through visual graphs. Machine learning creates a personalised behavioural profile for each user.		**Gains** Improving regularity and asynchronicity of connection between carers and relatives of the elderly for improved knowledge and sense of security in allowing elderly people to live at home as they want, caring on living their lives as they wish. Monitoring activity levels.	**Customer Job(s)** Living at home in a community and environment they have grown accustomed to. Keeping active.
Pain relievers Our home monitoring solution allows users to view and share their activity levels over durations such as days, months, weeks, years, etc.,			**Pains** Not knowing how active they are. Not knowing if they are becoming less active over time.	

Table 195 DS LEE Lean canvas RUC 4.

<table>
<tr><th colspan="5">ACTIVAGE Use Case 4 Emergency Trigger Lean Canvas</th></tr>
<tr><td>Problem

The response to an elderly person suffering from a fall is variable due to the unknown status that can persist when an elderly person suffers a fall. If this was known, it should be acted on. Raise an alert when person falls, notify carers of the fall.</td><td>Solution

Provide a wearable watch device with a fall detection algorithm that is worn around the wrist.</td><td rowspan="1">Unique Value Proposition

By providing a watch that is worn on the wrist during the day and night the likelihood of detecting a fall is very high.</td><td>Unfair Advantage

Our solution has a unique, patented falls detection algorithm</td><td>Customer Segments

People that are in danger of a fall.</td></tr>
<tr><td>Existing Alternatives

Telecare Service provides pendants and alarms in the home for people at risk of falling or who have had a recent fall, also enabling safe hospital discharge. Includes a 24 hour call centre and mobile response unit based at Assisted Living Leeds</td><td>Key Metrics

Positive/false positives.</td><td>High-Level Concept

Alarm with selective immediate response to falls.

Falls alerts notifications sent to family, friends and carers.</td><td>Channels

Customers can be engaged directly through local community centres.

Through charities, such as Age UK</td><td>Early Adopters

Someone who can wear a watch without problems. Is digitally literate and not afraid of technology.</td></tr>
<tr><td colspan="2">Cost Structure

Fixed costs:
Smart-phone
Smart-watch
Licences
Servers infrastructure</td><td colspan="3">Revenue Structure

Upfront costs for equipment, followed by subscription.

Subscription based model for a term of 12 months with option for renewal when term is about to expire.</td></tr>
</table>

Table 196 DS LEE Value proposition canvas RUC 4.

ACTIVAGE Use Case 4 Emergency Trigger Value Proposition Canvas				
Value map			**Customer profile**	
Gain creators Customers will know that should they have a fall a notification will be sent to someone who cares for them and will provide help promptly.	**Product & Services** Our solution provides a program that runs on a watch continuously monitoring for a fall. When user has a fall a message is sent to contacts, such as friends, family and carers.	FIT	**Gains** Prompt notification to people who can arrange for prompt help.	**Customer Job(s)** Notify someone when a customer has a fall.
Pain relievers Getting prompt care for a fall will increase the chances of having a better chance of full recovery in a short duration and reduce the chance of major surgery, etc.,			**Pains** Having a fall and injuring oneself.	

Table 197 DS LEE Lean canvas RUC 7

ACTIVAGE Use Case 7 Prevention of Social Isolation Lean Canvas

Problem	Solution	Unique Value Propositic	Unfair Advantage	Customer Segments
Elderly people who choose to live privately are at risk of becoming socially isolated. We aim to prevent social isolation.	Provide information about local events.	News of local events can be read in a single location providing convenience.	Our web platform and android app allow users to find local events that are occurring.	Customers that are digitally literate not afraid of technology and want to engage in local events.
Existing Alternatives	**Key Metrics**	**High-Level Concept**	**Channels**	**Early Adopters**
Neighbourhood Networks - these are local services running in Leeds for over 20 years and credited with reducing the social care spends. They provide signposting and social inclusion services for older people, specific to a local area.	Social interactions, if user is engaging with our platform.	Meetup with local events for elderly.	Customers can be engaged directly through local community centres.. Through charities, such as Age UK	Someone who wants to attend local events and engage with the local community.

Cost Structure	Revenue Structure
Fixed costs: • Servers infrastructure	Subscription based model for a term of 12 months with option for renewal when term is about to expire

Table 198 DS LEE Value proposition canvas RUC 7.

ACTIVAGE Use Case 7 Prevention of Social Isolation Value Proposition Canvas

Value map		FIT	Customer profile	
Gain creators By attending local events customers may benefit from exercise or cognitive games.	**Product & Services** Our solution provides an android app and web portal page listing local events details such as date and time, location and event organiser event details.		**Gains** Customer attends local events, such as leisure activities makes friends and enjoys the company of others.	**Customer Job(s)** Customer has a go to place to find out about local events.
Pain relievers Customers have a single handy location that can visit to find out about local events that may interest them.			**Pains** Customer avoids being socially isolated, and lonely.	

10.3.5 Strategy for local sustainability

10.3.5.1 Open Data strategy

Table 199 DS LEE dataset activity monitoring.

Dataset name	DS8.1.ACTVITY_MONITORING
Data identification	
Data set description	Two sets of sensors are installed. 1. Environmental sensors: Door State, Motion (PIR), Appliance Energy Meters, Home Energy Meters, 2. Personal Health Sensors: Heart Beat, Pedometer and Sleep Detectors

Type	Location	What are they monitoring ?	What is the dataset comprised of?	Will it contain future sub-datasets?
		Environment Sensors		
Motion sensors	Any chosen location throughout the user's house as detailed in Section 1.2	Motion in these locations in an expected or healthy range.	Time stamped log of detected motion.	No, only operating through the deployment duration.
Door sensors	Any chosen door throughout the user's house as detailed in Section 1.2	Door use frequency to check occupancy.	Time stamped log of detected door opens and closes.	No, operating through the deployment duration.
Power monitors	Any chosen appliance throughout the user's house as detailed in Section 1.2	Appliance usage patterns.	Time stamped log of detected appliance interaction.	No, operating through the deployment duration.
House monitors	Supplementary locations chosen throughout the user's house.	Home Power Consumption.	Time stamped power consumption log	No, operating through the deployment duration.

Gateways	Conveniently located in the user's house.	Collects all sensor data to send to IoT platform	All Data passes through gateways.	No, operating through the deployment duration.
		Personal Health Sensors		
Phones	User's proximity or on their person.	Heart rate, blood pressure, sleep cycles, pedometer, other sensor dependent or journaled health data, and questionnaire responses.	Time stamped sensor and journal logs, questionnaire responses.	No, operating through the deployment duration.
Wearables	On the user's person.	Falls log, heart rate, blood pressure, pedometer…	Time stamped falls and other sensor logs.	No, operating through the deployment duration.

Source (i.e. which device?)

Datasets are collected through 2 main means.

1. For Environmental sensors, fixed sensor devices send to vendor gateways and cloud APIs from Energenie and SmartThings are used.

2. For Personal Health Sensors: On-board smartwatch sensors paired with user smartphone, with Samsung Health App (Tizen and Android) and ACTIVAGE App (Android) installed.

Type	**Collection Method**	**Sensor Type**
	Environment Sensors	
Motion sensors	Sensor devices send to vendor gateways and cloud APIs from Energenie, using SmartThings.	Fixed Environment Sensor
Door sensors	Sensor devices send to vendor gateways and cloud APIs from Energenie, using SmartThings.	Fixed Environment Sensor
Power monitors	Sensor devices send to vendor gateways and cloud APIs from Energenie, using SmartThings.	Fixed Environment Sensor
House monitors	Sensor devices send to vendor gateways and cloud APIs from Energenie, using SmartThings.	Fixed Environment Sensor

Gateways	Receives data from all sensors	Gateway
Personal Health Sensors		
Phones	Use of phone sensors for designed Personal Health metrics collections and journal option in Samsung Health and ACTIVAGE Apps	Phone with all phone sensors and Samsung Health App for Phones and Watches(Android & Tizen)
Wearables	Paired to Smartphone allowing data to	Smartwatch paired to Smartphone with Samsung Health

Partners responsibilities	
Owner of the device	Samsung Electronics
Partner in charge of data collection (if different)	Samsung Electronics
Partner in charge of data analysis (if different)	Samsung Electronics, University of Surrey
Partner in charge of data storage (if different)	Samsung Electronics
Standards and metadata	
Info about metadata (Production and storage dates, places) and documentation?	Metadata will include timestamps in ISO8601 format, sensor type, quantity kind, and unit of the sensor using naming convention from the M3-lite taxonomy. Datatypes will include integers, floats and strings. Documentation can be found at: https://github.com/telsaleh/activage-aiotes-integration-suite
Standards, Format, Estimated volume of data	The format for open data will be in JSON with a schema following the FIWARE NGSIv2 standard. Data will be made available through the DS FIWARE Context Broker instance.
Data exploitation and sharing	
Data exploitation (purpose/use of the data analysis)	Collaborative research purposes for studying user personal health and capability of performing Activities of Daily Living (ADL).
Data access policy / Dissemination level (Confidential, only for members of the Consortium and the	The full dataset will be confidential and only the members of the DS and/or Consortium will have access on it. Furthermore, if the dataset or specific portions of it (e.g. metadata, statistics, etc.) are decided to become of widely open access, it will be uploaded to the ACTIVAGE open data platform. Of course, these data will be

Commission Services) / Public	anonymized, so as not to have any potential ethical issues with their publication and dissemination.
Data sharing, re-use and distribution (How?)	Data sharing will be restricted to the ACTIVAGE Consortium, and any exchange of data will be encrypted (data and connection). Any publication of data to the ACTIVAGE OPM will be anonymized, and in compliance with GDPR
Embargo periods (if any)	
Archiving and preservation (including storage and backup)	
Data storage (including backup): where? For how long?	The owner of the information is Samsung Electronics (SRUK) as the Data Controller, and Leeds City Council. Backup of data is currently held on cloud storage. Personal data will be removed within 6 weeks from the end of the project; anonymized data will be stored for a duration for 1 years after the project ends for academic purposes. Cloud storage will be subject to available funding, but in the case of funding cessation, the data will be locally stored and encrypted as a hard copy.

Table 200 DS LEE dataset emergency trigger.

Dataset name	**DS8.2.EMERGENCY_TRIGGER**
Data identification	
Data set description	Fall detection soft sensor is installed in a user smartwatch. Time stamped log of detected motion. No future sub-data sets, only operating through the deployment duration.
Source (i.e. which device?)	Datasets are collected through smartwatch sensors paired with user smartphone, with the ACTIVAGE Leeds App (Tizen and Android) installed on both the watch and phone. https://play.google.com/store/apps/details?id=com.samsung.activage
Partners responsibilities	
Owner of the device	Samsung Electronics
Partner in charge of data collection (if different)	Samsung Electronics
Partner in charge of data analysis (if different)	Samsung Electronics, University of Surrey
Partner in charge of data storage (if different)	Samsung Electronics
Standards and metadata	

Info about metadata (Production and storage dates, places) and documentation?	Metadata will include timestamps in ISO8601 format, sensor type, quantity kind, and unit of the sensor using naming convention from the M3-lite taxonomy. Datatypes will include integers, floats and strings. Documentation can be found at: https://github.com/telsaleh/activage-aiotes-integration-suite
Standards, Format, Estimated volume of data	The format for open data will be in JSON with a schema following the FIWARE NGSIv2 standard. Data will be made available through the DS FIWARE Context Broker instance.
Data exploitation and sharing	
Data exploitation (purpose/use of the data analysis)	Collaborative research purposes for studying user personal health and capability of performing Activities of Daily Living (ADL).
Data access policy / Dissemination level (Confidential, only for members of the Consortium and the Commission Services) / Public	The full dataset will be confidential and only the members of the DS and/or Consortium will have access on it. Furthermore, if the dataset or specific portions of it (e.g. metadata, statistics, etc.) are decided to become of widely open access, it will be uploaded to the ACTIVAGE open data platform. Of course, these data will be anonymized, so as not to have any potential ethical issues with their publication and dissemination.
Data sharing, re-use and distribution (How?)	Data sharing will be restricted to the ACTIVAGE Consortium, and any exchange of data will be encrypted (data and connection). Any publication of data to the ACTIVAGE Open Data Platform will be anonymized, and in compliance with GDPR
Embargo periods (if any)	
Archiving and preservation (including storage and backup)	
Data storage (including backup): where? For how long?	The owner of the information is Samsung Electronics (SRUK) as the Data Controller, and Leeds City Council. Backup of data is currently held on cloud storage. Personal data will be removed within 6 weeks from the end of the project; anonymized data will be stored for a duration for 1 years after the project ends for academic purposes. Cloud storage will be subject to available funding, but in the case of funding cessation, the data will be locally stored and encrypted as a hard copy.

10.3.5.2 Continuation strategy

While Leeds will not formally continue to be part of the ACTIVAGE Foundation after September 2020 we have put a number of plans in place to ensure that users are informed about the end of the project and are clear about how they can access technical support for the devices and apps should they continue to want to use them. We have also arranged for our Telecare technicians to uninstall equipment for those users who do not want to continue and do not feel confident in how to do this for themselves.

In August 2020 we wrote and sent text messages to all deployed users to thank them for their participation in the project. The letter notes that following:

- The date the ACTIVAGE App will stop working/be deleted automatically from users devices
- Alternative applications and instructions for using sensors after the project ends
- Information about the other Samsung project that participants can join after the end of the project if they wish to
- How to participate in the evaluation if they have not already
- How users can return their equipment if they longer want it

Leeds City Council have assigned resource to monitor the ACTIVAGE inbox until then end of October to ensure that any queries can be dealt with in this time.

10.3.5.3 Replication strategy

Samsung having been working with Leeds City Council to increase the number of trial users as a contingency Shropshire Council was approached. Around 25% of residents in Shropshire are 65 or over. The council had recently completed a pilot project with the University of Chester in the village of Broseley. Participants were supplied with consumer technology such as smartwatches, voice-activated devices and messaging apps that can be used or adapted to support the health and social care needs of vulnerable people.

Called the Broseley Project, the pilot scheme involved setting up the equipment to monitor certain information about the volunteer, with things like step count, heart rate and battery usage. The project was to show that the council could utilise high street equipment rather than expensive multiple bespoke devices to give them information about a volunteer so that it could eventually support them and their carers/families, etc. to stay in their own homes for longer.

The Broseley project proved that people were willing to wear such a device, were capable of keeping the device charged and were prepared to discuss the use of the devices with the council, University and family.

We are collaborating with Shropshire Council to roll out ACTIVAGE. Assistive technology in Shropshire in the expand and grow phase of the project. At the time of writing ACTIVAGE for Shropshire has 234 users, 116 elderly and 118 informal carers.

10.3.5.4 Scaling-up strategy

Samsung has been closely following the Elder care market through the duration of the project. Several demos and webinars were given to public authorities, MPs and local government decision makers through the project. With all the learnings & rich pilot experience Samsung plans to roll-out Samsung Assisted Living platform (spin off from ACTIVAGE) with its selected partners across Europe and US. The platform will consist of proprietary solution from Samsung utilizing foremost Samsung hardware products along with AIoTES. The Semantic Interoperability Layer (SIL) component would be highly exploitable and Samsung is considering to make it part of its core products. Samsung will expand and scale up to reach wider use cases as demanded by local authorities.

10.4 Appendix

Section 10.2.3 Evaluations Protocol Checklist

Table 201 DS LEE KPI Measurements Availability and Substitutions with Results

KPI ID	Measurement Available? (Yes / No)	Measurement tool as specified in D9.1? (Yes / No)	Substitution	Result
KPI_REQ_001 Improve Physical Wellbeing	Yes	Yes	None	2.4 Analysis of Results Section, requirement on improvement **PARTIALLY** met.
KPI_REQ_002 Improved Sense of Safety	Yes	Yes	None.	2.4 Analysis of Results Section, requirement on improvement **NOT** met.
KPI_REQ_004 Decrease Social Isolation	Yes	Yes	None	2.4 Analysis of Results Section, requirement on improvement **NOT** met.
KPI_REQ_009 Increase Physical Activity	Yes	Yes	None	2.4 Analysis of Results Section, requirement on improvement **MET**.
KPI_REQ_008 Savings to Health / Social Care System	Partial	No	Qualitative LCC / TC Response	Assisted Living Leeds did not replace any of it equipment with ACTIVAGE equipment due to no improvement to current solution, therefore no cost savings were realised.
KPI_REQ_010 Creation of business case for AHA IoT	Partial	Partial	Satisfaction of Table 5 Business Cases in ACTIVAGE Proposal B	We can review the piecewise response to Leeds Use Cases in SVN for a satisfaction of 59% of those applicable to Leeds.
KPI_REQ_011 Usage / Acceptance of wearable	Yes	Yes	None	2.4 Analysis of Results Section, requirement on improvement **MET**.
KPI_REQ_012 Usage / Acceptance of stationary sensor	Partial	Partial	None	2.4 Analysis of Results Section, requirement on improvement **MET**.
KPI_REQ_014 Support Service	No	No	ZenDesk Support Statistics	55.6% Satisfaction served in average 160hrs
KPI_REQ_015 Reduce fall risk screening cost	Yes	Yes	None	Assisted Living Leeds did not replace any of it equipment with ACTIVAGE equipment due to no improvement to current solution, therefore no cost savings were realised.

KPI_REQ_003 Increase community activities & facilities access	Yes	Yes	DSVLC Question 14 and Qualitative Anecdote by LCC / TC	Difference between final and base from a base mode of 2 (1 to 3 events per week) D~N(0.029, 0.613^2), normal distribution(mean, variance), the ranges for responses are wide and narrowing the response ranges may indicate a better positive change. LCC reports positive feedback from users for Events Tab in the app.
KPI_REQ_005 Decreased referrals to TC service	Yes	Yes	None	0% decrease
KPI_REQ_006 Decrease primary care visits	Yes	Yes	DSVLC Question 14 and Qualitative recommendation by LCC / TC	Difference between final and base from a base mode of 1 (0 to 2 visits per month) D~N(0.0, 0.34^2), normal distribution(mean, variance), the ranges for responses are wide and narrowing the response ranges will be more specific and may indicate a better positive change. There is no suggestion the project realised this benefit.
KPI_REQ_007 # of patients engaging +vely with technology	Partial, Pending by Jeong	No	UTAUT (AT) and SPQ	
KPI_REQ_013 improve fall detection	Partial	Anecdotal, no Data	Qualitative Anecdote by LCC / TC	Found to be less reliable than current LCC / TC service
KPI_REQ_016 detect people who would benefit from fall prevention	Partial	No	Qualitative recommendation by LCC / TC	No, due to unreliable fall detection algorithm

Section 2.4 Hypothesis template

1. Hx: Improvement Targets specified in the Section 2.3 Local evaluation Protocol Table
   a. ANOVA $F = \frac{nS_{Tr}^2}{S_E^2} = \frac{Variance\ between\ samples}{Variance\ within\ samples}, \quad P(F > F_{m,n}),$

      If $P\left(F > F_{3,n}\right) < 0.05$, it is likely that there is a significant difference between periodic samples. We can interpret the periodic samples as having changed over time and that they represent the population from which we drew them in an unbiased way.
   b. Using S^2 as an unbiased estimator for the unknown variance of the Leeds Elderly Population, from which the trial sample is taken on which the trial

sample is assumed to be normally distributed, provide the t-distribution value corresponding to the trial size's degrees of freedom (trial size – 1)

   i. T-distribution provides a confidence interval for mean improvement (difference between final and base scores μ_D). T-distribution Also provides a confidence interval for standard deviation for improvement Var(D).
   ii. The Student's t-distribution hypothesises the sample's descriptive limit for Leeds Elderly.

c. First improvement threshold [20% improvement, 16% improvement …] hypothesis which cannot be rejected for α = 0.05
   i. α type 1 error (likelihood of incorrectly rejecting null hypothesis) and β type 2 error (likelihood of incorrectly accepting null hypothesis where neighbouring improvement threshold is likely correct)
d. The critical number of participants required for satisfying an improvement threshold by a majority. Reject all improvement thresholds until number of present successful responses in the trial sample lies within $c_1 \; to \; c_2$ acceptance region for majority improvement.
   i. A closing statement on the experience by trial's majority which we reasonably expect to be in the confidence interval found in part b).

11 DS 9 FIN UC5 final report

11.1 DS Experiment report

11.1.1 User engagement report

The final number of confirmed users in DS FIN is UC5 are 152. Formal carers are 10 and elderly are 140, other OC pilot end users are 2. Baseline users are 134, intermediate users are 60 and final level users 51. DS FIN UC5 has exceeded its original target (100).

Table 202: DS FIN Total users recruited:

RUC	Elderly	Informal caregiver	Formal caregiver	Other stakeholder
05	140	0	10	2
TOTAL	**140**	**0**	**10**	**2**

Table 203: DS FIN Total number of facilities confirmed:

RUC	Private homes	Personal environments	Shared room in senior facility	Healthcare/Daycare facility	Other spaces
05	0	0	0	10	0
TOTAL	0	0	0	**10**	0

The facilities confirmed and installed are in total 10. Some of the facilities have been more active and been able to commit more users to pilot than others. The facilities are all located in Turku, which is the main pilot city for UC5. All of the facilities are operating under municipality of Turku and are elderly centres focusing either on supporting physical activity or supporting cognitive activity.

The elderly centres run activity programs for elderly living in Turku or surrounding areas. Elderly attend these programs based on volunteering, none of the centres are accommodating permanent inhabitants, but are open daily for daily activity programs. Inclusion criteria for recruitment is over 60 years old. No control groups were implemented in the trial design. The most successful pilots with largest number of participants have been those with dedicated activity groups, hosted by a physician (Kupittaa, Päiväkeskus, Ruusukortteli and Nivelyhdistys) The facilities confirmed during the entire project are:

- Kaarina Visiitti
- Ruusukortteli
- Meri-Karina
- Päiväkuntoutuskeskus
- SuperSeniorit
- Muistiyhdistys
- Nivelyhdistys
- Kupittaa vertaisliikuntaryhmä

- Aarnen talli
- Lehmusvalkama
- Strengthen your brain (Open Caller 1)

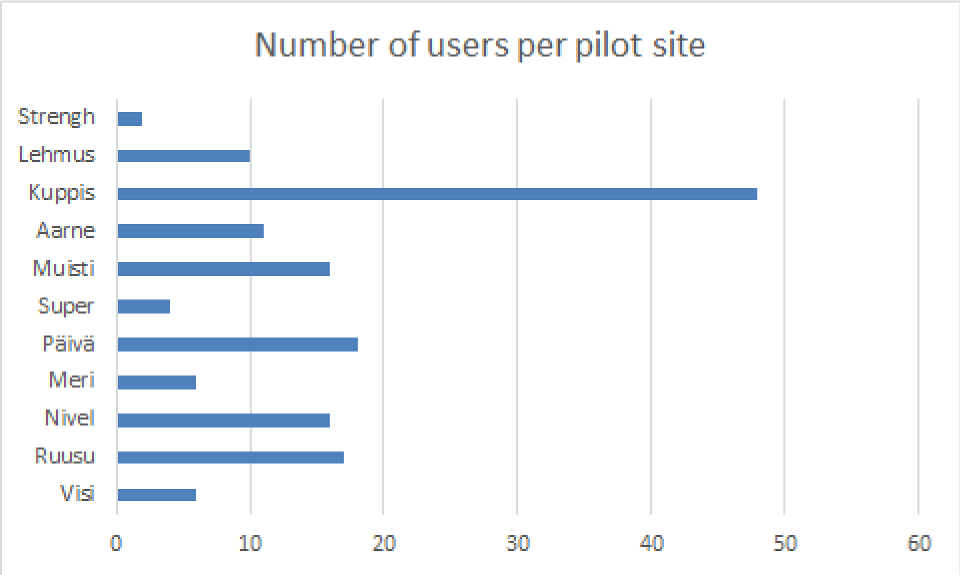


Figure 148 DS FIN Number of users per facility

11.1.2 IoT infrastructure deployment

The DS FIN UC5 total number of installations at individual facilities is 10. One IoT infrastructure serves one individual facility, i.e. multiple elderly centre users can use one set of equipment.

Number of devices per installation type include tv, laptop, Kinect motion detection camera and a tablet (in Kupittaa).

The percentage of installations completed over total targeted is 144%. Installations vs. targeted can be seen from figure below.

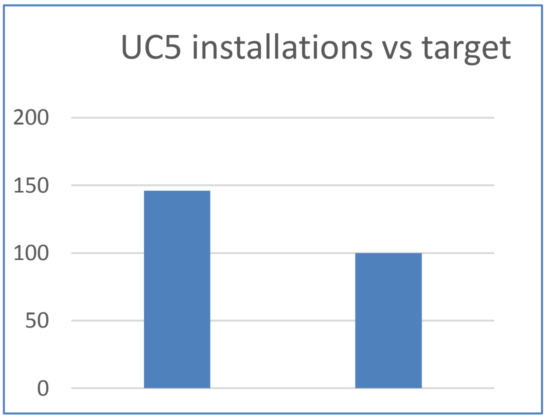


Figure 149 DS FIN UC5 installations vs. target

Table 204.DS FIN total number of installations completed

RUC	Private homes	Personal environments	Shared room in senior facility	Healthcare/Daycare facility	Other spaces
05	0	0	0	10	0
TOTAL	0	0	0	10	0

In DS FIN all installations are within RUC05 and the devices consist of a screen, laptop and tablet (optional), totalling in three user interface devices. In addition, there is a motion detection camera as environment sensor and cloud service as gateway.

Table 205. DS FIN Devices per categories installed

RUC	Gateways	Environment sensors	Wearables	Health / Alarm devices	Communication devices	User interface devices
05	1	1				3
TOTAL	**1**	**1**				**3**

In addition to Turku RUC05 experiments, DS FIN planned RUC05 experiments in Tampere, Saarikka. The IoT solution was planned to be a smartwatch for measuring body activities. Pulse used as first end to end data test and web portal for exercise planning.

Mobile device for past and real-time data illustration, reporting time use and reporting formalized feedback. IOT server for collecting data form all sources and data maturing and sync with Universaal server for distribution.

The functional description of planned Saarikka pilot

Caregiver plans exercise program for each patient by using eHoiva system. Caregiver visits patient home and brings needed devices for the exercise. The patient use the smartwatch for the planned session and caregiver use the mobile device to monitor real-time information collected from the watch and other devices. The caregiver and patient fill reporting and feedback forms provided by the mobile device at the end of the session. At the next time, information from earlier visits are used for improving the session and monitoring the progress.

Deployment

The original implementation needed to be redesigned from its original plans and many parts of the eHoiva implementation was needed to re-implement to support new hardware and integration with Universaal as a server.

2019:

Web based planning deployed.

Smartwatch. Test phase 2 devices.

Mobile device. Installed in 140 devices.

IOT server in operation.

2 Nurses trained.

2020:

Q2 planned experiment with real patients cancelled by client organization due to resources reallocation for COVID-19 time.

11.1.3 Experiment running report

11.1.3.1 Users participation

Experiments in DS FIN UC5 deployment is led by TUAS for the exercise promotion use case in Turku, with the technical support by GoodLife Technology and eHoiva. The equipment for this use case consists of 10 computer-based exercising games, tablet user interface, movement sensoring and cloud services, with additional screen if needed. The experiments are carried out mainly in elderly day centres in Turku.

Number of drop-offs by 30th of June is 27, which is approx. 17,7% of the total baseline users. The large number of drop-offs is because the pilot first started with independent and unsupervised training in elderly centres. This was not successful in the long term, as the users did not follow through the pilot after filling in the consent form and agreeing to take part to the pilot. As the centres were day centres with users participating in activities on voluntary basis, the staff and pilot personnel were unable to reach and contact the users.

Reasons for drop-offs	Number of drop-offs
Unsupervised training	27
Low motivation to commit	
Unable to reach and contact users	

The main reason for drop-off is the lack of commitment of the end user and the low motivation to keep playing towards intermediate and final stages (based on the interviews with formal caregivers of the centres). The volunteering-based participation has been identified as challenge and the contact to the drop-off users is not possible. Only in facilities with dedicated group activity and physician leading the activities, the drop-offs have not been happening.

Exercising with technology assistance and digital solution is not natural to elderly yet to keep them motivated and committed to the pilot for the entire pilot time (varying from 1 week to 2 months or more, to enable them to participate even with slower pace).

The COVID-19 outbreak led to very strict restrictions posed by the Finnish Government and forced all the elderly centres to close. Elderly people were to isolate at homes and not allowed to participate in activity groups or day centers programmes. This caused the UC5 deployment to a temporary 100% drop-off as all continuing end users could not access the pilot facilities after mid-March. The restrictions are estimated to ease by the end of July 2020, but it remains to be seen how actively the elderly dare to start participating again in the daily programmes of volunteer-based centres.

The usage levels have varied depending on the elderly centres operations (professional guided training in groups or unsupervised training independently) and depending on the commitment level of users. Generally, on the average, the usage levels were once per week. The total number of intervention weeks were on the average 8 weeks. Number of weeks played were on the average 5 weeks. The rest of the user participation KPIs are in the table below.

Table 206. DS FIN Local KPIs

Users participation KPI	Median	Average

Total number of exercise sessions performed (games played)	8	18,1
Average usage session lenght in seconds	85	102
Total number of intervention weeks	7	10,84
Number of weeks played	4	4,85
WAU: user activity in a week	0,77	0,73
MAU: User activity in a month	1,00	0,93
# of sessions per WAU	3,00	3,59
# of sessions per MAU	4,33	6,86
WAU / MAU ratio	0,77	0,76

11.1.3.2 Operational effectiveness

RUC	Number of issues	Description of main issues experienced
05	1	Main issues are related to the laptop not starting properly. In these cases, the facility contact person has made first a phone call, and if this has not resolved the issue, TUAS member of staff has visited the place within 24 hours to resolve the issue.

Average response time to end-user requests and inquiries have been within 12 hours. Incident management has been 100%. Average response time to technical/operational issues is within 12 hours. The number of solution upgrades have been one, with the initial exercise system was updated as GoodLife Kiosk system with additional physiotherapy movements and game offering with simpler user interface.

11.1.3.3 Use case exchange report

Use case exchanges were organized with DS MAD. DS FIN borrowed a set of equipment to DS MAD which was piloted in living labs. The set included laptop and Kinect, DS MAD used their own screen. Exchange was part of RUC_05.

DS MAD sent a cognitive game tablet to DS FIN. This was tested in Muistiyhdistys facility in October-November 2019 with approx. 10 users. Some of the users found the cognitive games difficult to play, but some enjoyed them. The service was new to DS FIN, it deployed RUC_06.

11.2 Local evaluation report

11.2.1 Goal of local evaluation: primary and secondary endpoints

The goal of local evaluation is to evaluate the usage and usability of the exercise promotion system within the end users. Evaluation was organized in Global Baseline, Global Intermediate and Global Final stages. DS FIN product in the UC5 (Exercise Promotion) consists of 10 computer-based exercising games, tablet user interface, movement sensoring and cloud services. Installation sites are care centres and care associations as well as leisure and activity groups for elderly in Turku (Finland) area.

The primary endpoint is that the exercising with IoT games is a positive experience for elderly people (target > 70% of participants). Users consider the device has increased their daily activity, and improved their balance and muscles. The secondary endpoint is that the user satisfaction and experience are higher or lower in certain installation sites, with specific characteristics of IoT games, and player engagement and retention rates (session length, frequency) and with certain type of players (demographics, abilities).

DS trial experience is, that devices bring joy to daily life and exercising of elderly yet require support of a trainer or a group to be fully adopted, adapted and used.

11.2.2 Local KPI collected

Local KPIs collected in DS FIN are:

Table 207. DS FIN UC5 local KPIs

Local KPI			Median	Average	N
Total number of exercise sessions performed (game plays)	**Game data. Number of sessions exercised with game play.**	Increased activity	8	18,1	
Average usage session lenght in seconds	**Game data. Average session lenght out of all sessions**	Average IoT session length	85	102	
Total number of intervention weeks	**Game data. First session minus last session / 7 days**		7	10,84	
Number of weeks played	**Game data. (calculated as weeks with sessions)**		4	4,85	
WAU: user activity in a week	**Game data. Weeks when the user has played per total intervention weeks**	Weekly IoT usage of patients	0,77	0,73	
MAU: User activity in a month	**Game data. Same as WAU but months. Months when the user has played per**	Monthly IoT usage of patients	1,00	0,93	

	total intervention months				
# of sessions per WAU	**Game data. WAU sessions: Number of exercise sessions per week actually played**	Engagement in use.	3,00	3,59	
# of sessions per MAU	**Game data. MAU sessions: Number of exercise sessions per month actually played**	Engagement in use.	4,33	6,86	
WAU / MAU ratio	**Game data. For individual user: Probability that the user exercises every week in a month. Overall: Portion of monthly users who uses weekly**	Retention in use	0,77	0,76	
Churn ratio (# of users who have started but stopped using)	**Manual: The user has not returned the ending questionnaire or has stopped otherwise, where 1=true.**	IoT drop-off users			27
% of users satisfied at Final (UTAUT)	**UTAUT: Average of Performance Expectancy and Attitude scores at Intermediate phase (8 questions valued from 1 to 7, where 7 most satisfied and over 4 is positive)**	Total satisfaction	77,0 %	4,95	
Relative time saved in rehabilitation care work	**CarerQoL additional questions for DS9: Device saves my time, improves work quality, decreases costs of care work**	Gains on the rate of rehabilitation		2,7	
Subjective satisfaction ratings	**UX Questionnaire: Questions 1-11. Likert 5 scale (1-5), over 3 is positive**	Overall satisfaction on the device	87,9%	3,96	
Subjective rating about increased activity	**UX Questionnaire: Questions 12-13. Likert 5 scale (1-5), over 3 is positive**	Increased activity	47,4 %	3,59	

Subjective rating about improved balance	**UX Questionnaire: Question 14. Likert 5 scale (1-5), over 3 is positive**	Improving balance	70,2 %	3,94
Subjective rating about stronger muscles	**UX Questionnaire: Question 15. Likert 5 scale (1-5), over 3 is positive**	Stronger lower limb muscles	49,1 %	3,61

On average, elderly participants used the device over 10 weeks and played exercise games each week more than 3 sessions. The WAU measurement (0,73) means the probability (73%) that participants return to play every week. Almost all users will play at least monthly (93%). A bit less than the half of the participants answering to the UX questionnaire thought that the device helps them improve their lower level muscles (49,1%) or increase their physical activity (47,4%), however, 70,2% of them consider the device improving their balance, which is highly important in the target group.

11.2.3 Local evaluation protocol

Local evaluation protocol consists of collecting data with standardized questionnaire UTAUT (average of Performance Expectancy and Attitude scores > 4.0). Basic statistics methodology is used for analyzing the primary end point. Correlations and related statistical tests will be used for testing significance regarding the secondary end point.

The evaluation was conducted in three phases:

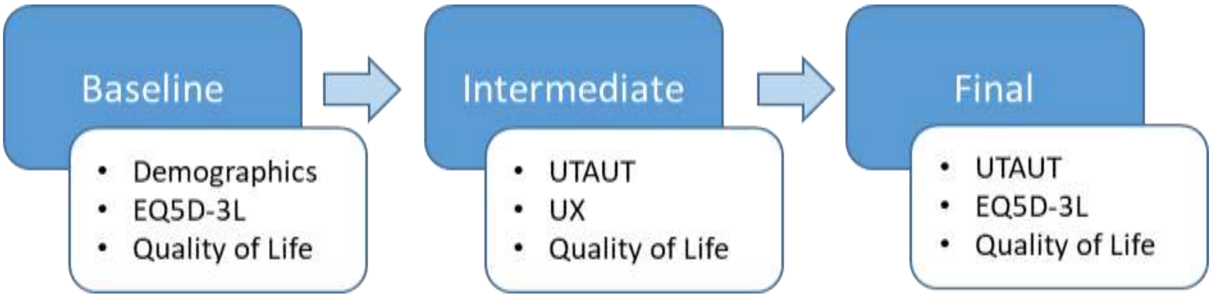


Figure 150 DS FIN local evaluation protocol

Before starting the pilot, all users were asked to sign a consent form and in the Baseline phase users were asked to fill in three questionnaires: demographics information, EQ5D-3L and Quality of Life.

In 4-24 weeks into the pilot, users were asked Intermediate phase questionnaires; UTAUT, UX and Quality of Life.

In 8-48 weeks into the pilot, users were asked Final phase questionnaires; UTAUT, EQ5D-3L and Quality of Life.

UTAUT questionnaire, answered in 7-point Likert scale, consists of 31 questions in 8 constructs: performance expectancy (PE), effort expectancy (EE), attitude (AT), social influence (SI), facilitating conditions (FC), self-efficacy (SE), anxiety (AX) and behavioural intention (BI).

UX questionnaire, answered in 5-point Likert scale, consists of 18 questions in 3 constructs: user's experience during the play (EXP), game usability and fit for player's training use (USAB), game effectiveness in player's training practice (EFF).

11.2.4 Analysis of results

Mean scores, which are well above 4 and 3, in both UTAUT and UX questionnaires indicate that games were very well accepted and that participants experienced the games positively in their exercising context. In UTAUT, mean scores of attitude (AT) and effort expectancy (EE) dimensions are the highest. Similarly, UX mean scores show that elderly participants enjoyed playing and found the body controls appropriate.

Despite considering the games usable, elderly did not feel very skilled or successful during the game play; probably because of the novelty of the training practice, possibly low number of play sessions with each game and only a little background in gaming. The reason lies as well in the unclear and unarticulated goals of games ("Should I crash or avoid balloons in this game?"). Low mean scores in AX and SE indicate that elderly are not afraid of using the gaming device, yet they do not believe they could be able to use the device with or without help. The explanation is that the device use (registration, login, game launch) was always aided by someone else (students, health care personnel etc.). Behavioural intention (BI) suggests that elderly are willing to play and plan playing during the next months, but not daily. Construct reliability in UTAUT is good, except in FC due to one question in a negative tone ("The device is not compatible with my other devices").

11.2.5 Conclusions

We have recorded play session data for each participant, which will open new insights into experiences and acceptance at personal and group levels. At the research instrument level, the tailor-made UX constructs could complement the original UTAUT model revealing some fundamental determinants of elderly acceptance of exercising games.

According to the UTAUT score 4,95 is above 3, the total satisfaction is positive.

With the longitudinal data collection, the ACTIVAGE project continues identifying changes in participants' quality of life due to IoT devices. According to DS FIN UX questionnaire, users identified their increased activity and improved balance as positive (above 3).

Overall, the importance of effectiveness research is in high demand. Alongside of ACTIVAGE pilots and the Large Scale Project, TUAS has been involved in nationally funded other effectiveness studies regarding exergames and their ecosystems.

11.3 Local sustainability plan

11.3.1 Product/Service Definition

Rehabilitation and exercising are known to be rather boring or involuntary activities, especially among those people who are in need of this kind of activity. In gamified rehabilitation and exercising we are assuming that if the activity itself is less like normal exercising the interest and motivation to start the activity is higher. There are lots of challenges because this approach is very different than the generally expected way of assigning physical therapy or exercising.

Created gamified rehabilitation experience is produced with GoodLife Kiosk trainer and TUAS exergames. Later on, these products are referred as Kiosk and Exergames. Both are independent solutions but using commonly designed architecture, and each have specified role in the service.

Usage of exergames in Kiosk can be either personalized or targeted. In personalized usage the user experience is personally designed for only one user and in targeted usage the experience is designed so that it is suitable for segmented user groups, such as elderly people with limited movability and balance.

The personalized experience is demanding for the resources. It requires many things from the rehabilitation service provider and from the patient. Firstly, the user of Kiosk and Exergames and the rehabilitation service provider needs to have therapist/patient relationship. In this scenario, the user usually has a rehabilitation plan with a patient profile / EMR record. The Kiosk is compatible with one of the most used exercise library backend and rehabilitation planner software. This backend is called Physiotools Online (www.physiotools.com). Therapist is required to plan the content per user and create an NFC tag to be used for identifying the user when the patient visits in any of the service providers Kiosks.

The targeted usage requires similar resources and architecture than personalized usage, but the difference is that the content configuration is done once and the updated when needed. In this scenario the service provider can think the Kiosk and its Exergames as a "popup" station for occasional visits from a known user group.

The Kiosk and Exergames architecture support mixed usage of these two cases, but the requirements and effort to track of personal activity in the ACTIVAGE project added some extra challenge when recruiting the service providers and their patients.

The overall product (the combination of Kiosk and Exergames) is scalable and can be adapted into many use cases. The Kiosk can be used without Exergames and the content can be standard physical therapy exercises. The Exergames can be used as independent set of enjoyable exercising games and be delivered without the Kiosk and the Physiotools connection. Also, the Kiosk itself can use other external content than TUAS Exergames. Working example of this was the open callers integration.

	Service provider	Kiosk	Exergames	Backend
Deployment phase	Kiosks are configured EMR system.	Kiosk hardware are deployed	Exergames are installed to Kiosk	Data pipeline configurations are made
Preparation phase	Therapist uses Physiotools to create content			
Initialization phase		Patient uses NFC (personalized usage) or chooses an Exergame from a list of available games (Targeted usage)		
Exercising phase		Kiosk launches the Exergame with incoming configuration data parameters	Exergame starts and uses the incoming data parameters to prepare the gaming experience. (Duration, repeats, difficulty etc.)	
			Exergame encourages and controls the user experience and measures the Game specific activity.	

			When the target activity is reached, the Game stores the measured activity into output parameters and closes	
Data collection phase		Kiosk is notified when the Exergame is closed. Kiosk reads the output parameters and sends them to backend		Backend receives the Exergame session and do the necessary data alignment and forwards the data to AIOTES environment

11.3.2 Market Analysis

Finnish institute of statistic released a report in 2019 that revealed that digital gaming has quadrupled during the last 25 years[63]. Increase itself is not a surprise, but the what is notifiable is that the biggest growth is not in stereotypic gaming age group under 30 years. The biggest growth is in the age groups over 44 years and now more than 20% of men and woman over 65 state that they have played digital games.

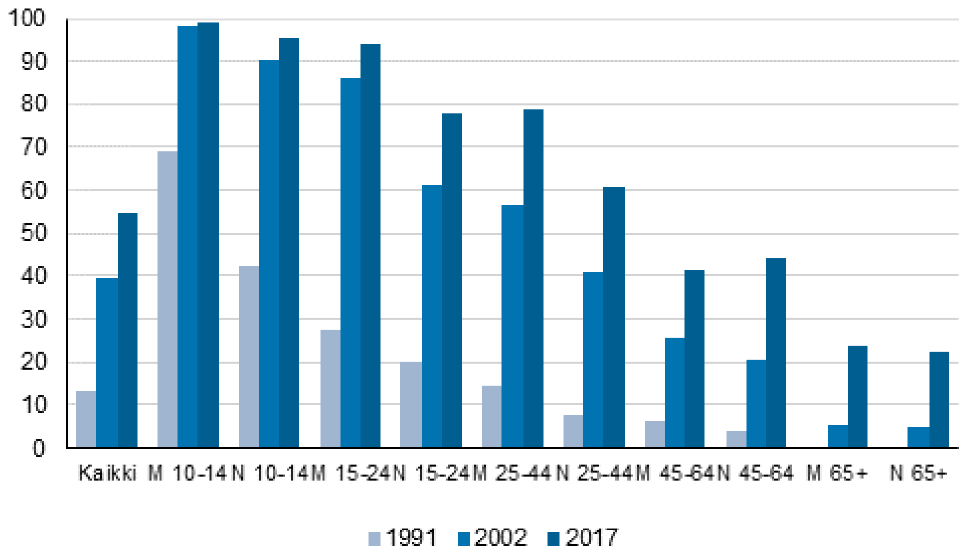


Figure 151: DS FIN digital gaming trends

Digital games can be played on many platforms, but when inspected how the elderly people had played, they behaviour is a bit different than in the other age groups.

63 *Suomen virallinen tilasto (SVT): Vapaa-ajan osallistuminen [verkkojulkaisu]. Digipelaaminen 2017. Helsinki: Tilastokeskus [viitattu: 30.7.2020]. Saantitapa: http://www.stat.fi/til/vpa/2017/02/vpa_2017_02_2019-01-31_tie_001_fi.html

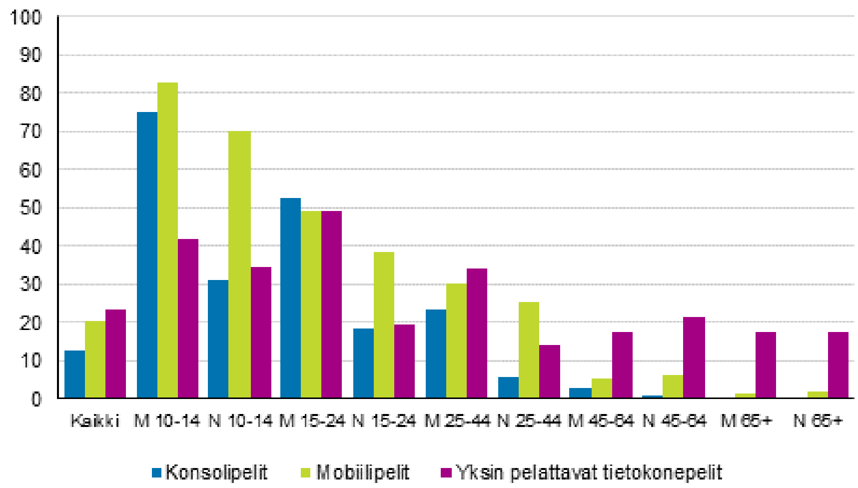
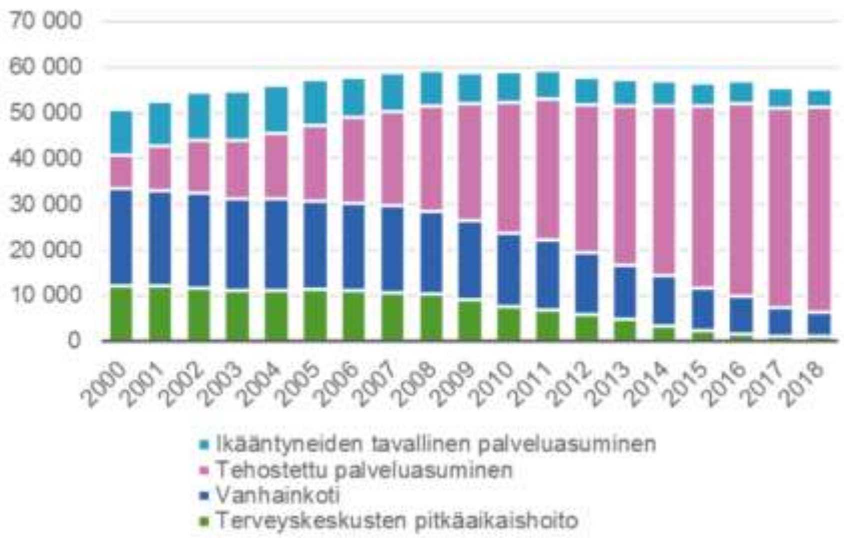


Figure 152: DS FIN preference of gaming platforms by age (Blue: Console games, Green: Mobile games, Red: Single player computer games)

Age groups after 45 states that the most played type was single player games on a computer. What is significant that other type of gaming barely exists. Based on these statistics, Exergames and Kiosks targeted on elderly people are operating on the right platform and have general acceptance that gaming exists.

Official statistics of Finland shows that about 20% of people aged 75 and above are included in some format of assisted living[64]. The graph below shows that the group is "Tehostettu palveluasuminen = Intensive sheltered housing" has grown the most. It is a form of living where a person is living in facilities where personnel is present 24/7 and services and care can be provided on needs based. The Intensive sheltered care services are provided by both public and private sectors.



From top to down:

- Standard sheltered living for ageing people

64 https://thl.fi/fi/tilastot-ja-data/tilastot-aiheittain/ikaantyneet/sosiaalihuollon-laitos-ja-asumispalvelut

- Intensive sheltered housing
- Residential care for older people
- Hospitalized long-term care

Out of these living options Intensive sheltered care is the best for Exergaming services. It has at least following advantages:

- Someone to operate and support the usage of devices
- Initial investment made by the service provider, but eventually the cost is embedded into a activity or similar service fee that the residents pay.
- Number of users per installation is high compared to assisted living at home
- In most private intensive sheltered housing services "daily rehabilitative activity", is part of the baseline service. One could assume that Exergames could be part of this kind of activity.

The Exergaming has its best potential as a preventative activity and an exercise format for people who would not normally participate into traditional indoor/outdoor activity.

11.3.3 Competition/sector Analysis;

11.3.3.1 Competition profile analysis

It is important to understand that preventative or recreational physical activity among the elderly people is not in the top priority list for the service providers. The health and mandatory routines come always first. In times like COVID-19 and with constant pressure of not having enough resources, the people working on in the hands-on service level often state that there is simply no time to give into the physical activity. Even if they would like to pay attention to it and they know the upside of active elderly. In homecare the instructed activities are more linked into daily chores not into exercising itself. However, in the official national instructions for home care in Finland, it is identified the importance of preventing fall downs and as one key aspect of that work is the balance. In cases where the physical activity exercising is in sufficient level, it is happening because of an active individuals and/or popular service.

For these reasons the number one competitor is the absence or neglect of physical activity.

Since to main competitor is more like challenges of the processes or situations rather than other solutions, the approach to win this "competitor" is more solution focused than outplaying strategy. Our solution should strengthen, or at least is not remove, the elements that are liked or appreciated and make sure we don't add any danger, burden or inconvenience to elderly or people who work with them.

11.3.3.2 SWOT analysis

Table 208. DS FIN UC5 SWOT analysis

STRENGTHS	WEAKNESSES
Exergaming is new and exciting thing Content is dynamic and updated remotely.	Hardware dependencies and requirements of high-end computers. Complexity of setup. Many things can influence into smooth operability and uptime.

Content can be localised. Not only the translation, but culturally and example use different content for children User experience can be either personal or targeted Compatible with Physiotherapy EMR Physiotools. Therapist can assign exercises and see the outcome results from the same environment. Fits into general process of therapist assigning a rehabilitation plan where part of the activity is completed by exergames. Socially activating. Something to do with fellow residents or with grandchildren. Remote access to deployed hardware.	Requires a stable and continuous Internet connection. Clothing and lightning have big influence how well the 3D camera can identify user movements. Onsite support might be difficult to organise
OPPORTUNITIES	**TREATHS**
Saves resources with independency. Easy to justify the costs. Service is available 24 / 7 after the Kiosk is installed. Therapist need only for content configuration, not for daily usage. High-end hardware enables to expand the usage with new technology. Ie. Virtual or augmented reality. Product is sold as a service.	Microsoft Kinect technology is not mainstream and may be discontinued. When working with cameras, there is always the opportunity of exploitation and security breach. Legislation of medical devices. The longer the device is in use, the bigger is the users need for variety and progression of the content. This means continuous expenses in content development. Intensive and continuous usage of hardware causes heating that might shorten the expected lifetime.

11.3.4 Value proposition and Targeted Customers

Table 209. DS FIN UC5 value proposition canvas

Value Proposition Canvas

Value map			Customer profile: Intensive sheltered housing	
Gain creators	**Product & Services**		**Gains**	**Customer Job(s)**
		FIT	**Elderly living** in sheltered housing are: - Using Exergames and Kiosk service - Paying from the service - Enjoying of usage - Are benefitting of the usage **People working** in sheltered housing are: - Capable to instruct usage - Think that the service helps them to do their work better. **Organisation** providing sheltered living service are: - Appreciating the fixed cost of scalable service. - Shifting pressure away from the personnel into technology. - Able to resell the service to residents	**Elderly living** in sheltered housing are: - living their life - expecting to get help and being taken care of. - trying to keep physically and socially active **People working** in sheltered housing are: - Capable to instruct usage - Think that the service helps them to do their work better. **Organisation** providing sheltered living service are: - Appreciating the fixed cost of scalable service. - Shifting pressure away from the personnel into technology. - Abel to resell the service to residents

Pain relievers			Pains	
			Elderly living in sheltered housing are: - Entitled to have physical activity in their daily life. - Are already paying for such activities but might not be getting proper service. - Would no doubt benefit of such activities - also in need of social activity and weekly routines. **People working** in sheltered housing are: - working with low resources - are not tech savvy by nature - working with tight schedules in slowly moving environment - sometimes resistant to new things. **Organisation** providing sheltered living service are: - responsible of operating in high service level - responsible of making profit or covering the costs. - having constant change in residents and personnel.	

11.3.5 Strategy for local sustainability

11.3.5.1 Open Data strategy (as much space as needed)

At this time there are no datasets generated during the project that we plan to make it available in the open data repository.

11.3.5.2 Continuation strategy

We will continue with the elderly centres that are willing to continue. The only precaution is that the actual operation of the equipment and possible user experience (data?) colletion must be independently conducted by the elderly centre.

11.3.6 Replication strategy

Not at this point. Possible replication initiatives depends on the scaleup considerations and research groups' strategy, most of all additional funding opportunities.

11.3.7 Scaling-up strategy

Not at this point. Possible scaling up is under consideration with the research group responsible of DS FIN at TUAS.

12 DS 10 LIS final report

12.1 DS Experiment report

12.1.1 User engagement report

The NDS LIS – CUF4IoTAHA pilot was conceived upon current AHA initiatives of Jose de Mello Saúde (JMS) and focused on providing added value to patients by monitoring the follow-up period in the comfort of their homes. Having in mind a patient-centred care strategy powered by ICT technology, a centralized, flexible platform was developed to be easily accessed by all stakeholders. The platform's interface and features was defined based on the end-user needs and preferences, and the improvement of the efficiency of healthcare professionals' work, enabling them to make better decisions supported by appropriate real-time collected data. Considering our pilot had a direct applicability in CUF's homecare delivery services, we have decided to address five interconnected and dependent Reference Use Cases (RUCs) to all recruited user.

The COVID-19 pandemic status impacted significantly on the project activities planned towards recruitment and engaging patients and caregivers into CUFIOT4AHA. Despite contingency measures, no results were achieved for starting the pilot at elderly's homes during the Pandemic Emergency Status. After this period (May/June), with a >2 months project deployment delay, NDS LIS had difficulties in resuming activities with the planned recruited patients and caregivers. In particular, difficulties with staff planning, compounded by the holidays period, made it difficult to accelerate during the Summer. At the end, our pilot managed only to complete 1/3 of total targeted recruited patients. Despite the project end on September 2020, the NDS LIS consortium will continue with the pilot, namely by recruiting additional patients beyond the project official dates.

Table 210: DS LIS Total users recruited per category :

RUC	Elderly	Informal caregiver	Formal caregiver	Other stakeholder
RUC01	30	30	60	0
RUC02	30	30	60	0
RUC03	30	30	60	0
RUC05	0	0	0	0
RUC10	30	30	60	0
RUC11	30	30	60	0
TOTAL	**30**	**30**	**60**	**0**

Once JMS has a AHA services that provides quality of life to their patients through the extension of their services at their clients' home, NDS LIS was deployed at older people private homes/apartments.

Table 211: DS LIS Total number of facilities confirmed

RUC	Private homes	Personal environments	Shared room in senior facility	Healthcare/Daycare facility	Other spaces
RUC01	30	0	0	0	0
RUC02	30	0	0	0	0
RUC03	30	0	0	0	0
RUC05	0	0	0	0	0
RUC10	30	0	0	0	0
RUC11	30	0	0	0	0
TOTAL	**30**	**0**	**0**	**0**	**0**

In order to monitor and have feedback of patient experience with CUFIoT4AHA solution, CoLAB created a Patient journal:

12.1.2 IoT infrastructure deployment

On NDS LIS we have deployed 5 UCs among 30 older people users at their homes, testing the data integration imported from 60 wearables and devices with the purpose of delivering an IoT-powered, integrated solution for the Healthcare services, home professional assistance and informal caregiver support in order to improve the quality of life of elderly people. To this end, we have validated the following results from each UC implemented:

1. **Daily activity monitoring** – Connection between IoT sensors (Garmin bands) and a AHA remote monitoring platform was developed and demo tested in the user group. The platform is now able to continuously analyse the data and present the information for an optimal follow-up by healthcare professionals. The dashboards have been validated by the healthcare professionals.
2. **Integrated care for Chronic Conditions** - Supporting seniors by helping them to share their health status continuously with different healthcare professionals at different levels (particularly between primary and secondary care, and between secondary care and rehabilitation and social support) and by promoting active communication between the different caregivers (both formal and informal).
3. **Health parameter monitoring** – Provided formal caregivers with integrated non-invasive solutions for remote patient monitoring, especially regarding vital signs (such as blood pressure, pulse/heart rate, temperature, pain level), important biometric (e.g. weight) and analytical parameters (e.g. glycaemia). 25% of targeted users had Type 2 Diabetes and could benefit from the usage of IoT-enabled devices for helping in self-management and data sharing with providers.

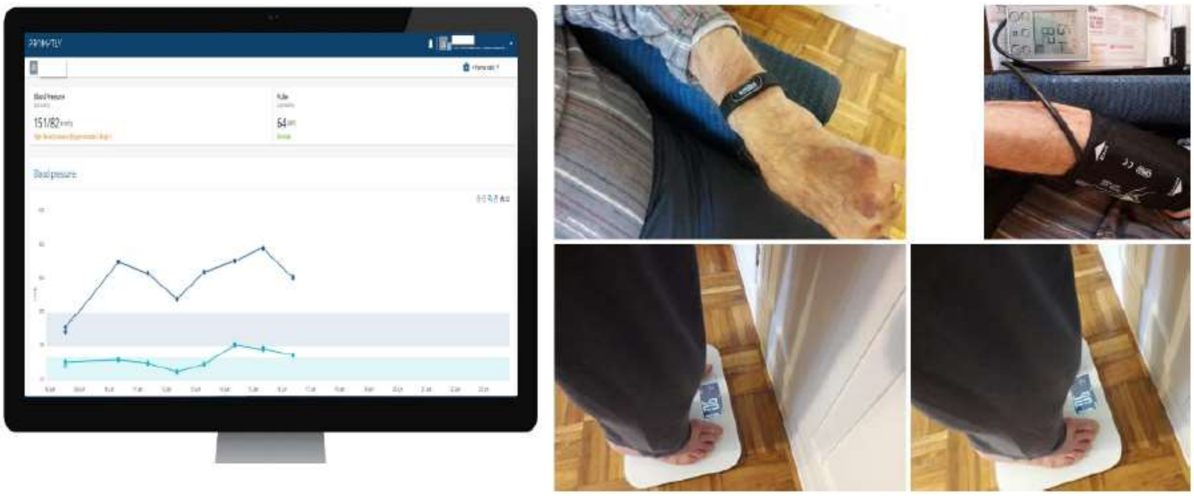


Figure 153: DS LIS CUF4IoTAHA Health solution monitoring

4. **Exercise Promotion** – This UC was not implemented due to the Pandemic.
5. **Notification of abnormal situation** – Formal or informal caregiver were notified about abnormal activity, including health parameters monitored, outside of normal range, and alerted if assisted senior had low activity.
6. **Support for caregivers** – Informal caregivers had access, through the platform, to their older family members current status, care needs, medication adherence and prescriptions.

Table 212: DS LIS distribution of installation per type of environment

RUC	Private homes	Personal environments	Shared room in senior facility	Healthcare/Daycare facility	Other spaces
RUC01	30	0	0	0	0
RUC02	30	0	0	0	0
RUC03	30	0	0	0	0
RUC05	0	0	0	0	0
RUC10	30	0	0	0	0
RUC11	30	0	0	0	0
TOTAL	**30**	**0**	**0**	**0**	**0**

Table 213: DS LIS devices installed per category

RUC	Gateways	Environment sensors	Wearables	Health / Alarm devices	Communication devices	User interface devices
RUC01	*0*	*0*	*30*	*30*	*0*	*30*
RUC02	0	0	30	30	0	30

RUC03	0	0	30	30	0	30
RUC05	0	0	0	0	0	0
RUC10	0	0	30	30	0	30
RUC11	0	0	30	30	0	30
TOTAL	**0**	**0**	**30**	**30**	**0**	**30**

12.1.3 Experiment running report

12.1.3.1 Users participation

Table 214: DS LIS Number of drop-offs by 30th of June.

Reasons for drop-offs	Number of drop-offs
Staffing difficulties due to Covid-19	70 caregivers

Table 215: DS LIS number of users in operation by 30th of June.

RUC	Elderly	Informal caregiver	Formal caregiver	Other stakeholder
RUC01	15	15	60	0
RUC02	15	15	60	0
RUC03	15	15	60	0
RUC05	0	0	0	0
RUC10	15	15	60	0
RUC11	15	15	60	0
TOTAL	**15**	**15**	**60**	**0**

12.1.3.2 Operational effectiveness

Table 216: DS LIS operation issues experienced

RUC	**Number of issues**	**Description of main issues experienced**
RUC01	1	Setting up of the Garmin Connect (Garmin's API that connects with our platform) application with the end-users/patients/caregivers smartphone, using Bluetooth connection.
RUC02	0	No issues to report

RUC03	2	Connectivity problems between the IoT devices (that use 4g as a mean of communication) and the CUFIOT4AHA platform due the lack of network at the patient's home; Some end-users reported problems when trying to understand the messages that were written in the Garmin Smartband, due to the lack of technical knowledge.
RUC05	N/A	This UC was not implemented due to COVID-19
RUC10	0	No issues to report
RUC11	1	Use of communication tools between formal and informal caregivers and older citizens for facilitating coordination was not implemented

During the project, CUFIOT4AHA had a dedicated clinical (e.g. head of nursing) and technical support team that was continuously available for end-users to communicate with via email and phone helpdesk.

The technical support team was available (either by email, phone or in person) to successfully address all the technical/operational issues. This parameter was not formally measured, but an average response time of 1 working-day was the standard to provide a working solution to the technical/operational issues that were raised during the testing of the solution.

Nr of solution updates/ upgrades (per RUC):

- UC 1- Daily activity monitoring: 2 updates
- UC 2- Integrated care for Chronic Conditions: 1 update
- UC 3- Health parameter monitoring: 4 updates
- UC 4- Exercise Promotion: N/A
- UC 5- Notification of abnormal situation: 0
- UC 6- Support for caregivers: 5 updates

12.2 Local sustainability plan

With CUF4IoT project, the partners have created a framework that allows to measure 3 type of indicators in the CUF AHA home care program:

1. Impact on Quality of Life (QoL) - By measuring Patient's quality of life with PROMs; recording daily physical activity through assessment of functional independence using the Barthel Scale; number of visits to the hospital or rehospitalizations; and reduction of days off work of older people relatives due to the platform assessment.
2. Sustainability – CUF, being a consortium member is also a key leader in the industry who validated the solution and supports the creation of a business model for the use of AHA in Portugal. This is a framework that allows cost-utility analysis, per quality-adjusted life year that provides an assessment of users' experience (PREMs) that also dropouts possible dissatisfaction with the service.
3. Innovation and Growth - We've uptake the use of IoT technologies by integrating successfully their open source components, included from the Marketplace, and making it friendly use without being aggressive to comfortable environments (seniors homes) which will lead, beyond the project, to the emerging of new business opportunities, potentiated by the demonstration of project results.

Targets defined and expected to achieve regarding these key performance indicators, apart from having been reachable, are not yet possible to quantify in percentage improvements.

Despite all the constraints suffered due to external factors that had impacted on number of users we intended to have involved in our pilot deployment, we have managed to reach project main objective of building an integrated IoT platform for the empowerment of AHA and the delivery of homecare services. This key concept to demonstrate the impact of IoT technologies for the integration and monitoring of home-based services across the continuum of care through a single platform, accessible to all stakeholders, was proven with the achievement of 5 main drawn objectives:

1. To deliver an IoT-powered, integrated solution for the Healthcare services, home professional assistance and informal caregiver support that improves the quality of life of elderly people in Lisbon, by promoting active and healthy ageing (AHA) and allowing senior citizens to live longer and more autonomously in their homes
2. To contribute to the expansion of the ACTIVAGE Large Scale Pilots and the AIOTES ecosystem in a new EU country - Portugal -, with the validation of the framework in a large health system in Lisbon
3. To ensure interoperability of the IoT technology deployed in the current project in order to potentially extend the current JMS AHA services portfolio by integrating at least one of the AHA applications soon to be available in the ACTIVAGE marketplace
4. To support the long-term sustainability and efficiency of healthcare systems, by improving patients' (and other users, e.g. caregivers) confidence and trust to sustain their long-term use of seamless IoT tech, avoiding unnecessary re-hospitalisations and emergency department admissions, or the need for assisted living facilities.
5. To contribute to the ACTIVAGE vision of fostering the EU's economic growth while accelerating innovative value-based business models that make use of IoT-backed technology.

CUF, a renowned brand in Portugal leading healthcare services in the private sector, in the field of AHA, provides services of medical, nursing, physiotherapy and psychology at home that consists of an integrated clinical and/or home-based support solution for patients that are unable - temporarily or permanently - to live fully independent. This existing ecosystem allowed to have a 'quasi' user-centred design (UCD) methodology in the conception and development of the AHA solution. The partners interacted with the elderly, their relatives and healthcare professionals - end users - to influence the way the product was shaped and improved in its usability.

Beyond the project, we will carry out product development roadmap based on continuous research, embracing further feedback and enabling quantitative validation of the impact of our solution (and its iterations) in users' lives.

The remote homecare program may be expanded to other cities in Europe. Within the private health system CUF, the tech provider intention is to scale-up the pilot for a mid to long-term large-scale home care activity which will validate the technology impact on AHA services in several areas:

- A value-based healthcare delivery with performance-based payment models and risk-sharing agreements with payers (both public and private);
- Broaden base of users with longer engagement periods with IoT-enabled devices embodying a relevant value proposition to AHA cohorts seeking greater capacity of self-management of certain medical conditions (in orchestration with healthcare providers);

- Service bundles (re)design with multiple price point offers and possible add-ons (not only to directly address end users but also to healthcare payers);
- Cost-optimized high standard care with increased operational efficiency rooted in cutting edge remote monitoring technology.

12.2.1 Value proposition and Targeted Customers

Table 217 DS LIS Lean canvas

ACTIVAGE Lean Canvas				
Problem	**Solution**	**Unique Value Proposition**	**Unfair Advantage**	**Customer Segments**
AHA Home services still too dependent on Human resources physical presence which compromise service scale-up due to difficult balance between service/revenue. Having an effective solution where users play a crucial role in its digitization conception to address clinical needs and engagement Improve patient remote monitoring and follow-up with measurements of patients feelings and emotions	Support AHA healthcare providers with continuous monitoring through stream data, allowing reduction of timing consuming of healthcare professionals Building a User-Centred Design IoT platform for the empowerment of AHA and the delivery of homecare Patient-reported outcomes measurements (PROMs) for measurement of therapeutic success	Ability to include additional streaming of data – patient-reported outcome measurements (PROMs) which are increasingly regarded as an important information for patient remote monitoring and follow-up.	Similar solution to CUFIoT4AHA can be replicated but the promoters have a background experience advantage that can hardly be copied by competitors, by offering to this solution additional stream of data (apart from IoT devices data) - patient-reported outcome measurements (PROMs)	

Existing Alternatives	Key Metrics	High-Level Concept	Channels	Early Adopters
Mismatch between the care services and data flows - Health home care services are currently being delivered by weekly physical visits of healthcare personnel to elder people homes, to collect and monitor their clinical status Main existing digital solutions collecting data from elder patients are just recording data (not streaming) with no real user's understanding of its value IoT technological solutions do not capture patients' moods, feelings and sensations that are crucial data to cross with clinical parameters for proper diagnoses.	Daily Activity – monitoring walking speed/mobility and sleep quality. Integrated care for Chronic Conditions - helping senior in sharing their health status continuously wit healthcare professionals and caregivers Promoting of exercise - exercise guides to improve elderly's physical and mental condition Notification of abnormal situation – Flag and notify the formal or informal caregiver about abnormal activity	CUFIoT4AHA will enhance the capability of Healthcare providers, with home care services, to capture, integrate and analyse IoT data for the benefit of patients and their families. It is a cloud base platform, built under a User-Centred Design, to support patients' surveillance while reducing operational costs to providers	Product Website Shareholders Network Social Media AHA related events - Summits, workshop sessions, fairs and other initiatives	

Cost Structure	Revenue Structure
Fixed costs - Product Development costs Variable costs – Customers' customized costs Customer acquisition costs – Marketing, quoting, negotiation and contracting costs Distribution costs – Platform-as-a-service (PaaS - includes APIs services to connect different devices and 3rd party services, unlimited licenses to access and use the platform by healthcare professionals in the care teams; patient engagement and communication tools (e.g. emails; sms; mobile prompts; etc.); multi-language feature; all version upgrades; service maintenance; data storage.), training and implementation costs Hosting – Web server provider	

People – Technical supporting team, Product manager, Data scientist and Sales manager	

Table 218. DS LIS value proposition canvas

Value Proposition Canvas				
Value map			Customer profile: Intensive sheltered housing	
Gain creators	Product & Services		Gains	Customer Job(s)

Cost efficient - Cost reduction from shifts of hospitalisations to home care; continuous remote follow-up avoiding regular physical visits to patients; costless communication module between patient and caretakers; reduces the burden agendas of doctors and nurses **Valuable** - Data analysis boosted with AI for research on patterns diagnosis (prediction and identification of pathologies) Secured - Anonymisation of patients' data **User-Centred Design Platform** - Tested and validated with Key Opinion users	Our product is a single platform, accessible by all stakeholders, that interconnects collected data form senior patients: their daily activity; Integrated care for Chronic Conditions; Health parameter monitoring; Exercise Promotion; Notification of abnormal situation; and Support for caregivers CUF4IoTAHA platform enhance the participation of patients, their caregivers and nurses in the digitization of follow-up needs, having been built under a User-Centred Design methodology where the assessment of its users' experience played a crucial role in the adoption and evaluation of the implemented solution		Integrated healthcare delivery systems 24/7 Maintenance and customer service Operations running smoothly Security data compliance with GDPR and national legislations Trust and Reliability data Close communication among users Dissemination of methodology to boost excellence in healthcare delivery Measurement of Outcomes (clinical results and quality of life)	Our customers are seeking for Value-Based Healthcare services, willing: - To cost-optimize high standard care with increased operational efficiency - to improve value in AHA, given the fragmentation of care and poor outcomes (eg low satisfaction, high comorbidities burden without monitoring) - to improve retention and reduce the dropouts of patients due to dissatisfaction with the service - To have a value-based healthcare delivery with performance-based payment models toward healthcare payers
Pain relievers			**Pains**	

cost-optimization and operational efficiency Data accuracy 24/7 Senior's engagement with self-management of their clinical condition			High operational costs due to personnel needed to deliver home services Low retention rate for home-based services after inpatient care Lack of an integrated IoT-based platform for following-up care	

12.2.2 Strategy for local sustainability

The technology promoter intends to license the IoT platform to healthcare providers (hospitals) and health systems (private and public) under a fee per user (target user engaged in the platform), which decreases with users' volume (economies of scale effect). This Platform-as-a-service (PaaS) includes APIs services to connect different devices and 3rd party services, unlimited licenses to access and use the platform by healthcare professionals in the care teams; patient engagement and communication tools (e.g. emails; sms; mobile prompts; etc.); multi-language feature; all version upgrades; service maintenance; data storage.

12.2.2.1 Open Data strategy

CUFIoT4AHA will not adopt an Open Data strategy, which was not planned for the project. As a clinical site and the underlying data sensitivity, the Home Care Services provided by CUF has a restricted data privacy policy, which does not allow to share patients' clinical data into an open data repository.

The patient informed consent incorporated on CUF4IoTAHA platform did not preview any data sharing beyond the frameworks already defined in the scope of the project

12.2.2.2 Continuation strategy

NDS LIS has a planned continuation strategy for the project, in particular the extension of the enrolment for the 4Q 2020 to complete the impact assessment. Therefore, NDS LIS will keep pursuing project goals and objectives beyond the project execution regarding results dissemination and exploitation. One of the partners is interested in developing a stronger business line around IoT for AHA , ie. there is a business opportunity for improving value in AHA, given the fragmentation of care and poor outcomes (eg low satisfaction, high comorbidities burden without monitoring) in many countries, which comes as a business opportunity to the CUFIOT4AHA platform.

Seniors patients are a population that frequently have informal caregivers, who need assistance for taking care of their loved ones and are easily "engageable" (ie. it is an interesting population for piloting communication tools). This is an important challenge NDS LIS has experienced within the pilot, and that may be further explored according to shared interest among consortium stakeholders. Furthermore, in terms of clients, there is an initial interest from clients/business leads, and hence, the need for stronger impact analysis and cost-benefit calculations. Promptly, while the consortium technology owner of the solution for commercial purposes, may further grow its dedicated team to manage, develop and market this IoT integrated platform.

12.2.2.3 Replication strategy

We expect to replicate our IoT AHA services beyond national borders and Europe. Our fist markets to approach, due to already existing customers and commercialization channels, apart from Portugal, are Spain, France, Brazil and South Africa. These last two offer a significant scale up potential due to their large dimension with a growing demand for such a solution, namely by private healthcare providers who want digital tools to help support its AHA customers, but also to follow-up and monitor elderly patients at home after discharge.

We believe that our presence in these markets may be a competitive advantage for future product scale-up, which we will try to take advantage replicating the CUFIoT4AHA pilot with some potential customers we are already in contact – Servicio Murciano de Salud (Spain) in Murcia, Bradesco Saude (Brazil) and Mediclinic (South Africa).

Our capacity to deliver and scale up this IoT integrated platform is anchored to our experience in selling healthcare solutions globally and in managing and delivering large eHealth projects. Within our customer base, we have global pharmaceutical companies in Europe, large insurance companies in South Africa and the largest academic medical center in Latin America.

12.2.2.4 Scaling-up strategy

Our target users are elderly patients that need an IoT platform that integrates all their monitoring data for (self)managing their care and connecting them to providers. Our customers are healthcare providers and health systems (public and private). We will build on ongoing partnerships with means to access the AHA cohort related associations and medical societies to increase product visibility in target populations. Stakeholders networks will play an important role to the commercial scaling-up of CUF IoT4AHA solution which we intend also to optimize on services and data possible to collect to improve analytical features and predictive models.

Regarding clinical data, apart from patient-reported outcome measurements - PROMs, already integrated in our solution we will integrate patient-reported experience measurements - PREMs for additional data evaluating patients emotional and psychological status. As per remote monitoring devices, the current collected data regarding patients activity (steps, distance, geolocation,…), user information and feedback, communication patterns between patients and caregivers, caregiver remote management information (Alarms, alerts and notifications), and sensors activation, batteries and connectivity status, can be easily enlarged or adjust to new stakeholders needs, when willing to interact with AHA patients suffering from specific chronic diseases.

13 DS 11 SOF final report

13.1 DS Experiment report

13.1.1 User engagement report

Table 219: DS SOF Total users recruited per category :

RUC	Elderly	Informal caregiver	Formal caregiver	Other stakeholder
RUC01	35	5	3	6
RUC03	23	7	5	9
RUC04	13	3	4	4
TOTAL	**71**	**15**	**12**	**19**

Table 220: DS SOF Total number of facilities confirmed

RUC	Private homes	Personal environments	Shared room in senior facility	Healthcare/Daycare facility	Other spaces
RUC01	10	0	0	0	2
RUC03	10	0	0	0	2
RUC04	10	0	0	0	2
TOTAL	30	0	0	0	6

Other spaces: Living labs

13.1.2 IoT infrastructure deployment

Table 221: DS SOF distribution of installation per type of environment

RUC	Private homes	Personal environments	Shared room in senior facility	Healthcare/Daycare facility	Other spaces
RUC01	10	0	0	0	2
RUC03	10	0	0	0	2
RUC04	10	0	0	0	2
TOTAL	30	0	0	0	6

Other spaces: Living labs

Table 222: DS SOF devices installed per category

RUC	Gateways	Environment sensors	Wearables	Health / Alarm devices	Communication devices	User interface devices
RUC01	12	120	5	10	20	30
RUC03	12	10	40	70	10	30
RUC04	10	0	10	10	10	15
TOTAL	**34**	**130**	**55**	**90**	**40**	**75**

Due to COVID19 restrictions the deployment has reached a 75% of the target.

13.1.3 Experiment running report

13.1.3.1 Users participation

Table 223: DS SOF Number of drop-offs by 30th of June.

Reasons for drop-offs	Number of drop-offs
COVID19	31
Logistic	3

Table 224: DS SOF number of users in operation by 30th of June.

RUC	Elderly	Informal caregiver	Formal caregiver	Other stakeholder
RUC01	18	3	2	5
RUC03	12	5	4	7
RUC04	7	2	3	4
TOTAL	37	10	9	17

13.1.3.2 Operational effectiveness

RUC	Issue experienced	Number of issues
RUC01	Misuse of sensor/device/interface	5
RUC03	Misuse of sensor/device/interface	4
RUC04	Wrong interpretation of data	2
	TOTAL	11

- The average response time to end-users' request has been 2 h.

- 90% of issues have been successfully solved.
- During the execution of the experiment 6 updates of the solution have been released

13.2 Local sustainability plan

This document is the Exploitation and Sustainability Plan for the AGEWARE project as part of the ACTIVAGE project. This report provides an insight in the options to bring the AGEWARE services to the market as a Service to end users (B2C) but also as a Service towards other elderly care organisation (B2B). This report also contains underlying analysis covering:

1. a market analysis (limited to Bulgaria),
2. a CANVAS business analysis,
3. a 36-months roadmap for new services that need to be developed,
4. an overview of potential sources and a plan to attract finance for the business plan.

In order develop a sustainability and exploitation plan for the results of AgeWare and the ACTIVAGE project, the CANVAS methodology was followed:

1. **The Value Proposition** in which we executed an analysis of the market needs via interviews with customer groups and defined specifications for value-adding elderly care services. Based these interviews functional specifications were extracted and critical hypothesis and KPI were defined. Via a living lab configuration, in combination with Sofia Patronage and Sofia Sunny Home, the new AgeWare living-environment for 50 elderly were tested and the KPIs were measured. The results were used to define the most feasible value proposition for initial exploitation.
2. The **Customer Segments**, the **customer relationships** and the **customer channels** are analysed in the dedicated market research activity. The target market we are addressing are elderly and people who need extra service in their daily life due to illness or other causes. We focus on the Bulgarian market and analysed 2 other cities (Leuven Eindhoven) in order to investigate option for expansion these services in other countries.
3. **Key Partners, Key Activities and Key resources** are being analysed, that are needed to serve the several customer segments with the AgeWare value proposition. Depending on several conditions, a different combination of key partners and key resources are needed. They key activities might stay them same. It is for instance expected that if we target public elderly care organisation as B2B customer, that we need to serve them via a 'public' AgeWare organisation that has the right resources. Similarly, when we target private elderly care organisations we might need to serve them via a 'private' AgeWare organisation..
4. **Cost Structure of the AgeWare Services** are being analysed. It is based on the combination of IT infrastructure, resources and activities that is needed to deliver the service B2B and B2B2C.
5. **Possible Revenue Stream from the AgeWare Services** are being analysed and based upon the value added to the elderly and the service organisation that support elderly. More details can be found in paragraph

13.2.1 Value proposition and targeted customers

13.2.1.1 The value proposition

The AGEWARE project developed following products:

1. An AGEWARE Platform, containing several services (see table 2) with UIs for several customer segments (see 3.3)

2. An AGEWARE homebrain controller, to connect domestic and private IOT devices

3. AGEWARE private IOT devices

4. AGEWARE domestic IOT devices

5. AGEWARE training material for several customer segments

Details of these products & services can be found in Table 225:

Table 225: DS SOFAGEWARE products

COMPONENTS/ EQUIPMENT/ TOOLS			DESCRIPTION
websites & platforms	**DSSOF-WP1**	AgeWare Platform (**AWP**)	the platform collects all data from 1. personal devices of the elderly, 2. devices in the house of the elderly, 3. from questionaires and connects to data-analysis services and connects to all stakeholder user interfaces.
	DSSOF-WP2	AgeWare Website (**AWW**)	The website is connected to the AWP and contains the user interface for each stakeholder. It can be accessed via smarthomes, tablets or via a TV, connected to the Homebrain. The website will be used to take daily interviews or questionairs about the wellbeing of the elderly person. The personal file, results from questionairs and data from devices can be viewed via the website and accessed by the stakeholders that are allowed.
	DSSOF-WP3	AgeWare WEBsite (**AWWEB**)	Website is targetting the wider audience and inform them about the AgeWare and ACTIVAGE projects.
	DSSOF-WP4	AgeWare Personal Schedule (**AWPS**)	this is a service running on the AWW in which a personal schedule defines what daily action the elderly has to do. For instance pills to take, measurement to do etc… . The agenda will be determined by the elderly incombination with the health-worker, doctor or nurse.
	DSSOF-WP5	AgeWare Personal Folder (**AGPF**)	The AgeWare personal Folder contains personal
Personal devices	**DSSOF-PD1**	AgeWare Home Brain (**AWHB**)	Central control unit (**Raspberry PI**) in the house that connect personal devices. Some alarm routines are perated in the homebrain. All data is stored in a personal cloud, accesable via AWW.
	DSSOF-PD2	fall detector	Personal Fall Detector unit that detects falling and has an alarm button. PFD is connect wireless to the AWHB. When fall is detected necessary stakeholders will be notified and action can be taken.
	DSSOF-PD3	heart beat detector	Personal HeartBeat measurement connected to the AWHB or to a smartphone. This measurement needs to be done according to the AGPS.

	DSSOF-PD4	blood pressure sensor	Personal blood pressure measurement connected to the AWHB or to a smartphone. This measurement needs to be done according to the AGPS.
	DSSOF-PD5	Sugar level sensor	Personal sugar level pressure measurement connected to the AWHB or to a smartphone. This measurement needs to be done according to the AGPS.
	DSSOF-PD6	Sensor for Oxigen in blood level in periferial blood	Personal oxigen level pressure measurement connected to the AWHB or to a smartphone. This measurement needs to be done according to the AGPS.
	DSSOF-PD7	Weight sensor	Personal weight measurement connected to the AWHB. This measurement needs to be done according to the AGPS.
	DSSOF-PD8	smart phone	the smartphone can connect to the AWW.
Home devices	**DSSOF-HD1**	TV	It is a normal TV that can be connected to the AWHB and gives access to the AWW. The interface to communicate with the website can be a mouse or a remote control.
	DSSOF-HD2	camera/microphone	The camera with microphone can be connected to the AWHB and can be used for phonecalls or video calls via the AWW on the TV.
	DSSOF-HD3	tablet	The tablet can connect directly or via the AWHB to the AWW.
	DSSOF-HD4	flood detector	flood detector will be connect to the AWHB and generates an alarm when flood is detected and when installed the main water valve will be closed. Relevant stakeholders will be informed about the alarm.
	DSSOF-HD5	smoke detector	smoke detector will be connect to the AWHB and generates an alarm when smoke is detected and when installed the power-swith to the kitchen will be switched off; Relevant stakeholders will be informed about the alarm.
	DSSOF-HD6	temperature sensor	Temperature sensors in one or more rooms that also can, when installed, control the heater-units in each room.

The AgeWare Products are being used to create the following services.

Table 226: DS SOF AGEWARE services

ID	Title	Targeted customer
DSSOFSRV1	intake interview assisted person	caregiver
DSSOFSRV2	daily questionairs	Caretaker; support: caregiver
DSSOFSRV3	daily personal schedule (DPS)	Caretaker; support: caregiver

DSSOFSRV4	video call to Caretaker Communication Centre (CCC)	Caretaker; caregiver
DSSOFSRV5	video call to family & friends	Caretaker
DSSOFSRV6	fall detection	Caretaker; support: caregiver
DSSOFSRV7	health measurements	Caretaker; support: caregiver
DSSOFSRV8	shopping list	Caretaker; support: caregiver
DSSOFSRV9	adjust the temperature in the house/room	Caretaker
DSSOFSRV10	adjust the air quality in the house	Caretaker
DSSOFSRV11	set automatic energy saving program	Caretaker

The AGEWARE products and Services can become Pain Relievers for some customers as given in the following table

Table 227: DS SOF AGEWARE Customer Pain Relievers

Customers Segments	Pain Relievers	How to stimulate
Care-takers	Improve social and physical wellbeing. Get improved support in specific areas (disease, shopping, cleaning etc..) through improved communication with care givers.	Good easy & attractive user interface; Low cost Value added services need to be developed.
Public Care-giving organisations	Get better insight in social and physical wellbeing and specific needs of caretakers Better manage the supply of services to the demand of caretakers.	Easy user interface; Make KPI's transparent; Give tools to improve ad manage KPI's
Private Care-giving organisations		
Volunteer Care-givers		
Doctors & hospitals	Get detailed overview on general health parameters of caretakers Get detailed overview on specific health parameters connected to conditions of a caretaker Enable online consults Enable post and after hospitalization health measurements & treatments	To be refined.

In order to become attractive for Caretakers we need to develop value adding services. One of the services that we want to include in the new version of AgeWare in a wellbeing and fitness services. For that we seek collaboration with TopSportsLab from Leuven in Belgium, which develop a fitness support system for top-sporters. We agreed to translate this service into a service for elderly that want to stay fit. Other value added services will be in the field of entertainment, education and hospitality.

Table 228: DS SOF AGEWARE Customer Pain Creators

Customers Segments	Pain Creators	How to decrease
Care-takers	No experience with smart devices, electronics & online services	Simple easy user interface. Training via caregivers.
Public Care-giving organisations	No experience with smart devices, electronics & online services	Training
Private Care-giving organisations	No experience with smart devices, electronics & online services	Training
Volunteer Care-givers	No experience with smart devices, electronics & online services	Training
Doctors & hospitals	Another	Training

13.2.1.2 Customer segments

Following customer segments can be identified:

1. The elderly population in Bulgaria
2. The public and private caregiving organisations
3. The volunteer caregivers
4. Doctors & Hospitals

13.2.1.3 Customer relationships & channels

Table 229: DS SOF AGEWARE Customer relationships

Customers Segments	Relationships
Care-takers	Currently no direct relationship. Link will be established indirectly B2B2C via the other customers segments. Possibly we can reach this target group via targeted advertisements (TV, Radio, Newspapers) which will create demand for AgeWare type of Services. Via their local Care-giver organisation they can ask for this kind of support.
Public Care-giving organisations	Currently we have a relationship with Sofia Patronage. They execute the AgeWare pilot and are potentially the pilot customers for the TRL9 AgeWare solutions. Their experience can function as showcase for other customers in this segment. These organisations we will address via: • the networks of SDA. • Directly via cold-calling the market analysis results • Advertisements as described before.
Private Care-giving organisations	Currently we have a relationship with Sunny Home. They execute the AgeWare pilot and are potentially the pilot customers for the TRL9 AgeWare solutions. Their experience can function as showcase for other customers in this segment. These organisations we will address via: • Directly via cold-calling the market analysis results • Advertisements as described before.

Volunteer Care-givers	Currently no direct relationship. These volunteers, we will address via: Advertisements as described before.
Doctors and Hospitals	Currently no direct relationship. These organisations we will address via: • the networks of SDA. • Directly via cold-calling the market analysis results Advertisements as described before.

13.2.1.4 Key Partners & Key Activities

Current organisation involved in the AgeWare project are:

Partners	Activities
SDA:	manage the overall AgeWare project and manage the political connection to the city of Sofia
Virtech:	manage the technical part AgeWare project: design & build the pilot AgeWare platform including IOT-devices to measure health and wellbeing parameters.
Sofia Patronage:	To test and validate the AgeWare platform as part of their public Care-giving services towards individual caretakers, living in their homes in Sofia.
Sunny Home:	To test and validate the AgeWare platform as part of their private Care-giving services towards caretakers living in the Sunny Home facility in Sofia

We still miss Hospitals and doctors that could use the health parameters to give online services to reduce risks of hospitalisations

For the exploitation of the AgeWare project results we need

Partners	Activities
SDA:	To manage the political connection to the city of Sofia, the role out of the services in Sofia and other cities in Bulgaria.
Virtech:	manage the technical part AgeWare project: design & build the pilot AgeWare platform including IOT-devices to measure health and wellbeing parameters.
Jibe.Company:	To translate the pilot AgeWare platform results into an open scalable, GDPR-compliant Service platform that enables the NewCo to execute services towards the potential customers of the new AgeWare platform.
TopSportLab	To supply added value service to the AgeWare Services: fitness & wellbeing services via daily tasks (with or with a professional trainer)
NewCo*	A New organisation created by the stakeholders in the AgeWare project to exploit the results of the AgeWare project. Create a business model & plan (part of the Ageware Project) Attract capital to implement the business plan

	Main parts of the NewCo organisation will cover: Development & Maintenance of a TRL9 level AgeWare platform Training of future customers to use the AgeWare platform Call-centre services to support all B2B and B2B2C customers of the AgeWare Platform
Sofia Patronage:	To test and validate the AgeWare platform as part of their public Care-giving services towards individual caretakers, living in their homes in Sofia.
Sunny Home:	To test and validate the AgeWare platform as part of their private Care-giving services towards caretakers living in the Sunny Home facility in Sofia

**Newco can be (1) an organisation that focus on the public B2B customer segments, (2)a new organisation that focusses on the private B2B customers segments or (3) a new organisation that focusses on the B2B2C customers segments or (4) a combination.*

13.2.1.5 Key Resources

In the current Key Resources we are focused on how to bring the AgeWare Products and Services in to the market. In first instance The Key Resources

Partners	Key resources
SDA:	Resources to endorse the AgeWare solutions to Sofia and other cities.
Virtech:	Resources to support Jibe.Company as architect and developer of the pilot AgeWare platform including IOT-devices to measure health and wellbeing parameters.
Jibe.Company*:	Resources to design, develop and maintain the pilot AgeWare platform results into an open scalable, GDPR-compliant Service platform that enables the NewCo to execute services towards the potential customers of the new AgeWare platform.
TopSportsLab*:	Resources to supply BigData analysis and personal feedback on health, wellness and fitness
NewCo	General Manager Financial Manager Call centre Manager Technology manager Marketing & Sales manager Workforce to execute all activities.
Sofia Patronage:	Pilot customer to test, validate & showcase the AgeWare platform as part of their public Care-giving services towards individual caretakers, living in their homes in Sofia.

Sunny Home:	Pilot Customer to test, validate & showcase the AgeWare platform as part of their private Care-giving services towards caretakers living in the Sunny Home facility in Sofia

**Discussion with these organisations have been started.*

13.2.1.6 Cost Structure

The main elements in the cost structure will be based on capital expenditures (CAPEX) and operational expenditures (OPEX).

- CAPEX consists out of following elements:
  - Development of the TRL9 AgeWare platform.
  - Office equipment
  - Call Centre equipment
  - Development of training material for several customer types.
- OPEX consists of following elements:
  - Staff
  - Management Team
  - Support Teams
  - Sales Team
  - Call Centre Team
  - Training staff
  - Sales team
  - Call Centre Team
  - Office cost
  - Rent, energy cost, etc
  - Insurances
  - miscellaneous
  - Advertisement cost
  - Third Party cost
  - Accountant & Lawyers
  - Technology Service Providers (Jibe/TopSportlab/Call Centre….)

The cost will depend on the amount of services that we need to supply. Growing amount of customers also means that we will have to invest along in office and call-centre equipment. Training material and the AgeWare platform will not need more investments.

This also will be the case for the OPEX. The more customers we serve, the larger will be the call-centre staff the bigger will be the office cost and the more support we need from technology suppliers.

In a excel financial model we analysed first financial models. The CAPEX and OPEX (see table below) are estimated based on a B2B2C service model for a newco. This newco will operate and manage all the AGEWARE platform infrastructure and supports B2B customers, like Sofia Patronage and Sunny Home, and B2B2C the customers(elderly) of Sofia Patronage and Sunny Home and their staff via a e-health call centre. This call-centre will monitor (via Medical IOT-devices) and contact the elderly (via daily/weekly questionnaires or via spontaneous social calls each 1.5 day, 10 minutes) and if needed the social-worker, medical-staff of Sofia Patronage/Sunny Home or family will be notified.

The operational cost are based on implementation in Bulgaria/Sofia with mainly Bulgarian staff and Bulgarian wages. We did not take into account that we would also service other countries in the Balkan or in the rest of Europe. In that case the staff would need to be multilingual and possibly the staff should have be targeting countries with their 1st -language. This certainly would raise the cost.

Another important element will be the investment cost that needs to be done to bring the current AGEWARE platform from TRL5 to TRL8/9 in order to ensure a professional & smooth service. I translated these costs, including other CAPEX cost in the model as leasing cost per month. This is not possibly not feasible for the involved software engineering companies, but it still has to be discussed. Office and call centre equipment is based on a minimum start-set, but with grow with the number of staff that we need to cover growth the B2B2C customers.

The operational cost is depending on the number of elderly that have to be B2B2C connected. This can be seen in the graph presented below. At the start the cost per elderly user would be around EUR700 but with volume it can go down to EUR9.77 (break-even) at 25,000 users and to EUR7 with more than 300,000 users.

Table 230: DS SOF AGEWARE Cost structure estimation

CAPEX	people	cost/p	cost	time	lease* cost per month
1. Development of the TRL9 AgeWare platform.			€ 200,000	24	€ 8,750
2. Office equipment	5	2000	€ 10,000	60	€ 188
3. Call Centre equipment	5	2000	€ 10,000	60	€ 188
4. Development of training material for several customer types.			€ 25,000	60	€ 469
TOTAL CAPEX			**€ 245,000**		€ 9,594
**interest rate for lease*	5%				
		operations			
	people	cost/p/m/ elderly	cost/m		
OPEX					
1. Staff					
a. Management Team	3	5000	€ 15,000		
b. Support Teams	1	1200	€ 1,200		
c. Sales Team	1	3000	€ 3,000		
d. Call Centre Team		600	€ 3,000		
	5				
2. Training staff					
a. Sales team	1	100	€ 100		
b. Call Centre Team	5	100	€ 500		
3. Office cost			€ -		
a. Rent, energy cost, etc	1	1000	€ 4,000		
b. Insurances	1	100	€ 100		
c. miscellaneous	1	1000	€ 1,000		
4. Advertisement cost	1	10000	€ 10,000		
5. Third Party cost			€ -		
a. Accountant & Lawyers	2	1000	€ 2,000		
b. Technology Service Providers (Jibe/TopSportlab/Call Centre….)		5%	€ 10,000		
c Technology provider (services, updates, sharing after year 1)		2%			
TOTAL OPEX per month			**€ 49,900**		

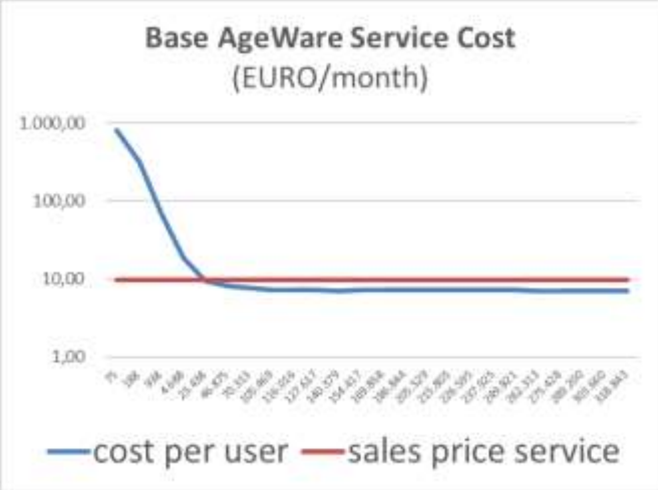


Figure 154: DS SOF estimated service cost per user

Not taken into account in this model are the investment cost needed to improve the personal living environment of the elderly. We estimate the cost at 600 euro per home with 1 elderly.

smart health support	needed instrument per user
watch	130
scale	80
datahub	100
virtech platform incl. call centre & smartTV	200
implementation	90
	600

Figure 155: DS SOF estimated cost per home

If we also deliver these solutions that it means a cost of 600 euro at the start of the service for each home. This could also be delivered to the elderly home via a leasing (5% interest) & maintenance (5%) contract for 4 years for EUR16.25 (ex. VAT).

13.2.1.7 Revenue Streams

Private income streams

Revenues streams will come from the B2B and B2B2C services. In the model we currently anticipate a revenue of EUR9.77 per month (ex. VAT) for the service described in 13.2.7. With this revenue level we need minimum 25,000 B2B2C customers connected in order to have a sustainable business.

REVENUE			
sales			
equipment lease	VAT	0%	16.25
cost of equipment lease			(16.25)
service contract			5%
services cost			7.82
margin		25%	1.95
	VAT	*0%*	-
COST SERVICES			***9.77***
SERVICE COST FOR CARETAKER	*VAT*	*0%*	*26.02*

For the revenue on the equipment we only process the lease cost, but we add a service contract for 5% over the lease-value and add 25% margin, resulting in a revenue stream of EUR9.77/month/per connection.

Other income streams

Together with the needed equipment in the home, the cost for the B2B2C elderly could grow up to EUR26.25 per month (ex. VAT). This could become too high for some of the Bulgarian incomes. Therefore we also looked at alternative income streams. These could be generated from parties that have an indirect financial benefit from the introduction of an AGEWARE-service in the living-environment of the elderly. These are parties are public and private health insurance companies that benefit from the fact in general the AGEWARE-service will:

- Prevent diseases and lower the number of expensive hospitalisations
- Empower the elderly citizen to be longer in self-control of their own lives and thus
- Lower the cost of social-support from organisations such as Sofia Patronage or Sunny homes.

Studies from the Worldbank and the WHO show that cost for the growing elderly population for the society will grow from 9%[65] towards 20% of the GDP in the coming 20 years and these cost have to be paid by private and public insurance companies. For Bulgaria this would mean EUR8,753.- per year and for a country as the Netherlands even up to EUR48.843.- per year. In the quick number exercise below, one can see that the AGEWARE service including equipment costs EUR31.50 per month and that would be 9.6% of the cost for elderly in BG today and 4.3% in 20 years when the cost grows towards the 20% of GDP.

If the AGEWARE services are able to reduce the elderly cost with 40%, than still the public and private insurance companies could increase their profit when they pay 100% of the AGEWARE services.

Bulgaria			
GDP BG		67,926.00	million US
		0.91	
GDP BG		62,144.14	million EUR
age related cost	20%	12,428.83	million EUR
per elderly		**8,753**	**euro/y**
		729	**euro/month**

AGEWARE SERVICE		26.25	
20% VAT	€	5.25	
	€	31.50	4.3%

Due to the COVID19 problems we could not validate the AGEWARE system in the real life of elderly

An essential step for the AGEWARE team is to have these real test and showcase the potential of cost reductions.

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[65] See pg 20 in report: Silver Economy - Market Analysis; May/June 2020; C. Gogova, J.H. Houf

13.2.1.8 P&L analysis

From the Revenue and Cost overview we created a cashflow and P&L analysis. The conclusion is that the business model is very viable and the profit per month could grow to EUR1.2 million per month (see figure below). With the bigger number of users, we also expect we can further optimise the price per month for end-users.

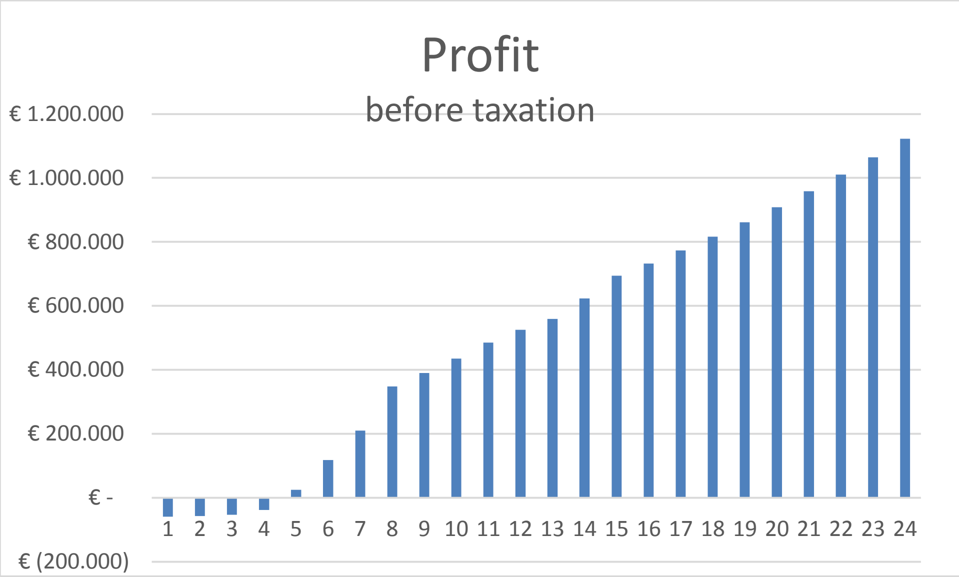

Figure 156: DS SOF profit per month projection

From the same analysis we also learn that we need to bridge the period till break-even. For that we need approximately EUR210.000,- and if we include the development cost for bringing the AGEWARE platform to TRL8/9, then this project would need, with a 15% an investment of EUR470,000.-

minimum investment		€	206,962
AGEWARE TRL8/9		€	200,000
contingency	15%	€	61,044
Total		**€**	**468,007**

Based on an interest rate of 10% the cashflow from this business shows a NPV of EUR2,570,410.-, a 20% share for an investor seem feasible.

13.2.1.9 Summary of the CANVAS analysis

With an elderly population of 200.000 people in Sofia and 1.2 Million in Bulgaria it seems feasible to find the first 25,000 customers that can afford the basic cost of the system and connected services.

This seems even more feasible when we can tap a potential income stream from public or private health insurance companies, as they have potentially an indirect profit from the improved health and lower disease related costs through the introduction of the AGEWARE services. In other countries, such as Germany or Switzerland, we already notice that up to 30euro/month is paid for AGEWARE type of services without the equipment cost, by governments and insurance companies.

13.2.2 Open Data strategy

Table 231: DS SOF Dataset measurements

Dataset name	DS11.01.Measurements
Data identification	
Data set description	

Data types at Deployment sites

	name	type	Size in bytes	Minimum significance	Max significance	Explanation
	DSid	TEXT	2	0	65536	id of the DS sending data
	DevType	CHAR	1			Type of device sending data, e.g. Pulsoximeter – 1, ECG – 2, Blood Pressure - 3
	EventTime	TIMESTAMP	4			Local time of occurrence of the event
	pulse	CHAR	1	20	256	
	saturation	CHAR	1	40	100	
ECG	DSid	TEXT	2	0	65536	
	DevType	CHAR	1			
	EventTime	TIMESTAMP	4			
	Lead	CHAR	1	1	12	Drain number according to where the body electrodes are located
	BinData	BINARY	144000	-	144000	The data taken from the ECG for a period of 10 seconds
	FileName	char	20			ECG image file name. The file is sent separately with upload
Fall and emergency call sensor	DSid	TEXT	2	0	65536	
	DevType	CHAR	1			
	EventTime	TIMESTAMP	4			
	AlertType	CHAR	1	0	256	0 - Fall; 1 - Emergency call; 2 - Call; 3 - others
Security camera	DSid	TEXT	2	0	65536	
	DevType	CHAR	1			
	EventTime	TIMESTAMP	4			
	FileName	char	20			Camera image file name. The file is sent separately with upload
Stethoscope	DSid	TEXT	2	0	65536	
	DevType	CHAR	1			
	EventTime	TIMESTAMP	4			
	FileName	char	20			Name of the sound file with the stethoscope recording. The file is sent separately with upload
Blood pressure monitor	DSid	TEXT	2	0	65536	
	DevType	CHAR	1			
	EventTime	TIMESTAMP	4			
	CharData	VARCHAR	4000			128 historical recordings of the ECG apparatus

Source (i.e. which device?)	*See above*
Partners responsibilities	
Owner of the device	Sofia Development Association
Partner in charge of data collection (if different)	Virtech

Partner in charge of data analysis (if different)	SDA, Virtech
Partner in charge of data storage (if different)	Virtech
Standards and metadata	
Info about metadata (Production and storage dates, places) and documentation?	Work in progress
Standards, Format, Estimated volume of data	A preliminary decision has been taken
Data exploitation and sharing	
Data exploitation (purpose/use of the data analysis)	AHA services, medical services, integrated comfort/wellbeing services
Data access policy / Dissemination level (Confidential, only for members of the Consortium and the Commission Services) / Public	Example text: Data to be open for third parties – two universities and some other third parties, on a GDPR compliant basis
Data sharing, re-use and distribution (How?)	Yes, we'll re-use the data in several other projects and initiatives in a GDPR compliant manner
Embargo periods (if any)	
Archiving and preservation (including storage and backup)	
Data storage (including backup): where? For how long?	Yes, in the infrastructure of Virtech. A cloud provider is under consideration

13.2.3 Continuation strategy

From the Exploitation and Sustainability analysis we can draw following conclusions:

1. The AGEWARE platform is working and validation is tested within the development team and their family members, due CIVID19 and no accessibility to elderly users and social- and healthcare-workers.
2. The feedback from these users is positive. The functionality seems adequate but the UI/UX needs to be improved.

3. The added value (more and longer independent living; healthier; more social contacts and less social isolation) that the system brings to individuals is positively received and seen as added value, but real validation in the field in necessary.
4. The added value (more cost-efficient and customer-need-oriented service in less time) for social and health-workers seem to be there, but real validation in the field in necessary.
5. The business model looks feasible and expandable.
6. The monthly cost for the service including VAT EUR12.- and for the needed hardware improvements EUR19.50 seems feasible some future customers but very high for many in Bulgaria. For West-European Countries this seems financially feasible. Therefore extra revenue streams are necessary in Bulgaria.
7. Extra revenue could come from public and private health insurance organisations as they have indirect benefits (lower health cost) from the use of AGEWARE services by their elderly customers. Evidence that this is a feasible model can be found in Switzerland and Germany.
8. When this extra revenue can be secured the business plan seems feasible and investment capital could be found. After 2 years operations, the ROI for an investor could be above 100% per year.

A main final conclusion could be that the concept of AGEWARE very well fits in the more and more digitizing society. Success of digital products is depending on the end-user experience. The project original plan was to design the UI/UX and functionalities in combination with the end-users, but unfortunately the elderly end-users and the healthcare workers were not reachable due to the COVID19 precaution measures. In order to present this business plan to investors we need to include a first design and validation phase with clear feedback from the future stakeholders and present hard evidence on the end-user acceptance, from both elderly and healthcare-workers, of the AGEWARE solutions, before a business implementation phase starts. This could reduce the investment risks and create extra opportunities to involve other stakeholder groups which makes fast replication afterwards possible.

13.2.4 Replication strategy

The replication strategy is oriented towards the public and private service providers of the type of Sofia Social Patronage and Sunny Home (an elderly home) – in Bulgaria, regionally (South-East Europe) and beyond.

13.2.5 Scaling-up strategy

The scaling-up strategy has been described above, including in the detailed business plan.

14 DS 12 BCN final report

14.1 DS Experiment report

14.1.1 User engagement report

Table 232: DS BCN Total users recruited per category :

RUC	Elderly	Informal caregiver	Formal caregiver	Other stakeholder
RUC01	6	2	4	2
RUC02	23	2	1	1
RUC03	5	2	1	1
TOTAL	34	6	6	4

Table 233: DS BCN Total number of facilities confirmed

RUC	Private homes	Personal environments	Shared room in senior facility	Healthcare/Daycare facility	Other spaces
RUC01	0	3	0	0	0
RUC02	0	0	0	0	23
RUC03	0	3	0	0	0
TOTAL	0	6	0	0	23

Other spaces: Personal room in senior facility

14.1.2 IoT infrastructure deployment

Table 234: DS BCN distribution of installation per type of environment

RUC	Private homes	Personal environments	Shared room in senior facility	Healthcare/Daycare facility	Other spaces
RUC01	0	3	0	0	0
RUC02	0	0	0	0	23
RUC03	0	3	0	0	0
TOTAL	0	6	0	0	23

Other spaces: Personal room in senior facility

Table 235: DS BCN devices installed per category

RUC	Gateways	Environment sensors	Wearables	Health / Alarm devices	Communication devices	User interface devices
RUC01	3	12	0	0	3	0
RUC02	0	0	0	0	0	23
RUC03	3	12	3	0	3	3
TOTAL	**6**	**24**	**3**	**0**	**6**	**26**

14.1.3 Experiment running report

14.1.3.1 Users participation

Table 236: DS BCN Number of drop-offs by 30th of June.

Reasons for drop-offs	Number of drop-offs
it has not been possible to carry out the planned technology deployment in the agreed time	5

Table 237: DS BCN number of users in operation by 30th of June.

RUC	Elderly	Informal caregiver	Formal caregiver	Other stakeholder
RUC01	3/6	2/2	2/4	2/2
RUC02	23/23	2/2	3/1	2/1
RUC03	3/5	2/2	1/1	1/1
TOTAL	29/34	6/6	6/6	5/4

14.1.3.2 Operational effectiveness

No technical/ operational issues reported

14.2 Local sustainability plan

14.2.1 Product/Service definition

EKENKU® (https://www.ekenku.com/?lang=en)

It is a professional IoMT platform and Mobile App for remote patient monitoring. The solution allows taking periodic personal parameters remotely, easily and safely. Vital parameters or activity are automatically sent from any place to a secure cloud storage. Clinical users can manage gathered information to assist their patients. Dynamic questionnaires, videoconference and communication tools and an extremely way to configure kits for different kind of patients and context. EKENKU® creates an efficient and customized monitoring service to be used for elderly, chronic patients, improving clinical trials experience or simply tracking wellness for some days after the patient's discharge.

This product is delivered in a Software-as-a-Service (SaaS) model to the final customer, usually hospitals. EKENKU does not require any server installation at the hospital premises. Clinicians have access to the patient data through a web interface and prescribe a kit to the patient that is composed by a mobile app, a tablet device, and several prescribed Bluetooth-enabled medical devices. The product provides videoconference and questionnaires to promote the communication between patient and clinician and medical devices to monitor glucose, pressure, oxygen saturation, weight, or physical activity.

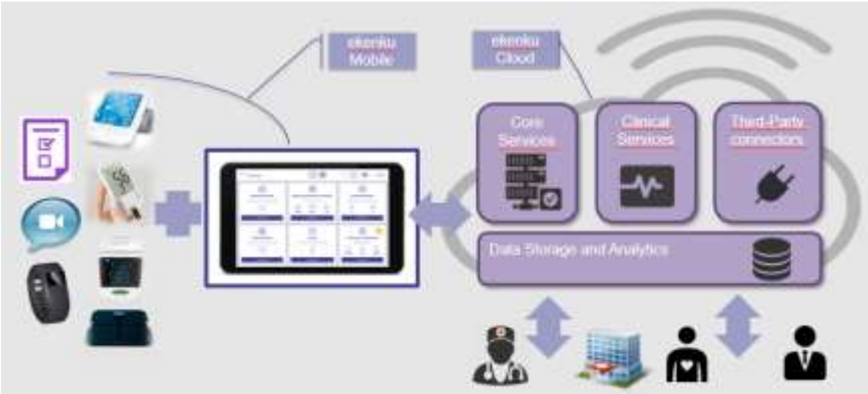

Figure 157 DS BCN Schema of EKENKU's solution

This solution has demonstrated an excellent level of performance in every project where it has been used. Customer surveys from patients and clinicians are very positive and the solution is usable, secure, stable and maintainable. Four hospitals within the Catalan Health System use EKENKU, namely Parc de Salut Mar (PSM), Consorci Sanitari del Maresme (CSdM), Consorci Sanitari de Vic (CSV) and Fundació Hospital d'Olot i Comarcal de la Garrotxa (HdO), scattered throughout the region. As of today, we have deployed 80 EKENKU mobile kits that have been used by more than 350 patients so far. The solution has been used in clinical trials to monitor patients during weeks or months and chronic patients with hypertension, diabetes, obesity, cancer and COPD. The average payback period for the hospital is between 3 to 5 months.

EKAURI® (https://www.ekauri.com/?lang=en)

It is a 3rd generation telecare system which enables and improves the Quality of Life, security and independence of elderly who are disabled or dependent and live alone or who are alone in their home for long periods of time. Through continuous notifications received from each connected home, we process the data, making it available to the caregiver and family environment. The goal is to monitor the habits, activities and even health status of the users, making home a safer place maintaining at the same time privacy and independence.

The high maturity level of this product ensures an effective deployment within the ACTIVAGE as also the early adoption required by this call project. Within an IoT technology context, small sensors are placed in the house of the resident/patient in the following places: front door, kitchen, living room, bathroom and bedrooms. Ambient information is then collected without the use of cameras or microphones (the privacy of the home is respected always). Through a proprietary wireless hub, the information received by the sensors is transmitted to the central servers. The caregiver and other professional team members (nurses, social workers, doctors, psychologists, etc.) can deal with it in real time to diagnose the patient and prevent incidents from occurring. Above all it can be used to improve the physical and emotional well-being and quality of life of the resident/patient.

Figure 158 DS BCN Schema of EKAURI's solution

14.2.2 Market analysis

The Catalan health care system in strongly decentralized and spends 9.1% of Catalan GDP. It is free, funded by taxes and with a co-payment for pharmaceutical products (free for pensioners and people with certain conditions). It is a multi-provider system publicly funded. Catalonia's Ministry of Health funds the system and sets standards, while the Catalan Health Service monitors the performance of providers, the majority of whom are contracted. Providers have the duty to share information with both Public Insurance (the Catalan Health Service, CatSalut) and other providers. Interoperability must be guaranteed.

Catalonia's health care system makes a strong emphasis on preventive medicine through the promotion of healthier lifestyles. The SISCAT Information Systems Masterplan[66] sets the new digital health strategy for Catalonia with main goals to: (i) Consolidate a person-centered model of information systems that enables clinical and managerial decision-making across the care cycle, (ii) Establish a governance model of information systems with a solid community support while ensuring care continuity, (iii) Set out a financing framework to ensure implementation and sustainability over time, (iv) Create environments and opportunities to design and implement innovative person-centered ICT-based care services and (v) Set out an ambitious roadmap, yet realistic, which will allow a long-lasting, successful and safe implementation of the new model.

The Catalan Health system is strongly decentralized with 7 Health Regions and a Health Board for every region. It has 63 hospitals for a population of 7.5 M with about 70% of facilities privately owned.

In recent years, EURECAT has established relationships with the main stakeholders in the Catalan Health Care System, mainly with the public health insurance, CatSalut, the public health provider, Institut Català de la Salut (ICS), and the Agency for Quality and Assessment (AQuAS). We are in the process of strengthening these relations. Most purchases (85-90 percent) are made through public hospital tenders and EURECAT is already qualified for these public tender opening bids.

The Catalan health care system is **transitioning from payment per volume of activity to pay-per-performance**. Performance-related pay represents a percentage of overall economic compensation and it is a fixed amount according to the achievement of objectives. These objectives are linked to the improvement of service provision in terms of quality and efficiency and must consider information systems as well as other aspects like accessibility, resolution and coordination. These changes should accelerate the introduction of monitoring technologies such as eKenku and eKauri in all health service providers no matter if they are public, commissioned non-profit or private. To overcome the "systemic" barrier it is key to sell the solution not only to every hospital but also directly to the CatSalut and to the ICS so they can promote changes in the internal organization and the evaluation process of the hospitals

66 https://pdsisbloggencat.files.wordpress.com/2018/02/pla_director_final_v27.pdf

that facilitate the acquisition of remote monitoring technology in the short-term and its sustainability in the long-term.

Additionally, to these stakeholders, EURECAT has well established relationships with IT system integrators that provide solutions and services to hospitals in Catalonia. We have also partnered with IT system integrators in the context of other digital health projects such as Nexus Sisinf, Seidor, Tecnocom or Indra. All these partners are providers of Hospital Information Systems (HIS) and increase our capacity of reaching to hospitals in Catalonia.

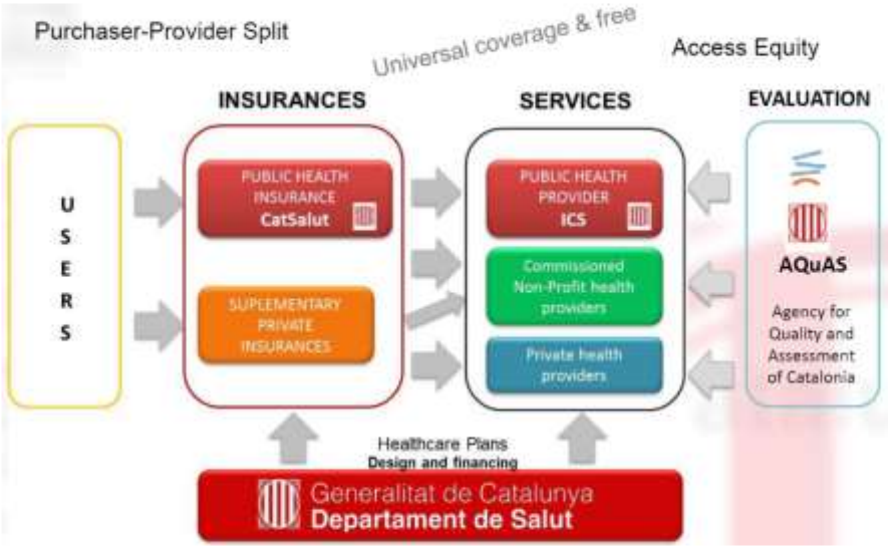

Figure 159 DS BCN Main stakeholders in the Catalan Health Care System

Both EKENKU® and EKAURI® products are the exclusive property of EURECAT. Both products are managed by the Digital Products Development Valorisation Unit (VAL-DPD) of EURECAT, that can decide on product deployment strategy including partner alliances, client acquisition and subcontracting of providers. Within the VAL-DPD Unit there is a Product Manager (PM) for every individual product and all the PMs report to the Director of the VAL-DPD Unit.

The involvement of a new partner, client or provider requires the signature of a legal agreement. The contract is negotiated by the PM with the supervision of the Director of VAL-DPD. Afterwards, it must be approved by EURECAT's legal department and signed by EURECAT's Managing Director or someone with the corresponding power of attorney.

For this proposal we consider EURECAT, Consorci Sanitari Alt Penedès I Garraf and Consorci Sanitari del Maresme as partners. When the project is approved, the partners will negotiate and sign a partnership agreement for the duration of the project where the duties of each partner are established to successfully develop the project. After the project ends, it is of common interest to analyze results and continue with follow-on activities, since the telecare is within the strategic lines of the partners. At that point we will explore and decide the suitable relationship to spread and scale-up services.

The products EKENKU® and EKAURI® have already established business models that have evolved in the past 4 years. In the case of EKENKU® it is being mainly used for eventual monitoring of patients with a critical condition or those who need tracking during a specific time interval after being discharged from Hospital facilities. The client hospital gives to the patient a mobile kit that consists of a tablet with an app and one or more medical devices or wearables. An average project with 20 kits has a set-up cost for the buyer of 20.000 € the first year plus a recurrent fee of 3.000 € the following years, and can be used easily with at least 20 to 80 patients. About 30% of the set-up cost is due to the acquisition of mobile devices (tablets) to lend to the patient. We also support a less reliable deployment model based on using the own patient's mobile devices to make it more affordable. In our current deployments with public hospitals, these costs are covered entirely by the hospital with no fees for the patients. We provide the product directly to the hospitals on a SaaS model where EURECAT hosts the data in a private cloud or indirectly through providers of Electronic Health Record (EHR). In both deployment models EURECAT provides training to the ecosystem of hospital providers so they can maintain the product. So far EURECAT has deployed EKENKU® for eventual monitoring of patients with heart failure, COPD and frailty.

EKAURI®, is being mainly used for 24x7 monitoring of elderly people. We provide the product indirectly through public or private entities that provide services to the elderly. With the entity permission and once the patient or their families have given their consent and accept the terms of service, included ethical issues concerning information management, trained installers deploy the kits in every home or residential building. A kit consists of 5-6 sensors and a communications hub. An average project with 20 kits has a set-up cost of 14.000 € the first year plus a recurrent fee of 2.400 € the following years. Kits can be easily uninstalled to be deployed in another location. Regarding caregivers, we provide a data interface to the public or private entities on a SaaS model where EURECAT hosts the data in a private cloud. On top of EKAURI® the entities can provide different caring services and they decide on the final pricing for the patients and their families, or even study internal KPIs to efficiency improvement to be able to assume the initial investment. So far EURECAT has deployed EKAURI® for 24x7 monitoring of patients with Alzheimer mainly to support carers for decision-making tasks.

14.2.3 Business model

Taking into account just the last Use Case studied after pandemic situation: nursing homes. And considering only those that have people with personal space not with bedroom sharing within the institution.

Table 238: DS BCN market size analysis.

		2020	2021	2022	2023	2024	2025
Residences for the elderly							
Number of residences		5.913	5.996	6.080	6.165	6.251	6.339
% of growth		0%	1,4%	1,4%	1,4%	1,4%	1,4%
Numer of users per residence (average)		69	69	69	69	69	69
Number of users		407.997	413.709	419.501	425.374	431.329	437.368
Restrictions							
Dementia		60,00%	60,00%	60,00%	60,00%	60,00%	60,00%
	% of growth						
Individual (room)		25,00%	25,00%	25,00%	25,00%	25,00%	25,00%
	% of growth						
TAM		61.200	62.056	62.925	63.806	64.699	65.605
Market Share (%)		3,60%	4,50%	5,63%	7,03%	8,79%	10,99%
	% of growth		*25%*	*25%*	*25%*	*25%*	*25%*
Number of users		**2203**	**2793**	**3540**	**4486**	**5686**	**7208**
Number of users (Accum)		**2203**	**4996**	**8535**	**13022**	**18708**	**25916**
Number of new clients		**31,9**	**40,5**	**51,3**	**65,0**	**82,4**	**104,5**

Market Calculation. The number of residences in 2014 (Font: Informe DBK) has been growing at an average rate of 1,4% (conservative estimation, font: Informe DBK). We estimated an average of 69 users per residence (font: Informe Envejecimiento en Red).

We obtained the total number of users/residences.

We applied two restrictions: 60% of people suffering from Dementia in Residences (font: Inforesidencias.com) +. 25% for individual rooms (75% are considered double). This is necessary to try to focus to a more specific target to better focus first phases of commercialization

Then we obtained the TAM (Total Addressable Market). We applied a Market Share in order to obtain: Number of users, Cumulated number of users (we used it to calculate HW Set-up Fee and Monthly Fee Incomes).

Finally, Number of clients' item: we used it to calculate Installation Set-up Fee Incomes.

License and fee calculation

Table 239: DS BCN Licenses set-up for eKauri platform deployment

Set-up Fee Residencial (Incomes)	2020	2021	2022	2023	2024	2025
Kit residential HW per user (num)	**2.203**	**2.793**	**3.540**	**4.486**	**5.686**	**7.208**
Cost Kit residential HW per user (€)	319,00 €	328,57 €	338,43 €	348,58 €	359,04 €	369,81 €
% of growth		3%	3%	3%	3%	3%
Installation	**201.320 €**	**255.173 €**	**323.432 €**	**409.950 €**	**519.611 €**	**658.607 €**
HW	176.255 €	223.403 €	283.163 €	358.909 €	454.917 €	576.608 €
SW + Training	25.065 €	31.770 €	40.269 €	51.041 €	64.694 €	81.999 €
Monthly Fee						
License (Accum (Loss + news))	**19.829 €**	**44.961 €**	**76.817 €**	**117.195 €**	**168.373 €**	**233.241 €**
Market Loss: 10%						

Table 240: DS BCN Annual costs

	2020	2021	2022	2023	2024	2025
Hardware costs	351.408 €	445.409 €	564.556 €	715.575 €	906.992 €	1.149.612 €
Users	2203	2793	3540	4486	5686	7208
Price per user	159,5	159,5	159,5	159,5	159,5	159,5
Headcounts	229.500 €	309.250 €	395.000 €	535.250 €	633.000 €	661.750 €
Commercial	60.000 €	126.000 €	198.000 €	207.000 €	288.000 €	300.000 €
Business cost	60.000 €	63.000 €	66.000 €	69.000 €	72.000 €	75.000 €
Number of employees	1	2	3	3	4	4
Administration and Finance	67.500 €	69.750 €	72.000 €	148.500 €	153.000 €	157.500 €
Business cost	45.000 €	46.500 €	48.000 €	49.500 €	51.000 €	52.500 €
Number of employees	1,5	1,5	1,5	3	3	3
Senior Developer	40.000,00 €	40.000,00 €	40.000,00 €	60.000,00 €	60.000,00 €	60.000,00 €
Business cost	40.000 €	40.000 €	40.000 €	40.000 €	40.000 €	40.000 €
Number of employees	1	1	1	1,5	1,5	1,5
Marketing	42.000,00 €	43.500,00 €	45.000,00 €	69.750,00 €	72.000,00 €	74.250,00 €
Business cost	42.000 €	43.500 €	45.000 €	46.500 €	48.000 €	49.500 €
Number of employees	1	1	1	1,5	1,5	1,5
Customer service	20.000,00 €	30.000,00 €	40.000,00 €	50.000,00 €	60.000,00 €	70.000,00 €
Business cost	20.000 €	20.000 €	20.000 €	20.000 €	20.000 €	20.000 €
Number of employees	1	1,5	2	2,5	3	3,5
Servers	11.015,92 €	13.962,68 €	14.158,15 €	17.945,46 €	17.059,40 €	21.622,79 €
Cost x User	5	5	4	4	3	3
Number of users	2203	2793	3540	4486	5686	7208
Commercial	18.479,28 €	24.353,56 €	31.962,50 €	41.820,02 €	54.592,77 €	71.145,58 €
2% *% on sales*						
Marketing/Advertising	27.718,93 €	36.530,34 €	47.943,75 €	62.730,04 €	81.889,15 €	106.718,37 €
3% *% on sales*						
Marketing Online	27.718,93 €	36.530,34 €	47.943,75 €	62.730,04 €	81.889,15 €	106.718,37 €
3% *% on sales*						
Travel	25.000 €	29.000 €	33.000 €	37.000 €	41.000 €	45.000 €
Annual Travel Cost	25.000 €	29.000 €	33.000 €	37.000 €	41.000 €	45.000 €
Fairs	65.000 €	69.000 €	73.000 €	77.000 €	81.000 €	85.000 €
Cost of Annual Fairs	65.000 €	69.000 €	73.000 €	77.000 €	81.000 €	85.000 €
Costs related to Att. Customer	8.812,74 €	11.170,14 €	10.618,62 €	13.459,10 €	11.372,94 €	14.415,20 €
Numer of Users	2203	2793	3540	4486	5686	7208
Average Cost per User	4,00 €	4,00 €	3,00 €	3,00 €	2,00 €	2,00 €
Outsourcing	27.718,93 €	36.530,34 €	47.943,75 €	62.730,04 €	81.889,15 €	106.718,37 €
3% *% on sales*						
Rentals	36.000,00 €	36.000,00 €	36.000,00 €	36.000,00 €	36.000,00 €	36.000,00 €
Price						
Others	92.396,42 €	121.767,78 €	159.812,49 €	209.100,12 €	272.963,83 €	355.727,91 €
10% *% on sales*						

The following table shows the P&L statement to summarize the revenues, costs, and expenses incurred during a 6 years period.

Table 241: DS BCN P&L eKauri summary

P&L	2020	2021	2022	2023	2024	2025
Total Sales	**923.964,20 €**	**1.217.677,84 €**	**1.598.124,90 €**	**2.091.001,20 €**	**2.729.638,33 €**	**3.557.279,13 €**
Set-up Fee	904.136 €	1.172.716 €	1.521.308 €	1.973.807 €	2.561.266 €	3.324.038 €
Monthly Fee	19.829 €	44.961 €	76.817 €	117.195 €	168.373 €	233.241 €
Costs	**920.768,95 €**	**1.169.504,57 €**	**1.461.939,42 €**	**1.871.340,07 €**	**2.299.648,04 €**	**2.760.428,53 €**
Hardware	351.407,82 €	445.409,41 €	564.556,42 €	715.575,27 €	906.991,65 €	1.149.611,92 €
Head counts	229.500,00 €	309.250,00 €	395.000,00 €	535.250,00 €	633.000,00 €	661.750,00 €
Servers	11.015,92 €	13.962,68 €	14.158,15 €	17.945,46 €	17.059,40 €	21.622,79 €
Seles Team	18.479,28 €	24.353,56 €	31.962,50 €	41.820,02 €	54.592,77 €	71.145,58 €
Marketing/Advertising	27.718,93 €	36.530,34 €	47.943,75 €	62.730,04 €	81.889,15 €	106.718,37 €
Marketing on-line	27.718,93 €	36.530,34 €	47.943,75 €	62.730,04 €	81.889,15 €	106.718,37 €
Travels	25.000,00 €	29.000,00 €	33.000,00 €	37.000,00 €	41.000,00 €	45.000,00 €
Events	65.000,00 €	69.000,00 €	73.000,00 €	77.000,00 €	81.000,00 €	85.000,00 €
Costs related to customer service	8.812,74 €	11.170,14 €	10.618,62 €	13.459,10 €	11.372,94 €	14.415,20 €
Subcontracts	27.718,93 €	36.530,34 €	47.943,75 €	62.730,04 €	81.889,15 €	106.718,37 €
Rental	36.000,00 €	36.000,00 €	36.000,00 €	36.000,00 €	36.000,00 €	36.000,00 €
Others	92.396,42 €	121.767,78 €	159.812,49 €	209.100,12 €	272.963,83 €	355.727,91 €
EBITDA	**3.195,25 €**	**48.173,27 €**	**136.185,48 €**	**219.661,12 €**	**429.990,29 €**	**796.850,61 €**
Amortization	5.774,78 €	7.610,49 €	9.988,28 €	13.068,76 €	17.060,24 €	22.232,99 €
EBIT	**- 2.579,53 €**	**40.562,78 €**	**126.197,20 €**	**206.592,36 €**	**412.930,05 €**	**774.617,61 €**
	-0,3%	3,3%	7,9%	9,9%	15,1%	21,8%

Conclusions:

- SALES

  The sales have been split into set-up fee and monthly fee.

  - Set up fee is a commercial barrier to achieve clients. This set up fee for clients is a Capex, while the monthly fee is an Opex.
  - In that sense, we consider that it might be considered different scenarios before choosing commercial strategy for Ekauri commercialization.

- COSTS

  The costs have been classified into 4 groups:

  - Hardware
  - Operative
  - Commercial
  - Others

- HARDWARE

  The proper cost of the hardware. It should scale by being linked to the volume of production.

- OPERATIVE

  Considers HC, Servers, Customer Service and Outsourcing.

- COMMERCIAL

  Includes all variable costs to promote the business and to support Commercial HC, which are included into Operative area.

- OTHERS

  Other fixed and variable costs considered to be necessary to running a business.

Other final considerations:

The scalability of the Hardware is a must to make this project profitable and scalable internationally.

The uncertainty regarding the stock needed before selling can add risk to the project.

14.2.4 Strategy for local sustainability

14.2.4.1 Open Data strategy

There are not valuable datasets from patient data generated to be available for further exploitation

14.2.4.2 Continuation strategy

After the integration and deployment of platforms equipped with sensors that advance the state of the art of research and care for the elderly and groups of patients suffering from Parkinson's ,the main goal is continue working to improve patients quality of life and also supporting caregivers' efficiency.

In this project, a series of advances regarding technology and initial use cases have been worked and achieved, in such a way that it was possible to validate new services for the elderly and chronic patients. At first, use cases were raised that were based on the installation in homes of various technological kits, so that care professionals could continuously and remotely learn from users' habits and obtain data that would help them improve. diagnosing, preventing problems and increasing the quality of life of the end users of the services implemented.

Due to the measures taken by the different governments after the declaration of a health emergency due to the COVID-19 pandemic, it was reconsidered with the health providers involved in the project to add more use cases to those initially proposed. In this way, a technology planned for private homes in nursering homes could be used. Both in the Consorci Sanitari del Maresme and in the Consorci del Alt Penedés Garraf there are residences that serve people from the same health areas and are closely related to the Hospital and health entities. It is the Sant Josep and Camils residence respectively.

Since October, once the ACTIVAGE project is finished, the deployments and validations proposed during the REVEL-PARK project and which have not been fully carried out, will continue. For this purpose, we are already working on requesting internal support from each entity involved within the support programs in these existing lines. In Eurecat there are internal research and valorization programs (PRIV) and for health providers there are some other options. One we are exploring and have already implemented first steps is the one called 'Projectes d'especialització i competitivitat territorial (PECT)'. This funded program endowed with FEDER funds and within healthcare entities involved in the project had already been working on the support line for active aging. For this reason, the documentation and budgets are being reviewed to finalize the validations proposed in this project within the framework of other actions that allow the planned deployments to be supported in the short term. It is currently awaiting the resolution of the PECT project requested in mid-2020 from the Garraf Provincial Council and waiting for the Valorization Committee in Maresme to take further decisions regarding Parkinson and frailty people programs,

14.2.4.3 Replication strategy

During the last years, EURECAT's technological center, innovative SME Sense4Care and the healthcare providers involved in the project have established relationships with the main stakeholders in the Catalan Health Care System, primary market for the new services deployed, mainly with the public health insurance, CatSalut, the public health provider, Institut Català de la Salut (ICS), and the Agency for Quality and Assessment (AQuAS).

Within the work carried out on the project, in addition to the design and technological development necessary to carry out the planned deployments, the use cases and services that can be used in future deployments have been taken into account. The following have been detected:

- UC1 / RUC03. The integration of the STAT-ON device into the AIOTES environment has provided EKENKU remote monitoring platform the capacity to deliver specific services for the monitoring of patients with Parkinson's. In addition to the information sent by the device itself, the platform has another series of functionalities (videoconference, questionnaires, connection of devices for taking constants, sending notifications, ...) that make the use of the STAT-ON can be completed with other devices that provide information to the professional to offer more precise care support to both elderlies o chronic patients.
- UC2 / RUC01. The EKAURI platform allows routine monitoring to offer support services for caregiver decision making. This use case, with older people, in a situation of loneliness, frailty or a slight degree of dependency, allows to test the deployment and propose strategies that allow replicating the deployment model in many other centers that also work in a similar way to those studied during this project.
- UC3 / RUC02. This use case is precisely the one that is most specific to this study, with the sensors and devices proposed. Although the use of other devices or wearables and even varying the environmental sensors of the initial kit we have seen that they create great interest in many other study areas (complex chronic patients, mental health patients, users with physical degenerative diseases) and even for the promotion of healthy habits and the collection of information that enables the empowerment of the user who uses the tool. This would be achieved through the support of the professional caregiver, who knows necessities of each individual person and with the technology support can offer more effective care, helping to improve human resource management and the prevention and promotion of healthier lifestyles.

14.2.4.4 Scaling-up strategy

The increase in life expectancy and longevity are a clear indicator of the improvement in social development, improvements in medical care, nutrition, healthy life, physical activity, technological improvements, etc. As indicated by Eurostat demographic reports, this evolution will be very similar in all developed countries.

This increase in the population of the upper layer of the pyramid will have a great social and economic impact, and consequently the traditional models of social assistance and health will have to be modified and updated. In this sense, the progressive incorporation of Home Care Services (HCS) in the health system is helping to decongest certain hospital services, as well as to provide the patient with a more humane and favorable environment for their recovery.

The Catalan health care system is transitioning from payment per volume of activity to pay-per-performance. Performance-related pay represents a percentage of overall economic compensation and it is a fixed amount according to the achievement of objectives. These objectives are linked to the improvement of service provision in terms of quality and efficiency and must consider information systems as well as other aspects like accessibility, resolution, and coordination. These changes should accelerate the introduction of integrated platforms as the ones proposed in this region, which along with the learning and co-creation facilitated by the ACTIVAGE environment will allow us to adapt the product to the different social and economic realities in Europe.

Other actions that we are already carrying out to adapt technologies to actual context and compete with existing solutions are the execution of a set of research projects where artificial intelligence is being incorporated into Cloud infrastructures of EKAURI® and EKENKU® platforms in order to better manage the large amount of information stored and serve to personalize the care. This will help us scale current services and increase use cases and deployment environments.