Information and Communication Technologies

Collaborative Project

Unobtrusive **S**mart **E**nvironments **F**or **I**ndependent **L**iving

USEFIL

Grant Agreement Number 288532

D8.4 END OF PROJECT VOLUME

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Abstract: This document is an End of project 'volume' to disseminate the main findings of the project to important stakeholders in all EU countries. A streamlined version of this report will be disseminated to the public.

Keywords: USEFIL, results, platform, elderly care

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**R – Report, P – Prototype, D – Demonstrator, O – Other.

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Table of Contents

1 INTRODUCTION 5

2 USEFIL OBJECTIVES 6

3 USEFIL SYSTEM 9

4 PILOTS DESCRIPTION 14

5 SYSTEM MATURITY AND AVAILABILITY AT THE END OF THE PROJECT LIFETIME 17

5.1 HOME PC SOFTWARE MODULES 18

5.2 USEFIL MAIN SERVER SOFTWARE MODULES 19

5.3 SMART TV SOFTWARE MODULES 22

5.4 WEB INTERFACES 23

5.5 WRIST WEARABLE UNIT SOFTWARE MODULES 23

5.6 TABLET SOFTWARE MODULES 24

6 PILOTS EXECUTION AND END USERS' FEEDBACK ANALYSIS 26

6.1 TECHNOLOGY ASSESSMENT, USABILITY AND END USER ACCEPTANCE 26

6.2 PUBLIC VIDEO PRODUCTION SHOWING THE USEFIL PILOTS 28

7 CHALLENGES ENCOUNTERED 29

Table of Figures

FIGURE 1 THE AGEING PROBLEM 6

FIGURE 2 BRIDGING THE GAP 7

FIGURE 3 LOW COST OFF-THE-SHELF SYSTEMS 9

FIGURE 4 USEFIL'S INTERCONNECTED DEVICES 10

FIGURE 5 USEFIL PORTAL FOR ELDERLY USERS 10

FIGURE 6 DEVELOPERS PORTAL 11

FIGURE 7 COMMUNICATIONS ON THE USEFIL PLATFORM 12

FIGURE 8 INTELLIGENT ALGORITHMS AT THE USEFIL CLOUD BACKEND 12

FIGURE 9 USEFIL THREE TRIAL SITES 14

1 Introduction

The FP7 funded project Unobtrusive Smart Environments for Independent Living (USEFIL) aimed to address the gap between technological research advances and the practical needs of elderly people by developing advanced but affordable in-home monitoring and web communication solutions. USEFIL intended to use low cost "off-the-shelf" technology to develop immediately applicable services that assist the elderly in maintaining their independence and daily activities.

There have been many European projects that have tried to address the issue of bringing technology into the realm of in-home care for the elderly, but we have rarely seen this to translate into a widely adopted product. USEFIL wanted to address this challenge and to bring ICT solutions within elderly' real life settings.

The main purpose of the D8.4 is to disseminate the main findings of the project to important stakeholders in all EU countries. Following the complex and ambitious nature of the USEFIL project, there was a need to get an extension for 4 months for conducting the pilot studies. The final findings regarding acceptability, usefulness and health benefits of the integrated USEFIL platform are presented in 'D7.3. Report on the analysis of trial results, acceptability, and usability'

During the project duration, the project consortium has developed a number of reports, press releases and articles that disseminated to the public the main findings of the USEFIL project, though mainly on a technical level. These dissemination activities were intensive, ensuring that the results of the project that were available at any given time have been disseminated as appropriate.

However, beyond the above, the determination of the project partners to exploit the results of the project after the end of it calls for continuation of these dissemination activities, in particular development of additional dissemination reports that will be communicated to a wider public.

2 USEFIL Objectives

The main objective of the USEFIL project was to develop a suite of services and applications, which are useful, easy to use, and desirable to target users. More specifically, the project objectives are presented in the following paragraphs.

Consistently low birth rates and higher life expectancy are transforming the population structure of the EU, with the proportion of over-65s having increased by nearly four percent over the last twenty years. The total number of seniors living alone is also rising, which has led to increased demands placed on society's care and medical services. Although ICT technologies could increase safety, independence and quality of life for elderly people living alone, the adoption rates of such advancements show that these technologies are still not accepted by the majority of the elderly population. There have been many European projects that have tried to address the issue of bringing technology into the realm of in-home care for the elderly, but we have rarely seen this translate into a widely adopted product.

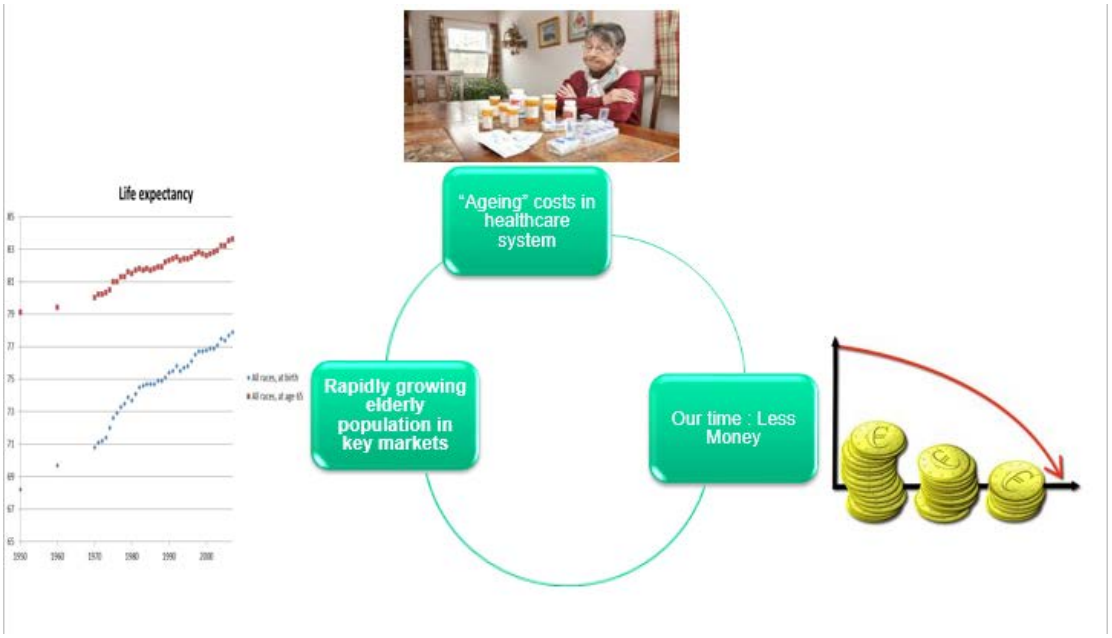

Figure 1 The Ageing Problem

The FP7 funded project Unobtrusive Smart Environments for Independent Living (USEFIL) tried to address the ageing problem within EU by extending the period people live independently at their homes. USEFIL wanted to address this challenge and to bring ICT solutions within elderly' real life settings. USEFIL tried to fill the gap between technological research advances and the practical needs of elderly people by developing advanced but affordable in-home monitoring and web communication solutions. USEFIL intended to use low cost "off-the-shelf" technology to develop immediately applicable services that assist the elderly in maintaining their independence and daily activities.

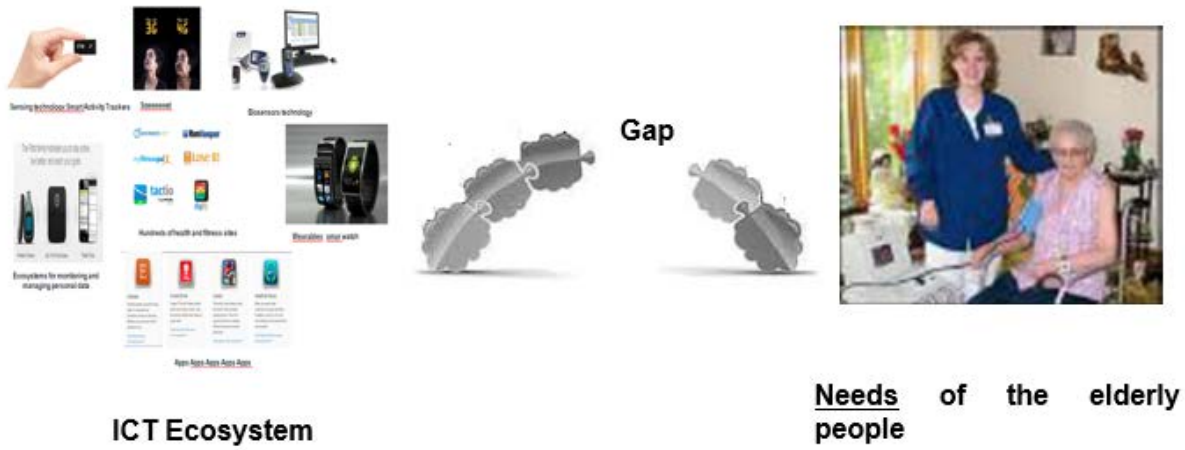

Figure 2 Bridging the gap

The systems and applications that have been developed are able to unobtrusively record, irrespective of an older person's mobility state:

- Elderly behavioural indicators for problems such as cognitive decline or geriatric depression,
- Emotional status,
- Health vital signs,
- Activities of daily living (ADL)

In result, means are provided to:

- Supply information services,
- Enable individuals to keep their social lives active

Following these two pillars of adoption, the USEFIL project had the following Social and Technical Objectives:

Ease of use:

- Develop a simplified approach exploiting easy to use unobtrusive low cost ICT solutions that provides safety and security to elderly persons in their living places, using fewer devices and adopting a frugal innovation stance
- Provide personalized services adaptable to individual needs and preferences
- Promote practicality by developing systems and services, installation of which will not require retrofitting of residences of elderly people or special skills for installation

Usefulness/Benefits (for end users and other stakeholders):

- Support the elderly in maintaining their social activities and increase the level of their social contacts

- Promote “ageing well” and prevention concepts by redefining the way of treating elderly people, in particular supporting healthcare services using low cost ICT technologies and facilitating the integrated care
- Adopt a frugal innovation approach by promoting cost- and time-efficient healthcare solutions for end users and carers that:
    - Integrate low cost and low maintenance off-the-shelf systems into an operational complete platform
    - Provide secure applications , services and decision support systems
    - Persuade and facilitate worldwide developers to develop applications leading to a reduction in costs the governments have to spend for providing ICT services for the ageing population

3 USEFIL System

To address the above objectives, the USEFIL project consortium has developed a holistic platform consisting of a number of systems and modules. The majority of utilized hardware devices are not developed within the project, but are low cost off-the-shelf systems. Instead, the project focused on extending the capabilities of these devices with software realizing innovative monitoring algorithms and communication scenarios. That is, existing ICT technology is extended and exploited to benefit the elderly population. The off-the-shelf components of the USEFIL system include a smart watch, a Kinect depth sensor, a tablet, a Smart TV, and a regular PC.

Figure 3 Low cost off-the-shelf systems

In addition, a specialized integrated system, the smart mirror, was developed equipped with a low-cost video camera that monitors a person's emotional and physiological state. Such a camera integrated into a mirror gathers data on physiological indicators such as pupil size and skin colour using facial detection algorithms. The results provide clues about the person's emotional state and may also spot serious health issues.

All of these devices are interconnected, so, for example, the smart watch can be used as an easy and safe way to login into to USEFIL portal accessible via the Smart TV.

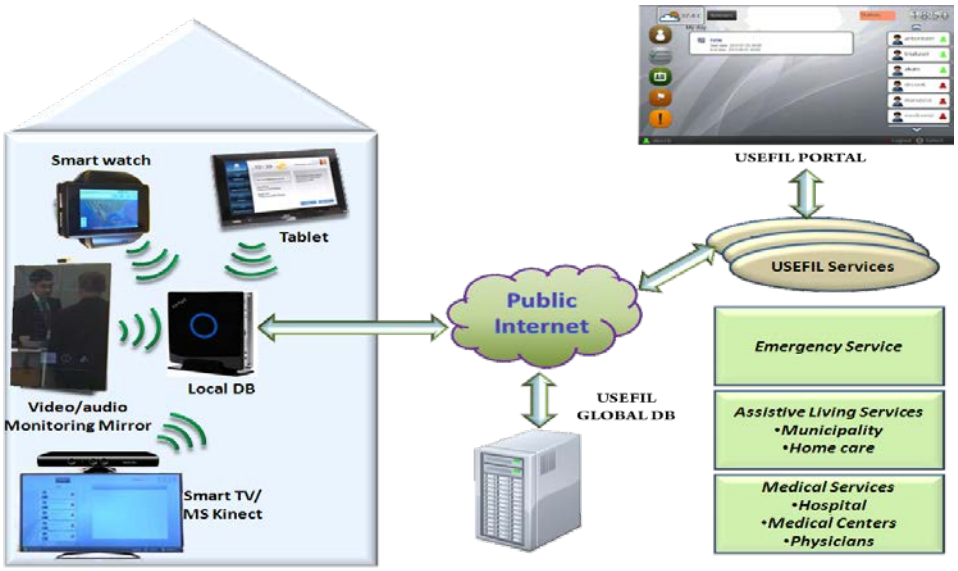

Figure 4 USEFIL's interconnected devices

The users of the USEFIL platform are able to register with the USEFIL portal, creating their own pages so that they can interact with the whole system. The elderly users and the health professionals can have access, using different user interfaces. The elderly users interact with the portal via Smart TVs or tablets to access own data, see reminders, communicate with doctors, as well as to access other USEFIL applications that address elderly's needs for social communication and healthy being. Carers and health professionals can interact with the USEFIL portal from their Internet-connected PCs or other devices, to access the monitoring data, to prescribe medications, schedule appointments, send reminders, communicate with elderly users via audio and video, as well as create electronic questionnaires.

Figure 5 USEFIL portal for elderly users

Readers are encouraged to visit the USEFIL portal at the following address http://portal.usefil.eu, register and experience developed applications.

As USEFIL platform is built to be open, third-party developers are able to develop their own applications aimed at the ageing population and adding to the system, vastly increasing the scope of services available. A portal for developers http://devs.usefil.eu is available. After a successful registration, a developer will gain access to information and developer tools for implementing and registering his own application to the USEFIL portal. Examples, source code, API documentations, forums and support from USEFIL's developers will provide help. A developer can upload a new application and, after a successful audit from the platform's administrators, the application will become available through the platform's store.

Figure 6 Developers portal

An important aspect of the USEFIL system is supporting communications of elderly persons, both health-related and social. In addition to realizing different communication channels, including text messaging and video, the USEFIL also realizes an innovative *awareness system*. It is conceived to supplement remote interactions between humans with channels that are usually available during face-to-face encounters but missing in telecommunication or tele-cooperation. The awareness system in USEFIL has been realized as an integral part of the tablet messenger and allows users to inform each other about their context: current location (e.g. at home, at work, travelling, etc.), activity (e.g. eating, working, cooking, etc.), mood, as well as availability for communication. Such a context can be set manually or also obtained automatically from Kinect depth sensor data.

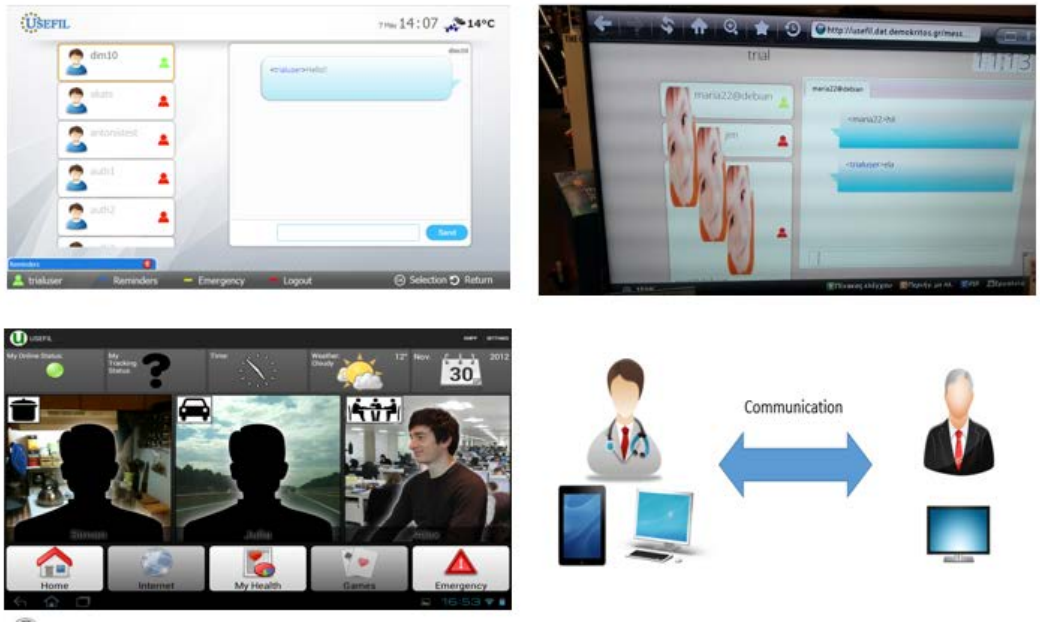

Figure 7 Communications on the USEFIL platform

The USEFIL Cloud backend is constantly online, storing data about the member users. This backend also hosts a Decision Support System that promotes the vision of data mining in order to uncover signs of progressive health and mental deterioration. This is achieved through innovative algorithms that can model typical human behaviour and extract correlations from sets of fused data. Thus, the Cloud intelligence is used for the benefit of an elderly user.

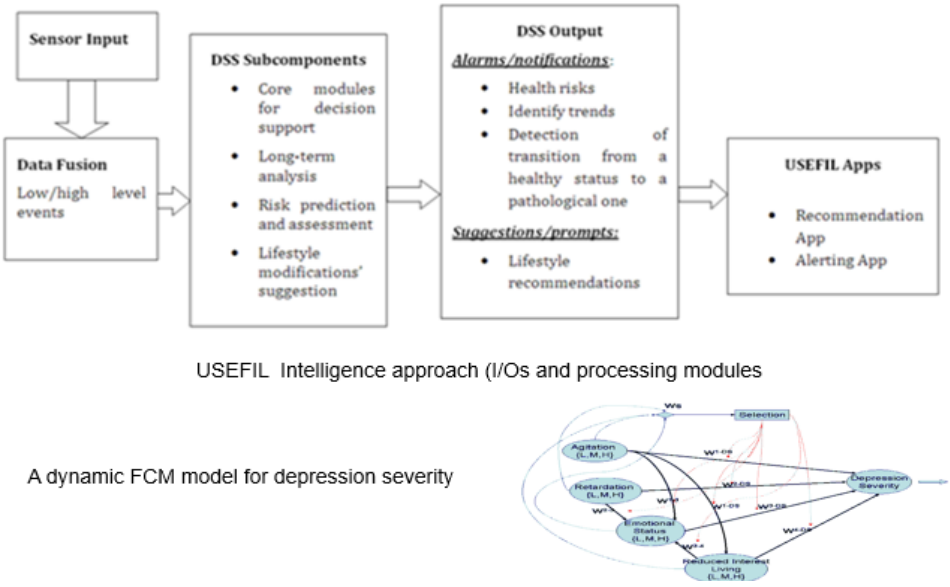

Figure 8 Intelligent algorithms at the USEFIL Cloud backend

USEFIL addresses the pressing issues of ageing, health and inclusion by promoting an approach that places an elderly individual firmly in the centre. However, the involvement of others is also one of the key aspects of the approach, with everyone from friends and family to medical professionals and carers encouraged to get involved with the platform. This helps to foster the interaction between the elderly and doctors and carers for improved treatment, personalised to the needs of the elderly, and also the interaction with family and friends that allows the elderly to keep their social network alive even if they are unable to move outside their home.

4 Pilots Description

The USEFIL platform has been tested in pilots in Greece, the UK, and Israel.

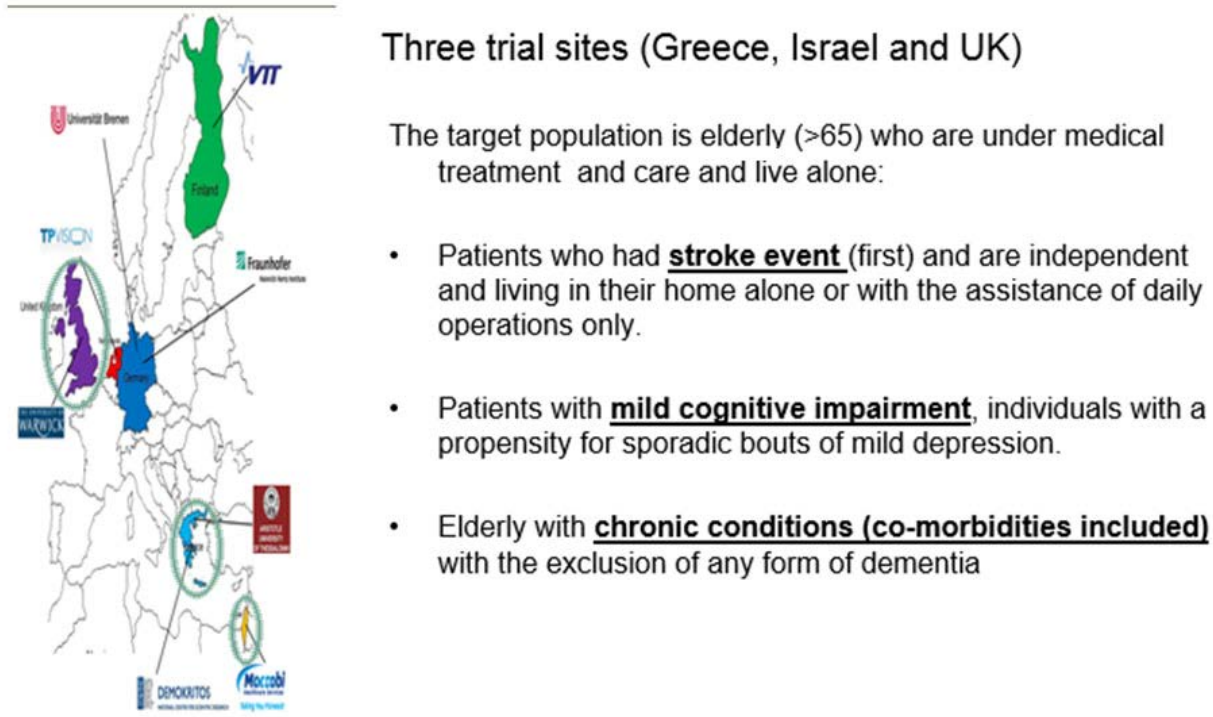

Figure 9 USEFIL three trial sites

The USEFIL pilots are proof-of-concept trials that were carried out across three sites: in Greece, the UK, and Israel. The USEFIL system was trialled on three different scenarios: mild cognitive decline, chronic health conditions, and stroke events and their effect on ADL. The overarching objectives of the trial were four-fold, to:

1. Determine the subjective impact of the USEFIL system on the quality of life and feelings of independence and security of the target users.
2. Determine any quantitative indicators of well-being and sustained quality of life.
3. Determine acceptance and satisfaction amongst all the stakeholders (elderly, informal carers and the healthcare professionals).
4. Validate the new technologies developed in the USEFIL project for detection and alerting of depression, ADL and cognitive decline.

To address the objectives of the USEFIL project, we used an array of appropriate outcome measures to suit the different scenarios.

- Validated Questionnaires

  Validated questionnaires designed for use with older people and carers were administered by the research psychologist at regular intervals (dependent on the questionnaire but varying between 2-4 weeks, or pre- and post-trial). Individual scores were compared over time & across subjects:

a) Questionnaires for elderly persons

b) Questionnaires for (informal/ formal) carer/ relative

- Tests for health status

  The USEFIL Decision Support System (DSS) provides alerts regarding several generic health parameters, e.g. sleep, mobility, socialization, balance. We used a battery of tests that assessed the elders' health status and allowed for a comparison of the results with the DSS alerts. Self-reports served as a means of validating any "abnormal" events that the DSS recognizes.

- Qualitative data

  Analysis of interviews & focus groups identified common thematic categories and themes around participants' views on day-to-day use of USEFIL system; features and functionalities utilised; and impact on personal health and wellbeing & family relations.

The trials adopted a structured approach, similar to efficacy trials. The USEFIL system was tested to answer the core questions above and, in addition, each site investigated the use of the system in particular scenarios as described above. Participants in the trials consisted of an elderly user and their carer(s). Across the three trial sites, carers included informal carers such as friends and family, as well as healthcare professionals (formal carers). In the general case, all older participants used the USEFIL home-system. A control group was not required since the study sought to identify subjective measures of the impact of the USEFIL system and any quantitative measures that are used were assessed both before and after the use of the system to observe any improvement.

Trials proceeded in 6 stages: recruitment, installation, initial period, on-going period, uninstallation and exit. The recruitment stage focused on obtaining a critical mass of participants to the trials. In the installation period, the participants homes have been outfitted with the USEFIL system and user training provided. The initial period allowed for the user learning curve and technical trouble-shooting, while the on-going period represented the bulk of the trial data collection and 'normal' usage of the system. Following this, there was the uninstallation of the USEFIL system and an exit phase.

During the mid-phases of the trial (while the USEFIL system was in use), validated instruments described above were used at regular intervals to provide quantitative data on key quality of life and health outcomes. This was triangulated with in-depth qualitative interview data collected before, during and after the trial period.

The trials collected detailed quantitative data using validated questionnaires and inputs from sensors using the decision-making system through interviews with older people every two weeks. Analysis of questionnaires and sensors used statistical methods. The sample tried to investigate elders' depressive symptoms sufficient to measure their experiences and able to be analysed. Thirteen elderly participants across the three trial sites allowed for the holistic USEFIL system to be assessed.

As all research projects, so has USEFIL taken into account its share of ethical responsibility regarding the use of trial users data, especially as these concern confidential personal medical conditions. In order to secure the confidentiality of data being collected, the participants were provided with an 'Informed Consent' form comprising of procedure description, the purpose, benefits, risks, discomforts, and precautions of the study, nature of the data, duration of the collection, data storage, confidentiality and data retention policy. Additionally, they were provided with the right to withdraw their consent at any time during the trials.

Those involved in the USEFIL project have been careful to be sensitive regarding the privacy of the elderly people. No video, audio or personal data ever left the house; only fused data were transmitted

and saved in the Cloud. This approach – to temporarily store data within the house, analyse it and locally fuse it – ensured that the data being transmitted has high confidence value and will provide carers and doctors with crucial information.

Additionally, the data collected were stored anonymized, i.e., no information on name, age, sex, origin, etc. were retained in any files, other than in the consent form. Collected data were stored digitally in a single database within the secured computing environment of the Division of Applied Technologies (DAT), Institute of Informatics and Telecommunications (IIT) of NCSR 'Demokritos'. Data were only accessed by IIT and will not leave the premises of IIT. No data access to third parties will be granted. Collected data and any backups will be irreversibly destroyed within a year of the end of the project. Collected data will be used only for the training or adaptation of statistical models for automatic speech recognition, based on the aggregation of features extracted from them.

USEFIL consortium partners during the project's lifetime identified and outreached various stakeholders passing to each of them a clear message with the obvious benefits from the project, using a variety of dissemination methods tailored to the specific needs of the target audiences. This deliverable is produced in order to disseminate the main findings of the project to important stakeholders listed below.

Group A. General Public, Elderly people, family members and their associations, Informal Carers,

Group B. The academic community

Group C. Care and Clinical Specialists, Health professionals and executives, Distributors and Resellers Community, Formal Carers, Elderly Organisations, Nursing Homes

Group D. Tele-assistance and Tele-care services providers, Medical device companies, Industrial Investors

Group E. Local Municipal Partnerships, Media contacts, Public Stakeholders, Health Journalists, Science Journalists

5 System Maturity and Availability at the End of the Project Lifetime

While the trials which the USEFIL project has been able to conduct produced valuable data, they also provided insight into the maturity of the developed system components.

For those parties who consider developing products or services based on USEFIL's results or to engage in further research with members of the consortium we provide an overview of the developed system components along with an evaluation of individual modules below.

Since the system is fairly complex, its components have been classified according to the hardware unit on which it is installed. We evaluate these components in terms of maturity, stability and usability. For the maturity rating the well-known Technology Readiness Levels have been used, which have originally been defined by the NASA as follows. TRL 1: Basic principles observed and reported: Transition from scientific research to applied research. Essential characteristics and behaviors of systems and architectures. Descriptive tools are mathematical formulations or algorithms.

TRL 2: Technology concept and/or application formulated: Applied research. Theory and scientific principles are focused on specific application area to define the concept. Characteristics of the application are described. Analytical tools are developed for simulation or analysis of the application.

TRL 3: Analytical and experimental critical function and/or characteristic proof-of-concept: Proof of concept validation. Active Research and Development (R&D) is initiated with analytical and laboratory studies. Demonstration of technical feasibility using breadboard or brassboard implementations that are exercised with representative data.

TRL 4: Component/subsystem validation in laboratory environment: Standalone prototyping implementation and test. Integration of technology elements. Experiments with full-scale problems or data sets.

TRL 5: System/subsystem/component validation in relevant environment: Thorough testing of prototyping in representative environment. Basic technology elements integrated with reasonably realistic supporting elements. Prototyping implementations conform to target environment and interfaces.

TRL 6: System/subsystem model or prototyping demonstration in a relevant end-to-end environment (ground or space): Prototyping implementations on full-scale realistic problems. Partially integrated with existing systems. Limited documentation available. Engineering feasibility fully demonstrated in actual system application.

TRL 7: System prototyping demonstration in an operational environment (ground or space): System prototyping demonstration in operational environment. System is at or near scale of the operational system, with most functions available for demonstration and test. Well integrated with collateral and ancillary systems. Limited documentation available.

TRL 8: Actual system completed and "mission qualified" through test and demonstration in an operational environment (ground or space): End of system development. Fully integrated with operational hardware and software systems. Most user documentation, training documentation, and maintenance documentation completed. All functionality tested in simulated and operational scenarios. Verification and Validation (V&V) completed.

TRL 9: Actual system "mission proven" through successful mission operations (ground or space): Fully integrated with operational hardware/software systems. Actual system has been thoroughly demonstrated and tested in its operational environment. All documentation completed. Successful operational experience. Sustaining engineering support in place.

In our case the *representative environments* (TR5) were the living labs of the trial partners, whereas the *relevant environments* (TR6) where the real homes of USEFIL's elderly users.

For each module the tables below provide information of the following kind.

User Type

EU: end user (elderly/patient)

MP: medical professional

SA: system administrator

Maturity

TR4: tested in developer lab

TR5: tested in living lab

TR6: tested in user home

Stability

US: unstable

OC: occasional problems

CS: completely stable

Usability

UT: untested

IR: improvement required

AC: acceptable

5.1 Home PC Software Modules

Module	Purpose/ Functions/ User Type	Maturity	Stability	Usability	Remarks
Local database	Temporary in-house storage of user related measurements and events for data fusion and sequence analysis (MP/SA)	TR6	CS	UT	Open source RDF data base server with project developed ontologies
Sensor data fusion	Estimation of user states or high-level activities from measurements and	TR5	OC	UT	Fused data are also written into local database

software module	detected basic activities (SA)				
Server uploader	Copies fused and basic data of diagnostic relevance from the home server to the main server on the internet (SA)	TR6	CS	UT	Target data in SQL format
Clothes change detection	Video based analysis of user behaviour for detecting (un)dressing as an indicator of independent living ability	TR6	OC	UT	
Audio event detection software module	Analysis of user generated sounds for detecting activities of daily living in the bathroom, speech events and voice parameters indicative of the user's mood	TR6	OC	UT	Uses data from microphones that are directly connected to the home-pc or to the LAN
Face signs detection	video-based masurement of pupil size, face colour oszillation and mimical features for various diagnostic purposes (SA)	TR5	OC	IR	Complex module consisting of diverse subcomponents developed for Linux. A less stable Windows port has been prepared for the final trial configuration
Input devices sharing service	Removes the restriction of using input devices like Kinect-sensors or the Wii Balance Board with only one application at a time (SA)	TR6	CS	UT	
Gait analysis	Uses skeleton movements estimated from Kinect's depth camera image are used for detecting a number of behaviours and for measuring some gait parameters (SA)	TR6	OC	UT	

5.2 USEFIL Main Server Software Modules

Module	Purpose/ Functions/ User Type	Maturity	Stability	Usability	Remarks

Global database	Stores most user data including user profile, medications and health and behaviour measurements	TR4	CS	AC	
Server web API	Access to global database via SOAP	TR4	CS	AC	Used by all database clients in the USEFIL system
Decision support system software module	Intelligent processing of fused data. Long-term trend analysis, along with disease state deterioration provide alerting to carers.	TR4	CS	UT	Real-time execution of the Decision Support System due to insufficient information provided by the rest components of the system and short time of the trial execution period. Off-line analysis of gathered data in seniors' homes have revealed some early promising results with respect to seniors' mobility and emotional status.
Alerting app	Alerts doctors regarding patient's condition	TR4	CS	IR	
Medication ordering app	Orders medicines when quantity approaches zero	TR4	CS	AC	
Medication reminder app	Reminds users about medications	TR6	CS	AC	
Recommendation app	Provides suggestions to the users depending on the DSS results	TR4	CS	AC	
Self therapy app	Provides some games for cognitive, physical training	TR5/TR6	OC	AC	Exergaming platform tested with seniors at LivingLab premises, where cognitive games piloted in seniors' homes in addition.
Consultation app/Audio - video communications app	Provides text/video/audio communication between users	TR6	OC	IR	
Surveys app	Provides surveys that doctors create and users answer	TR5	CS	AC	

User data access app	Provides users with their health data saved in the database	TR6	CS	AC	
Doctor data access app	Provides doctors all the data form their patients	TR6	CS	AC	
Emergency app	Users can use it in case of emergency and inform relatives/doctors	TR5	CS	AC	
Calendar app	Provides users the ability to create events/reminders and be notified for them	TR5	CS	IR	
User authenticatio n service	Service that authenticates the users of the system and prevents any other users from using it	TR6	CS	AC	
XMPP Hubservice	Provides access to arbitrary user data which can then be made available to other authorized users through the USEFIL messenger (SA)	TR4	OC	UT	Each data source requires a custom plugin. The only module currently implemented provides access to a user's schedule stored on a calendar server
Carer notification service	The carer notification service is intended for pushing notifications to doctors/psychologists and other including informal carers, using a variety of means including XMPP messaging, email, SMS, etc.			IR	Still under development and validation.
Questioning service	The Questioning core service allows administrating questions via the XMPP chat and is thus more appropriate for one-two questions ad-hoc sessions.			IR	Still under development and validation.
Video confe-rencing service	Service in which the text/audio/video communication is built on	TR6	OC	IR	
Calendar service	Service that is used by the Calendar App	TR6	CS	AC	

DMA Gateway	Provides a connection between USEFIL's global database and Maccabi's commercial web-based Desease Management Application				The DMA is an alternative for USEFIL's own doctor's application. It serves as a frontend for medical professionals to interact with users and to access their data. The gateway is an example of how USEFIL's system can be integrated with already existing systems

5.3 Smart TV Software Modules

Module	Purpose/ Functions/ User Type	Maturity	Stability	Usability	Remarks
Login	Page that authenticates users that are registered in the system	TR6	CS	AC	Current status is acceptable, but still improvements towards an alternative (not username and password) login system could be considered.
Home page	Displays all available services	TR6	CS	AC	
User information button	Displays personal data, medications, diseases etc	TR6	CS	AC	
Health button	Displays health data in graphs and tables	TR6	CS	AC	
Calendar button	Displays calendar events	TR6	CS	AC	
Contacts button	Displays friends and their information that they share	TR6	CS	AC	
Therapy button	Displays cognitive, physical therapy games	TR6	CS	AC	
Communication button	Enables users to communicate through text	TR6	CS	AC	
Emergency button	Informs relatives/doctors in case of emergency	TR6	CS	AC	

Settings button	Displays some settings that user can change	TR6	CS	AC	

5.4 Web Interfaces

Module	Purpose/ Functions/ User Type	Maturity	Stability	Usability	Remarks
Elderly user interface	Interface specialized for elderly people	TR6	OC	IR	
Family carer interfaces	Interface specialized for elderly people	TR6	CS	AC	
Doctor interfaces	Professional Interface suitable for doctors	TR6	CS	AC	

5.5 Wrist Wearable Unit software modules

Module	Purpose/ Functions/ User Type	Maturity	Stability	Usability	Remarks
Clock screen	Displays the time and contributes to the unobtrusiveness of the WWU functioning as a wrist-watch	TR6	CS	AC	
Heart-rate screen	Takes a measurement and displays the heart rate of the wearer.	TR6	OC	IR	Erratic measurement behaviour has been recorded.
Messaging screen	Displays messages sent through the USEFIL communication infrastructure.	TR4			
Help screen	Provides the elderly with an emergency communication channel by sending SMS and chat messages to preset contacts.	TR5	CS	AC	
Help confirmation screen	Provides robustness to the emergency help functionality by requiring an extra verification step to avoid false alarms.	TR5	OC	IR	Verification is difficult for very elderly people due to screen size
Debug screen	Provides debug information to technical personnel.	TR4	CS	AC	

WWU local storage	Maintains locally the data recorded by the WWU until connection to the rest of the USEFIL infrastructure, through the local DB can be established for uploading.	TR6	CS	AC	

5.6 Tablet software modules

Module	Purpose/ Functions/ User Type	Maturity	Stability	Usability	Remarks
Messaging	Text based one-to-one conversation between users (an elderly, his friends, relatives, formal cares and medical professionals) (EU, MP)	TR6	CS	IR	Stability partly depends of the stability of the XMPP messaging server
Awareness	Pictorial display context, activity and state based on either his manual input or on cues from sensors or from calendar entries (EU, MP)	TR6	OC	AC	
Reminders and notifications	Messages received from the "elderly messaging service" like e.g. medication reminders pop up (EU, MP)	TR5	OC	IR	Text characters not readable.
Access to USEFIL web interface	The Android messenger app contains "web views" in which selected parts of USEFIL's web portal can be accessed. e.g. the history of own health parameter measurements (EU, MP)	TR6	CS	AC	
Integration of external devices	Blood pressure and oxygen level can be measured with according devices via a special app which can be called through a button in the messenger app. After the measurement the messenger will be restored (EU, MP)	TR6	OC	IR	External measurement app can hang the messenger and prevent its restauration
Tablet local storage	An SQLite database on the tablet is used for storing chat histories and diverse states of the app (N/A*)	TR4	CS	N/A*	*This module has no user interface

Any reader interested in one or more of the above modules is encouraged to contact any representative of any project partner. If necessary he will then be referred to the respective IPR owner for technical details or conditions of usage.

6 Pilots execution and end users' feedback analysis

USEFIL pilots were held in three pilot sites, in UK, Greece and Israel. Both lab and home pilots took place. Active and Healthy Ageing Lab in Thessaloniki and Warwick Brain and Behaviour Lab hosted the two lab pilots, where USEFIL technology was tested mainly for usability and user acceptance studies.

Lab pilots, apart from testing the system with real end users, played a key role in successful recruitment of senior people in Greece. Seniors had the opportunity to be introduced to technologies in a controlled environment, where they could get the help needed to start using the system. Seniors had the chance to build strong bonds of trust with the research investigators and become accustomed to technology. Seniors were encouraged to take an active role in the technology assessment through personal interviews and focus groups, letting them imagine how this technology will fit into their daily lives and their living environment. Less technophobe people were more likely to accept installing these technologies into their homes. As a next step, we have recruited people that have shown positive attitude towards the USEFIL system and install it to their homes.

Maintenance of the USEFIL system, - while installed at home- required extreme effort from the research team and sometimes was even impossible to keep some of the components to run in a robust way.

NCSR has set up additional pilots within the area of Athens with real end users where mainly tested the usability of some the developed applications.

6.1 Technology assessment, usability and end user acceptance

The Smart TV with the familiarity it presents to the user[1], facilitates both unobtrusiveness (no weird electronic devices to interact with, just a TV set) and ease of use (elders are familiar with TV remote controls)[2]. The results of the evaluation in this deliverable are in line with the finding in the literature. Although in the AHA LL the SUS scoring was not as high as it was expected, which may be attributed to the fact that the seniors utilized the smart TV just to navigate in the USEFIL web portal. Consequently, the low scoring could reflected the difficulty of the seniors in using the USEFIL web portal. Contrary, when the Smart TV entered the participants' home, the SUS score increased. In addition, the Smart TV was also perceived as more enjoyable and less difficult than in the AHA LL environment. Equally important, the participants did not perceived the Smart TV as a monitoring device when it replaced their own TV sets.

A study among 11 seniors (above 60 years old) who utilized tablet, showed high acceptance and satisfaction rates among the user group[3]. Relevant questionnaires can be found in D7.3. In accordance to these findings, the tablet was satisfying for the participants of USEFIL both in the AHA LL as well in

[1] M. Obrist, R. Bernhaupt, and M. Tscheligi, "Interactive TV for the Home: An Ethnographic Study on Users' Requirements and Experiences," Int. J. Hum. Comput. Interact., vol. 24, no. 2, pp. 174–196, Feb. 2008.

[2] E. I. Konstantinidis, P. E. Antoniou, G. Bamparopoulos, and P. D. Bamidis, "A lightweight framework for transparent cross platform communication of controller data in ambient assisted living environments," Inform Sciences, vol. 300, pp. 124–139, Dec. 2014.

[3] F. Werner, K. Werner, and J. Oberzaucher, "Tablets for Seniors–An Evaluation of a Current Model (iPad)," in Ambient Assisted Living, Springer, 2012, pp. 177–184.

the home also. Moreover, it perceived as useful due to the fact that the participants were enthusiastic on learning new technological stuff.

The smart Watch, the mirror and the health monitoring devices were perceived as monitoring tools since their nature and primary role is to measure the heart rate, calculate face signs and measure blood pressure correspondingly. In contrast, when shifted to homes, the participants stopped conceiving the smart watch as a monitoring device.

However, the perception of ease of use, satisfaction, usability and enjoyment shifted to lower levels when these devices entered the participants' home. This could be attributed to the fact that the participants had to interact with the devices, most of the times, without the facilitator's help, who visited them some times the week. An interesting outcome, contrary to the general trend, is that the Smart TV usability levels risen in the home settings. This is perhaps due to the familiarity of the seniors with the TV. Additionally, it was very difficult, if not impossible, by the participants to utilize the smart hub of the tv in order to get access to the USEFIL portal. Based on this observation (during the AHA LL trials), the seniors were not asked to undertake this when in their home.

From both the Living Lab participants' and the House participant's focus groups the following conclusions were drawn:

- The elderly were very positive in introducing new technologies in their life.
- The main obstacles to technology introduction would be in order of severity
    1. Issues of privacy and monitoring
    2. High learning curve and documentation issues
    3. Fear of isolation and substitution of real world interactions with electronic ones.
    4. Stigma of helplessness associated with assistive technologies
- The needs of the elderly from an AAL system can be focused on (in order of significance):
    - Emergency alerting and immediate support
    - Unobtrusive intervention for maintaining an acceptable state of well being
    - Added value services such as suggestions and e-commerce.
- The elderly perceived the commercial cost of such a platform as prohibitive for a standard B2C model. Perceived viable models included (in order of perceived viability):
    1. B2B model with subsidization of cost to end user
    2. B2I model with social security subsidization of cost to end user.
    3. Mixed B2I2B (business to institution to business) with cost subsidization (against the end user) shared between commercial providers and social security institutions

It must be noted that the main perceptions altered between Lab pilots and the House pilot participants were regarding technology intrusion, as well as usability and functionality impact when the technology migrated from the Lab to the familiar and intimate space of the Home. Specifically what was altered was:

- The perception of technology and monitoring invasiveness which was greatly exacerbated when the technology was deployed in house.
- The impact of usability issues which was also greatly exacerbated by experiencing the same, even milder usability issues, in the familiar home space
- The impact of functional inconsistencies in the health measurement modules also greatly exacerbated by the
- The hierarchy of benefits of the platform shifted when it was deployed in the house. Specifically there was a significant shift from emergency alerting and immediate support to Wellness and health maintenance interventions.

Based on usability findings and the monitoring added value that each device has to offer, according to the correlations extracted in lab and home pilots, one can easily see the trade off that there exists among sensors diagnostic accuracy and acceptance of the technology by seniors. For example, TabletPC was one of the most favourable devices among the seniors used the USEFIL system. They enjoyed learning how to use it and they were keen to use it. In addition, stating their mood through an intuitive self-report, provided rich information about the emotional health status of the participants. On the other hand, although WWU provided great monitoring capabilities related to mobility patterns of the seniors and was also related to recognition of depressive symptomatology, there were problems in using it in daily life, since its battery life was considered too short for seniors, who had to charge it every day. This resulted to leave it for days charging, neglecting the need for wearing it. Therefore, there was a lack of getting data most of the days, due to the battery limitation.

6.2 Public Video production showing the USEFIL Pilots

A public video was also produced to demonstrate further details of the pilot activities of the project. The video is accessible in YouTube through

https://www.youtube.com/watch?v=4B7hggKdfEM&feature=youtu.be

7 Challenges Encountered

The USEFIL project has been an immensely interesting project, which resulted in prototypes being created and used by trial users. There have been many challenges along the way. One of them is the method to transfer feelings into technologically recognizable behaviours. An example has been the recognition of a patient's facial expression and whether this could indeed provide a hint to a person's mood as there is some doubt whether humans let emotions "leak through" to the face when there is no receiver for the facial display is present to interact with. One of the main challenges facing the project concerned the development of a "smart" mirror that uses an inexpensive web camera equipped with microphone and can assist in assessing the physiological, emotional and functional state of the monitored user. The physiological signs include heart rate, breathing rate, colour paleness and pupil size among the others. Their emotional state was accessed initially via face analysis and in stage two via voice analysis.

Other issues concerned the diagnostic value of human movement patterns as it seems that physicians rely on tacit knowledge about such patterns that is difficult to communicate and therefore as yet difficult to implement in a software pattern detector. To resolve this issue, the communication process between engineers and technicians was furthered by providing practical examples of the parameters that have been unobtrusively measured, which were then commented on by the clinical partners.

The codification of events has been another concern so as to come up with a structured approach for monitoring events in order to effectively reach conclusions. The level of difficulty was sometimes increased by different "languages" employed by technological and medical partners.

Another issue for consideration has been the critical mass of subjects partaking in the study as the possibility of patients choosing not to continue testing the developed system could endanger the pilots and the final outcome of the project as a whole. This has been addressed with replacing the drop-out subject in the study with the next randomly selected eligible person.

Finally, the issue of validating and tuning the technological monitoring system, given the novelty of the overall approach, has not been possible using large sample data.