ELF@Home

Elderly sELF-care based on sELF-check of health conditions and sELF-fitness at home

D2.1 Service Requirements Report

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Deliverable nature:	Report (R)
Dissemination level: (Confidentiality)	Public (PU)
Contractual delivery date:	30 November 2013
Actual delivery date:	29 November 2013
Version:	1.0
Total number of pages:	60
Keywords:	Requirements

Abstract

This report contains the results of tasks 2.1, 2.2 and 2.3 of the ELF@Home project and summarizes the functional and non-functional requirements for the proposed system. Requirements were grouped in two categories: functional requirements and non-functional or technical requirements. The methodology used to find functional requirements was based on end-user involvement through focus groups with primary users and interviews with secondary users. Technical requirements are based on the analysis of the functional requirements made by project partners taking into account the foreseen architecture for the proposed solution.

Executive Summary

This report contains the functional and non-functional requirements that will guide the research and development of the ELF@Home system. These requirements have been produced as part of the work in task 2.1 (User functional requirements), task 2.2 (User interface requirements) and task 2.3 (Technical requirements) of the WP2 (Requirements gathering, user involvement and general architecture). The main output of these tasks is a list of requirements that the future system should fulfil in order to satisfy end users and companies expectations. From the user's point of view the system should be functional and usable, while from the perspective of the companies the system should allow the implementation a profitable business model.

Requirements gathering were conducted by involving the three main actors interacting with the ELF@Home system: primary end-users, secondary/tertiary end-users and companies that will provide the service. The methodology used to define the requirements was coupled to the particularities of these actors:

- Primary end-users were involved in the requirement gathering by using a methodology based on focus groups.
- Secondary/tertiary end-users, mainly care professionals such as doctors or nurses, were involved by interviews.
- Companies were involved by continuously analysing user requirements and by thinking the technical implications of these requirements.

Most of the requirements listed in the requirements catalogue presented in this report are focus on three groups:

- Functional aspects: what fitness exercises should be implemented in the ELF@Home system and what medical variables should be measured in order to track the health status of the users. These functional requirements affect the required technical development of the project.
- Usability aspects: how users expect to interact with the system and what is the desired interaction channel. These requirements affect also the technology development.
- Technical aspects: technical restrictions that should be taken into account while implementing the functionalities of the previous points.

Major findings in the requirement gathering are related to the importance of allowing social interaction between users and the possibility of including outdoor fitness activities. Although the ELF@Home system is focus on indoor fitness exercises the activities carried out indicate that the ability to interact with other users, the enjoyment of the activities and the possibility to propose outdoor activities are important aspects for end-users. Users are also very interested in the possibility of tracking their health status over time. From the technical point of view, some important requirements arose during this initial analysis: the possibility of supporting multiple users in the same home and privacy and security aspects are the most important requirements studied.

Conclusion

The requirements listed in this report will be used in the following phases of the ELF@Home project to guide the technical development of the proposed solution ensuring that the final solution is tailored to user needs and expectations.

Document Information

Acronym	ELF@Home
Full Title	elderly sELF-care based on sELF-check of health conditions and sELF-fitness at home
Project URL	http://www.elfathome.eu/
Document URL	http://www.elfathome.eu/results/public-deliverables

Deliverable	**Number**	D2.1	**Title**	Service Requirements Report
Work Package	**Number**	WP2	**Title**	Requirements gathering, user involvement and general architecture

Date of Delivery	**Contractual**	M6	**Actual**	M6
Status	version 1.0		final x	
Nature	prototype □ report x demonstrator □ other □			
Dissemination level	public x restricted □			

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Keywords	Requirements

Version Log			
Issue Date	**Rev. No.**	**Author**	**Change**
2013/09/10	0.1	John Waterworth	Initial structure/skeleton
2013/09/24	0.2	Juan Luis Carús	Initial content for technical requirements
2013/09/11	0.3	John Waterworth	Initial content for user requirements
2013/10/16	0.4	Rainer Diebold	Contribution to technical requirements
2013/11/03	0.5	John Waterworth	Contribution to user requirements
2013/11/04	0.6	Johan Olsson	Contribution to technical requirements
2013/11/05	0.7	John Waterworth	Contribution to user requirements
2013/11/05	0.8	John Waterworth	User requirements review
2013/11/07	0.9	Paula Álvarez	Contribution with Medical requirements
2013/11/08	0.10	Víctor Peláez	First complete draft
2013/11/20	0.11	Víctor Peláez	Second Complete draft
2013/11/25	0.12	John Waterworth	Initial review
2013/11/26	0.13	Víctor Peláez	Review 1 of second complete draft
2013/11/26	0.14	Daniel Tantinger	Review 2 of second complete draft
2013/11/27	1.0	Juan Luis Carús	Final version

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Abbreviations

AAL: Ambient Assisted Living

BPM: Beats Per Minute

HDP: Health Device Profile

HL7: Health Level Seven

HR_{max}: Maximum heart rate

ICT: Information and Communication Technologies

ISP: Intelligent Service Platform

REST: Representational State Transfer

SOA: Service Oriented Architectures

WP: Work Package

Definitions

ELF@Home: Elderly sELF-care based on sELF-check of health conditions and sELF-fitness at home.

1 Introduction

This document introduces the benefits of exercise for the elderly and the user involvement approach adopted for ELF@Home, and then reports the results of Task 2.1 – User functional requirements and Task 2.2 – User interface requirements (Section 2), and Task 2.3 Technical requirements (Section 3). The complete list of functional and non-functional requirements will be used as input for the development of the ELF@Home system.

1.1 Physical exercise and the elderly

It is well known that physical exercise has a significant beneficial effect on health. Furthermore, in recent years there have been many investigations that conclude that the absence of this exercise is related to the development, maintenance and worsening of many chronic diseases, such as cardiovascular disease, type 2 diabetes mellitus, colon and breast cancer, and cognitive decline in the elderly.

Ischemic heart disease, along with stroke and other cardiovascular diseases is one of the main causes of death in industrialized countries, and it has been observed that regular physical activity is associated with a lower risk of developing such diseases. In order to establish what kind of exercise would have more benefits in the elderly, it would be wise to consider the following:

- The correlation between the amount of physical activity and health benefit: you can get great health benefits by practicing small amounts of exercise and this benefit does not have to scale up by increasing the amount of the same, as in ischemic heart disease.
- The intensity of physical activity: we know that moderate and high intensity physical activity have a positive effect on cardiovascular health. Although, there is no evidence on low intensity exercises, we do know that for people over 65 years of age there is a correlation between walking and a lower risk of ischemic heart disease.
- Frequency of physical activity: since it has been shown that in people with cardiovascular risk factors training once a week does not reduce mortality, and practicing sporadic intense exercise even increases the risk of cardiovascular events, experts conclude that practicing exercise 3 times a week, and if possible, every day would be the best option.

On the other hand, physical activity is recognized as a highly protective factor in cognitive functions of the elderly, both in normal brain aging and in different stages of cognitive impairment. Many studies on healthy population have shown how physical exercise is associated with less deterioration of cognitive functions, highlighting the improvement in memory and attention.

A review of the different studies in this matter conclude that there is a high probability that exercise would have an impact on cognitive functions, preventing age relating cognitive decline and improving cognitive functions in mild cognitive impairment. Resistance or aerobic activities would be associated with improvements in cognitive performance, while non-aerobic exercises, such as stretching or relaxation, would not offer the same results.

From the point of view of public health, both cardiovascular disease and cognitive impairment are main problems, both for its prevalence and for the economic costs involved. There is an increased dependence on drugs in the prevention of cardiovascular disease, while we attend a lack of effective pharmacological treatments for cognitive impairment; therefore, the emphasis on physical exercise becomes of high importance, especially in the elderly, who are not particularly familiarized with physical activity.

1.2 User involvement in ELF@Home

The overall aim of user involvement in ELF@Home is to conduct a truly user-driven project, in which the users participate as part of the project team and on their own terms. In this way, the project will develop a product or range of products that target users are more likely to want to use, and be able to use.

During the ELF@Home project in Sweden we are working according to the e-Inclusion approach [1]. The e-Inclusion approach reinforces the elderly's full participation in a project by building up their experience of technology in order for them to have opinions and to express their views about the proposed products during the process of design and implementation. The approach also ensures that a usable product is produced for the intended target group.

The user involvement approach taken was motivated by prior experience with innovating technology with and for elderly users, and in particular the following insights: 1) The elderly, like all "age groups" are not homogenous in terms of prior experience with interactive technology, overall capabilities, personalities and interests; 2) They are generally reluctant to express their views, needs and priorities as regards new or proposed technology – they tend to be more "polite" than younger people, less confident of their competence, at least initially; it is generally difficult for them to imagine the overall project vision or possibilities of technology.

To get a useful level of user participation it is necessary to take the above factors into account by: 1) discussing individual needs, preferences and priorities as they relate to the project goals; 2) forming focus groups of users to broaden the range of characteristics in terms of, for example, age and fitness levels, as well as to overcome individual reluctance to express their views, and especially negative views of proposed innovations; 3) hold regular meetings, with some "added value" for participants beyond the project goals, to maintain interest, keep the target users informed and involved in the innovation process. This might be something as simple as coffee and cake, or some other social activity such as a meal out or a visit to a place of interest. It is important to establish a social focus group of users, and to get to know individual users, their lifestyles, interests, hobbies, likes and dislikes.

The approach taken to identifying user functional requirements involved three main aspects: 1) interviews with individuals, 2) brainstorming with representative elderly users in focus groups, and 3) information obtained from medical experts.

2 User functional and interface requirements

This section details the results of Task 2.1 – User functional requirements (T2.1), and Task 2.2 – User interface requirements (T2.2). The aim of T2.1 was to establish the functionalities of the complete service by taking into account end users opinions, as well as medical and enterprises expertise. The aim of T2.2 was to analyse user interface requirements by interviewing end-users and by holding user focus group meetings. In this task we tested the home-fitness idea and motion based interfaces to gather the requirements and recommendations for the designers. In turn the designers propose different approaches for each part of the interface to the elderly, in order to get their advice and feedback. The following table summarises the functional requirements (FRs) detailed in the following sections.

Table 1: Functional requirements

Id	Requirement	WP	Importance	Comments	Section
FR1	Sensor devices easy interaction	WP3	High	Sensors must be easy-to-use and unobtrusive	2.1.1.3
RF2	Fitness exercises support	WP5	High	It must be a Combination of resistance and strength exercises	2.1.2.3
FR3	Caregiver health status evaluation	WP5	Medium	At the start of the program, a formal caregiver must evaluate the user health status deciding which exercises are not adequate for him	2.1.4.2
FR4	Medical variables acquisition	WP3	High	The system should indicate users the variables to be acquired according to the frequency acquisition.	2.1.3
FR5	Check health conditions to do exercises	WP5	High	The health status must be analysed to detect if the user has healthy conditions to do the exercises.	2.1.4.2
FR6	Warm up exercises support	WP4 WP5	High	Users must warm up before doing physical exercises	2.1.4.1
FR7	Fitness exercises personalization support	WP5	High	Fitness exercises must be personalized for each user according to its health status. The fitness exercises must be divided into levels and users will change the level according to its improvements.	2.1.4.2
FR8	Fitness exercise sessions generation	WP4 WP5	Medium	Fitness exercise sessions must last around 20 minutes. They must be dynamic to improve the user motivation and combining equitably resistance and strength exercises.	2.1.4.1
FR9	Fitness exercise assistance support	WP4	High	The system must assist elderly doing the exercises. It must encourage elderly and detect if they are not doing the exercise rightly.	2.1.4.1
FR10	Outdoor exercises support	WP5	Low	The system should suggest outdoor exercises to users.	2.1.5
FR11	Exercises motivation support	WP3 WP4 WP5	High	The exercises motivation is crucial to the system to ensure user involvement	2.1.6

2.1 User functional requirements

This sub-section details the main results of Task 2.1 – User functional requirements. The aim of T2.1 was to establish the functionalities of the complete service by taking into account end users opinions, as well as medical and enterprises expertise. The results consist of the use case catalogue, a specification of medical requirements, the fitness exercises catalogue, and the medical variables catalogue.

To identify relevant views for Task 2.1 in interviews and focus groups, a set of open-ended questions was used to prompt discussions (see Table 2).

Table 2: Open-ended questions

Open-ended question prompts for Task 2.1

(to be adapted/interpreted by interviewer as needed/appropriate)

1. General information on users

Demographics of users

Age, gender, marital status

Living conditions

Family and social life

Current health situation

Current use of technology

Mobile phones (smart? Uses?), TV box, computer and internet, tablet?, types of games if any (e.g. Kinect, Wii)

2. Current situation of elderly exercising and fitness awareness

What exercise do you take?

Solitary or social?

When taken, how frequent?

How do you feel about current level of fitness?

How do you keep track of how fit you are?

Do you have regular medical check-ups? If so, where and how often?

How do you feel about keep fit exercises?

What inhibits you from doing more exercises?

Would you like to do more exercises?

Would you like to have more information about your own fitness?

3. View of future use of ELF@Home

When and where would you like to do more exercise?

How do you feel about checking your own fitness at home?

How do you feel about exercising in front of the TV at home?

4. Specific functional requirements

To discuss:

Functional requirements regarding sensor devices?

Functional requirements regarding TV/motion interface?

2.1.1 Use case catalogue

2.1.1.1 Types of users

The Swedish user group consists of 12 elderly people, age range 71-85, eight women and four men, living in their own homes. There are two couples and the rest of the group members are living alone. Most of the Swedish users have some experience with using computers, but the degree of computer literacy varies a lot within the group.

2.1.1.2 Types of usages

Most of the Swedish users are physically active to some extent, but they all say that it is not enough and want their physical activities to be more frequent, "fun" and regular.

Examples of the activities they do today are; walking (some with a dog), cycling, shovelling snow, morning workout (only one person did this), Nordic (cross-country) skiing, choir singing, and gardening. Most of the users regard music as helpful during exercise.

Today none of the users measure their fitness or performance on activities.

2.1.1.3 When and where users would like to do exercises

Most of the users think that physical activities should be a regular routine in their daily lives. They want to do their physical activity both in their home and outside the home, but they prefer to do most of it outdoors.

There were different opinions about whether physical activities should be carried out individually or in groups. Most believe that it should be possible to do it both individually and in groups, and that it is important that some physical activities can be performed both indoors and outdoors.

The Swedish users do not have much experience with sensor devices, but they have tried a camera-based emotion detection application, to which they had a very negative attitude at first. But after testing it themselves they found it good and useful.

They are willing to try different sensor devices, but they must see the benefit from using them and it must be unobtrusive and possible to wear both indoors and outdoors.

They do not see any problem with using a TV/motion interface but it must be engaging and they should see some benefit from doing that.

2.1.2 Exercise motivation of elderly people

In order to help pointing the development in the right direction, Innovationsmanufaktur started some investigations and compilations regarding exercise motivation with respect to the ELF@Home project and condensed those into the following conclusions. Detailed information on this can be found in Appendix I.

2.1.2.1 Motivations/stimulations – general thoughts

- Health alone is a core motivator generally influencing people´s behaviour, but not immediately stimulating action. Health-sustaining activities therefore need more attractors.
- The group of the elderly is rather heterogeneous. Therefore, it is necessary to form subgroups concerning exercise motivation, health affinity etc., and address each of these groups individually.
- Elderly people in general like to exercise outside enjoying the nature and the fresh air.
- No product for the elderly should be sold as "product for elderly". Elderly people want to buy something adapted to their needs but not something that stigmatizes them as old.

2.1.2.2 Motivations/stimulations – focus

- One of the best exercise stimulations is fun.
- Many elderly people like to perform activities that keep them in contact with people they know, especially their children and grandchildren.
- Especially elderly men often like to compete with each other concerning best time, longest route etc.
- Especially elderly women often like to work out together, exchanging views and ideas and enjoying the feeling of doing sport together ("social sport").

2.1.2.3 Motivations/stimulations – realization

- Exercise stimulations should, if at all possible, be combined with other effects like gaming, social interaction, routines etc.
- Exercise stimulations need to have the right level of challenge and routine. Usually, the elder people get, the less important challenges become. However, that does not necessarily mean eliminating all challenge.
- To retain the fun in exercise stimulation there must be some sort of change or diversion. This could be realized by different levels and challenges, games, surprises, and other means.
- Exercise stimulations should be integrated into the living environment (social, temporal and emotional) of the elderly and should have a close relation to their daily activities so they can be used to give the elderly recommendations on how they could easily integrate exercise into their daily lives.
- Function is more important than design for elderly people. Simple usability has the highest priority (e.g. good contrast, user friendly buttons, font, font size etc.)

- The realization of exercise should take place in an inviting atmosphere, in which the elderly people feel safe and that they enjoy being in.

- Many elderly people prefer paying a little bit more to have a good consulting to being alone with a fitness program. They are afraid of doing something wrong, so they really need a good introduction, constant feedback, and a feeling of safety if they are to accept exercise offers.

- Getting positive feedback and seeing their training progress is very important to the elderly. Therefore, an assistant showing the elderly people benefit points, giving them individual feedback and further stimulations etc. should be developed; however, with a notion of personalization rather than a purely technological look and feel.

- Regular fixed dates with other people or with a virtual assistant for the training sessions make a sustainable success easier.

- As far as the exterior of products is concerned, elderly people often like natural materials like wood, wool etc.

2.1.3 Medical requirements

The following sections describe some medical opinions about physical activity in older people. These data were gathered through a questionnaire developed by the SGGPA professionals that take part in the ELF@Home project. The questionnaires were completed by healthcare professionals who are not participating in this project.

2.1.3.1 Questionnaire

Two factors were taken into account in the questionnaire design process: the questionnaire should not be very long and it should be easy to answer. These requirements were considered because the healthcare professionals requested to answer the questionnaire were volunteers. Therefore, the questionnaire had only 9 questions.

The questions in the questionnaire can be grouped into two main topics:

- **Physical exercise (Questions 1 – 5)**: Healthcare professionals were asked about the physical exercises they usually recommend to their patients (whether they usually recommend it, the exercise frequency and intensity and the more useful kind of exercises to prevent frailty).
- **ELF@Home system (Questions 6 - 9**): There are some final questions about their impressions on the system proposed in the ELF@Home project (whether they find it useful and if they would recommend it to their patients)

The complete medical questionnaire is described below (Table 3):

Table 3: Medical Questionnaire

1. Do you find interesting to recommend physical exercise in daily life to your patients?

   YES ☐ NO ☐

2. If you recommend physical exercise, do you know the percentage of your patients that do it?
   .....

3. Do you recommend the physical exercise to your patients in a general way ("you should do some exercise") or do you give them a series of specific exercises?
   .....

4. For detecting frailty in the elderly, which kind of exercises do you find more interesting: strength or resistance ones?
   .....

5. Which frequency of exercise do you recommend to your patients (days/week) and which should be the duration of each session?

   Days/week: …….
   Session duration (minutes): …….

6. Do you think that the system we present is adequate?

   YES ☐ NO ☐

7. How would you improve the system?
   .....

8. Would you use it with your patients?

   YES ☐ NO ☐

9. If a technical device that facilitates the scheduling and monitoring of physical exercise in older people was commercialized, do you think people would buy it?
   .....

2.1.3.2 Questionnaire results

The questionnaire was answered by seven healthcare professionals. They were given the questions of Table 3 and a description of the ELF@Home proposed system, so they could give their opinions about it. The user profiles cover different areas related to healthcare for older people: three geriatricians, one occupational therapist, one general practitioner, one sports medicine doctor and one physiotherapist.

Physical exercise

Every healthcare professional agrees on the beneficial effect on health of physical exercise, so all of them recommend physical exercise to their patients. Nevertheless, they all know that a low percentage of the patients do the exercises. This percentage varies in their answers but all of them (except the physiotherapist) agree that it is lower than 50%. Some of them give more specific answers, defining this percentage as "lower than 10%", "between 15 and 20%" or "25%". The sports medicine doctor states a division between his patients: the ones that are being treated for a specific problem and the ones that want a healthier life. All of patients from the first group do the recommended exercises whereas only 50% of the second group follows the doctor recommendations. On the other hand, the physiotherapist thinks that almost all of his patients follow his recommendations.

Healthcare professionals were also asked about their method for recommending exercise. Two professionals stated that they give a series of specific exercises to their patients, in contrast to other four professionals that recommend exercise in a more general way and if the patients ask for or need more help, then they provide specific exercises. Another professional answered that, as he treats patients of a residence for the elderly, all of them do specific exercises in the activities of the residence. Results are shown in Table 4.

Table 4: Results for Question 3

Q3: Do you recommend the physical exercise to your patients in a general way ("you should do some exercise") or do you give them a series of specific exercises?	
Answer	**Percentage**
In a general way	57 %
Specific exercises	29 %
Other	14 %

There are two groups of exercises for preventing frailty in the elderly: resistance and strength exercises. Table 5 shows the opinions given by the professionals about their preferences on this matter. Nearly the half (43%) of the healthcare professionals prefer resistance exercises whereas 28.5% of them prefer strength ones. The remaining 28.5% thinks that both of them need to be done.

Table 5: Results for Question 4

Q4: For preventing frailty in the elderly, which kind of exercises do you find more interesting: strength or resistance ones?	
Answer	**Percentage**
Resistance exercises	43 %
Strength exercises	28.5 %
Both	28.5 %

Table 6 shows the results for the exercise frequency that professionals recommend to their patients. Regarding the number of days a week, none of them proposes less than 3 days each week. Five out of seven recommend 3 to 5 sessions a week, whereas the other two professionals prefer a higher frequency (from 5 to 7 sessions a week).

Concerning the session duration, their answers are very varied. One of them prefers short sessions (20 minutes), and other one prefers long sessions (60 minutes). Four other professionals propose different duration ranges that can be defined as 30 to 60 minutes. In addition, there is one professional that proposes a short time (20 to 30 minutes) for fitness exercises and a long time (60 to 120 minutes) for walking.

Table 6: Results for Question 5

Q5: Which frequency of exercise do you recommend to your patients (days/week) and which should be the duration of each session?		
Professional	**Days / Week**	**Session duration (mins)**
1	3 - 5	30 - 40
2	5 - 7	30 - 60
3	7	20 - 30 of exercises 60 - 120 of walking
4	3 or more	60 or more
5	At least 3	At least 40
6	5	20
7	3 - 4	45 at most

ELF@Home System

The professionals also had to answer four questions about the ELF@Home System. The first one was intended to know if the ELF@Home system is adequate. They were unanimous in their answers, because 100% of them considered that it is adequate.

Regarding their interest in using the system with their patients, 6 out of 7 (86%) would use it, and only one professional answered negatively. Table 7 shows these data.

Table 7: Results for Question 8

Q8: Would you use it with your patients?	
Answer	**Percentage**
Yes	86 %
No	14 %

The questionnaire also took into account the commercial aspects of the proposed system, so healthcare professionals had to answer if people would buy it. The results are shown in Table 8.

Table 8: Results for Question 9

Q9: If a technical device that facilitates the scheduling and monitoring of physical exercise in older people was commercialized, do you think people would buy it?	
Answer	**Percentage**
Yes	57 %
No	29 %
It depends	14 %

- 57% of the professionals (4 out of 7) think that people would buy it. Nevertheless, two of them state that the price and the system features will be a decisive factor. The other two are more optimistic: one of them thinks that people would like a device that "forces" them to do daily exercise and another one thinks that the device demand would had an exponential growth as the development of its possible benefits continues.
- 29% of the professionals (2 out of 7) think that people would not buy it.
- The remaining 14% of professionals (1 out of 7) are not sure about it. This healthcare professional states that it would depend on lot of factors such as price, dissemination, the area that is needed for its use, or its ease of use. He adds that, based on his experience, his patients do not usually buy small equipment (such as chest pulls).

Finally, healthcare professionals were given the opportunity to propose some improvements to the system, with the following results:

- Two healthcare professionals did not propose any improvement.
- One healthcare professional thinks that the figures representing the exercises should include some arrows describing the movement and that they should show a model of an older man.
- Another one thinks that exercises for the arms should be included.
- The other three healthcare professionals provide some medical comments for some exercises.

2.1.3.3 Discussion of medical questionnaire results

Questionnaire results show that healthcare professionals give a lot of importance to physical activity in older people, as all of them recommend their patients to do some exercise. Nevertheless, their main problem is that they do not know for sure if a patient is doing the exercise and how often he works out. In fact, they think that only a small percentage (lower than 50%) of their patients really does the recommended exercises. This problem will be solved by the ELF@Home system, as the user's activity will be monitored. This will give the healthcare professionals a lot of information: if a user is doing the exercises, how often he does the exercises, if he does them in a correct way, etc.

Professionals do not agree on the method for exercise recommendation: some of them prefer specific routines and some of them do more general recommendations. The ELF@Home system has been designed to use specific exercises, because the system will test if the user does the exercises in the correct way.

Different opinions were also given for the question about the type of the recommended exercises: some of the professionals prefer the strength exercises whereas some of them prefer the resistance ones. The ELF@Home system should provide both kinds of exercises. The indoor ones are mainly focused on strength but the outdoor ones (walking or jogging) are focused on resistance.

Regarding the frequency and duration of the exercise sessions, healthcare professionals provide very different answers. This may be due to their different profiles and the kind of patients they treat. For the ELF@Home system, the healthcare professionals have recommended indoor and outdoor plans of exercises that establish the frequency and duration of the sessions. These parameters have been defined to be suitable for the potential users of the system.

Questionnaire results show that 100% of the professionals think that the ELF@Home system is adequate and 86% of them would use it with their patients. Nevertheless, they are not sure about the commercialization process of the system. More than the half of them answer affirmatively but the other half think that patients would not buy it or they are not sure about it.

The utility of the proposed system and the healthcare professionals' interest in it is obvious.

2.1.4 Medical variables

The ELF@Home system should be able to collect a set of health indicators in order to track the health status of elderly users and to provide them with a personalized fitness program. The medical variables to collect are related to the potential users of the ELF@Home system. Potential users of the system should have the following characteristics:

- People over 65 years.
- Barthel Index: > 90.
- Without diseases that affect their functional capacity.

The biomedical parameters that should be recorded are described in the following list, including how to measure them and the ideal frequency of record:

- **Cardiovascular Measures:**
  - Blood pressure.
  - Heart frequency.
  - Oxygen saturation.
  - Baseline capillary glucose (if type 2 diabetes mellitus).
  - Position: Decubitus and standing.
  - Frequency: before, immediately after and one minute after exercising.
- **Anthropometric Measures:**
  - Weight.
  - Height.
  - Waist circumference.

- Brachial perimeter
- Body mass index: weight / height^2
- Frequency: 1/week

- **Functional ability test:**
  - Balance: standing, on each foot.
  - Walking speed.
  - Grip strength.
  - Frequency: 1/month.

2.1.5 Indoor exercises

This section describes the set of fitness exercises that should be supported by the ELF@Home system in order to provide good physical training for elderly people from the point of view of the medical science. Considering the main goal of the ELF@Home system, the exercises presented in this section are restricted to exercises that users can do at home.

Different considerations about the personalization and planning of the exercises for users are also described.

2.1.5.1 Fitness exercises catalogue

The set of possible fitness exercises to be supported by the ELF@Home system are described below (Table 9 to Table 25). There is a table describing each exercise, the necessary equipment and the goal of the exercise. The exercises in the catalogue can be divided into two groups according to its objective: resistance exercises and strength exercises.

It has to be taken into account that users should warm up at the beginning and at the end of the exercises. The goals are: to reduce the risk of injury during exercises (the body gradually gets used to the activity), to increase body temperature to reduce the risk of cramps, especially in the muscles, and to mentally prepare users for the exercise in order to increase the performance and benefits of the physical activity.

Table 9: Exercise "Warm-up"

Task	Warm-up
Description	Displacements in different directions doing various exercises: 1. Walk forward and backward 2. Long steps 3. Lift the knees 4. Lift the heels 5. Lateral displacements 6. Shoulder abduction and adduction 7. Forward displacements and standing on one foot
Equipment	None
Objective	Increase the temperature of muscles and joints to prevent further injury
Figure	 **1**  **2**  **3**  **4**  **5**  **6**

Table 10: Exercise "Knee lifts"

Task	Knee lift
Description	1. Stand up with your feet placed about hip-width apart 2. Walk exaggerating the gesture of lifting your knee. Touch your knee with the opposite hand 3. Repeat with the other knee
Equipment	None
Objective	Gait and balance improvement
Group	Resistance exercise
Figure	 **1**  **2**

Table 11: Exercise "Balance with a chair"

Task	One foot balance
Description	1. Using a chair as a support, lift a knee 2. Repeat with each knee
Equipment	A chair
Objective	Static balance
Group	Resistance exercise
Figure	 **1**  **2**

Table 12: Exercise "Balance without a chair"

Task	One foot balance
Description	1. Stand up with your feet placed about hip-width apart 2. Maintain balance with one leg in abduction. You can use a wall or a chair as a support if necessary. 3. Return to the starting position 4. Repeat with the other leg
Equipment	None
Objective	Static balance
Group	Resistance exercise
Figure	 **1**  **2**  **3**  **4**

Table 13: Exercise "Tandem gait"

Task	Tandem
Description	1. Walk on a 3 meters long line placed on the floor 2. To move forward, you must put one foot in front of the other 3. The toes of one foot touch the heel of the other foot 4. It is important that both feet are in contact
Equipment	Floor marking equipment (elastic band, tape or similar)
Objective	Dynamic balance
Group	Resistance exercise
Figure	 **1**  **2**  **3**  **4**

Table 14: Exercise "Lateral walking"

Task	Double lateral step
Description	1. Starting from a point, do a lateral step 2. Put your feet together 3. Do another lateral step 4. Put your feet together and return to the starting point
Equipment	None
Objective	Dynamic balance
Group	Resistance exercise
Figure	 **1**  **2**  **3**  **4**

Table 15: Exercise "Standing from a chair"

Task	Combined movement
Description	1. Sit in a chair 2. Stand up 3. Lift your hands 4. Low your hands 5. Sit down again 6. Lift your legs 7. Maintain a high and constant rate
Equipment	A chair
Objective	Strength endurance
Group	Strength exercise
Figure	 **1**  **2**  **3**  **4**  **5**  **6**

Table 16: Exercise "Arms extension"

Task	Shoulder abduction
Description	1. Stand up with your feet placed about hip-width apart 2. Lift your arms wide apart 3. Take air while performing the abduction, then release it slowly as you return to the initial position
Equipment	None
Objective	Strength
Group	Strength exercise
Figure	 **1**  **2**

Table 17: Exercise "Calves"

Task	Standing heel lift
Description	1. Stand up using a chair as a support 2. Stand on tiptoe lifting your heels
Equipment	None
Objective	Strength
Group	Strength exercise
Figure	 **1**  **2**

Table 18: Exercise "Forward lunge"

Task	Forward lunge
Description	1. Stand up with your feet placed about hip-width apart 2. Lift one leg forward bending both knees 3. Return to the starting position placing your feet parallel. Switch to the other leg
Equipment	None
Objective	Strength
Group	Strength exercise
Figure	 **1**  **2**

Table 19: Exercise "Reverse lunge"

Task	Reverse lunge
Description	1. Stand up with your feet placed about hip-width apart 2. Lift one leg backward bending both knees 3. Return to the starting position placing your feet parallel. Switch to the other leg
Equipment	None
Objective	Strength
Group	Strength exercise
Figure	 **1**  **2**

Table 20: Exercise "Pedalling in a chair"

Task	Pedalling in a chair
Description	1. Sit down in a chair and move your feet as if you were pedalling 2. Your back has to be leant against the backrest
Equipment	A chair
Objective	Strength
Group	Strength exercise
Figure	 **1**  **2**

Table 21: Exercise "Feet flexion/extension"

Task	Ankle plantarflexion/dorsiflexion
Description	1. Sit down in a chair and lift your toes resting your heels on the floor 2. Lift your heels resting your toes on the floor. Try to find the maximum range of movement
Equipment	A chair
Objective	Strength
Group	Strength exercise
Figure	 **1**  **2**

Table 22: Exercise "Push-ups against a wall"

Task	Pressure against a wall
Description	1. Stand up next to a wall with your elbows close to your body 2. Move your body and legs together and aligned towards the wall. Your elbows should be kept close to your body while flexing to prevent shoulder injuries. The further away from the wall your feet are located, the more strength will be needed
Equipment	None
Objective	Strength
Group	Strength exercise
Figure	 **1**  **2**

Table 23: Exercise "Squat"

Task	Squat
Description	1. Stand up with your feet placed about hip-width apart and in a slight external rotation 2. Low yourself until your thighs are almost parallel to the floor
Equipment	None
Objective	Strength
Group	Strength exercise
Figure	 **1**  **2**

Table 24: Exercise "Hip adduction"

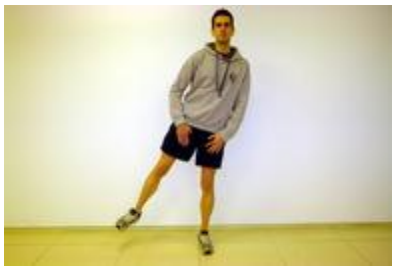
Task	Hip adduction
Description	1. Stand up with your feet together 2. Separate your leg from your hip 3. Return to the starting position 4. Repeat the exercise with the other leg
Equipment	None
Objective	Strength
Group	Strength exercise
Figure	 **1**  **2**  **3**  **4**

Table 25: Exercise "Trunk twist"

Task	Trunk twist
Description	1. Stand up with your feet placed about hip-width apart with your hand held together 2. Move your trunk to the right without moving your feet 3. Return to the starting position 4. Move your trunk to the left without moving your feet
Equipment	None
Objective	Strength
Group	Strength exercise
Figure	 **1**  **2**  **3**  **4**

2.1.5.2 Fitness exercises planning personalization

Depending on the user health status, the fitness exercises suggested to the user should be different. At the beginning of the activity program, a formal caregiver should evaluate the user health status deciding which exercises are not adequate for him.

As a starting point an exercise plan divided in 16 levels should be supported. Each level is characterized by a number of series, repetitions and resting time between exercises. All users should start at level 1 and skipping levels should not be allowed. Table 25 shows the suggested fitness plan to be supported by the ELF@Home system.

Change between levels should be evaluated each week according to user's performance and/or health status during the previous week. Users can change the level or can stay one more week on the same level depending on these conditions.

The exercises planning for each day should be generated randomly to provide a specific number of exercises from the resistance group and from the strength group. The exercise planning should be generated to last about 20 minutes.

The health status should be analysed in real time to detect if the user has healthy conditions (blood pressure, heart rate and oxygen saturation) to do the exercises. If the user is not in healthy conditions, the fitness

exercise planning should not be provided. The healthy conditions to do exercises are defined using the following thresholds. If a user has medical values outside of the healthy thresholds, he should be advised to see a doctor.

- Maximum Heart rate: 60% of HR_{max}
  - HR_{max} = 220 bpm – age (for males)
  - HR_{max} = 210 bpm – age (for females)
- Maximum Blood pressure: 160/90 mmHg
- Minimum Oxygen saturation: 92%

The heart rate can also be monitored in real time during the exercises execution. If the heart rate is above 70% of the HRmax, users must be advised to decrement exercise intensity. If the heart rate is above the 80% of HRmax, the fitness exercise plan must be stopped.

Table 26: Frequency recommendations

LEVEL	1	2	3	4	5	6	7	8
SERIES	2	2	3	3	3	3	3	3
REPETITIONS	8	10	10	12	12	12	15	15
RESTING TIME	30-60"	30-60"	30-60"	30-60"	30-60"	30-60"	30-60"	30-60"

LEVEL	9	10	11	12	13	14	15	16
SERIES	3	3	3	3	3	3	3	3
REPETITIONS	15	20	20	20	25	25	25	30
RESTING TIME	30-60"	30-60"	30-60"	30-60"	30-60"	30-60"	30-60"	30-60"

2.1.6 Outdoor exercises

In addition to the indoor exercises described in section o, this section provides guidelines for outdoor exercises that can complement the indoor exercises.

The kind of outdoor exercises that can be considered need to fulfil these requirements:

- There is no need for special knowledge to do the exercise.
- No expensive equipment is needed.
- It has to be customizable, because each user has different physical characteristics.

The proposed outdoor exercise is walking and/or jogging. It is a very simple exercise that everybody can do, no special equipment is needed and the user cannot do it easily at home. This kind of exercise can be personalized for each user by adjusting its intensity. For that, two different plans are described: the first one

is for walking (called Basic Exercise Plan) and the other one combines walking and jogging (called Advanced Exercise Plan).

2.1.6.1 Exercise intensity

In order to track exercises intensity it should be necessary to measure the user heart rate. The ideal heart rate while doing physical activity is calculated as 60 - 65% of the maximum heart rate. The maximum heart rate (HR_{max}) is defined as "the highest heart rate an individual can achieve without severe problems through exercise stress" and depends on age and sex. It can be calculated by these formulas:

- HR_{max} = 220 bpm – age (for males)
- HR_{max} = 210 bpm – age (for females)

For example, a 70 year old man will have a HR_{max} of 220 – 70 = 150 bpm, so he should do exercise at 90 bpm. If the user's heart rate is lower than this threshold, the exercise will not have the desired training effect whereas a higher heart rate means that the intensity of the exercise is too demanding for him.

In order to ensure an appropriate intensity of the outdoor exercise users should be equipped with a heart rate monitor or other sensor able to obtain an indirect measurement of the heart rate. This device should have the recommended heart rate for each person and it should give advices to the user:

- If the user's heart rate is lower than the recommended heart rate the user should increase the pace.
- If the user's heart rate is higher than the recommended heart rate the user should lower the pace.

Therefore, the support of outdoor fitness activities enforces some technical requirements for the activity sensor proposed in the ELF@Home system:

- Heart rate monitoring.
- Heart rate threshold verification.
- User interface to warn user about heart rate thresholds.
- Optional: Position tracking

For a meaningful analysis of user activities, the activity sensor has to be able to measure the following data:

- Movement in all axes.
- Heart rate.

The minimum requirement for tracking the user's movement is to measure relative movement of the user. This could be done using three accelerometers and three gyroscopes. For an absolute reference of the movement three magnetometer sensors can be used. Based on this sensor data it will be possible to determine the position of the user while moving (angled, upside-down, etc.).

For measuring heart rates the sensor element has to be attached to specific areas of a body (e.g. a chest belt). There are a number of stand-alone sensors available on the market. They could send the measured data via a wireless protocol (e.g. Bluetooth or ANT+) to the activity sensor.

The internal battery of the activity sensor must have a big capacity to enable a long-enough measurement session (e.g. a long walking session of about 4-5h). For uncomplicated handling by the user, charging the battery will be done via contactless charging (Qi-technology).

One of the key requirements coming out of the user interviews regarding the activity sensor is about "wearability". The activity sensor has to be small, lightweight, easy to attach/mount and unobtrusive for normal body movements. One consequence of this is that the heart-rate sensor should be de-coupled from the activity sensor.

2.1.6.2 Exercise plans

Two different exercise plans are provided, a Basic Exercise Plan (for walking) and an Advanced Exercise Plan (for walking and jogging).

When a user starts this outdoor training, the system should recommend him to start with the Basic Exercise Plan. After completing it, users should proceed with the Advanced Exercise Plan. Within both plans it has to be ensured that the user stays in the recommended heart rate zone to ensure a positive training effect.

Although for some users the Basic Exercise Plan could be too simple, it is advisable to complete all the basic sessions before starting the advanced training.

Exercise sessions

Each plan is divided in levels, having each level a recommended duration of one week. Each level has a different number of sessions, being each session one day of training. The workout for each session is described in Table 28 for the Basic and Table 29 for the Advanced Plan.

It is important that the user does some warm up – stretching before and after each session. He/she should have to do all of the exercises shown in Table 8. Each one of them is meant for stretching a group of muscles.

Table 27: Stretching exercises

Exercise	Duration	Figure
1	20 - 30" each leg	  Right leg Left leg
2	5 – 10" each leg	  Right leg Left leg
3	10 – 15" each leg	 Right leg

		 Left leg
4	20 – 30"	
5	10 – 15"	
6	10" each leg	 Right leg  Left leg
7	10 – 15"	
8	15 – 20" each side	 Right side

		 Left side
9	10 – 15" each leg	 Right leg  Left leg
10	10 – 20"	
11	8 – 10" each side	 Right side  Left side

12	5" twice	

Basic Exercise Plan

The Basic Exercise Plan is a very simple plan because the only proposed exercise is walking. In each session, the user will have to walk for as many minutes as Table 9 shows. As the weeks go by, the duration of the exercise will be increased.

Table 28: Basic Exercise Plan

Level	Session	Description
Levels 1, 2, 3	Tuesday	30' walking
	Thursday	35' walking
	Saturday	60' walking
Levels 4, 5, 6	Tuesday	35' walking
	Thursday	40' walking
	Saturday	65' walking
Levels 7, 8, 9	Tuesday	40' walking
	Thursday	45' walking
	Saturday	70' walking
Levels 10, 11, 12	Tuesday	45' walking
	Thursday	50' walking
	Saturday	75' walking
Levels 13, 14, 15	Tuesday	50' walking
	Thursday	55' walking
	Saturday	80' walking
Levels 16, 17, 18	Tuesday	55' walking
	Thursday	60' walking
	Saturday	85' walking
Levels 19, 20, 21	Tuesday	60' walking
	Thursday	65' walking
	Saturday	90' walking

Levels 22, 23, 24	Tuesday	65' walking
	Thursday	70' walking
	Saturday	95' walking

Advanced Exercise Plan

The Advanced Exercise Plan is designed as an initiation to jogging. As its intensity is higher than the Basic Exercise Plan, the first few levels combine walking and jogging. Gradually, time for walking should be shortened and time for jogging should be lengthened, so by level 12 the user should be ready to do sessions of jogging without walking.

The sessions in this plan will take place three times a week until levels 11 and 12, when there should be four sessions. The Advanced Exercise Plan is described in Table 29.

Table 29: Advanced Exercise Plan

Level	Session	Description
Level 1	Tuesday	10' walking + 3' jogging + 5' walking + 3' jogging + 4' walking + 3' jogging + 5' walking
	Thursday	10' walking + 3' jogging + 5' walking + 3' jogging + 4' walking + 3' jogging + 3' walking
	Sunday	10' walking + 4' jogging + 5' walking + 3' jogging + 4' walking + 3' jogging + 3' walking + 3' jogging
Level 2	Tuesday	9' walking + 5' jogging + 4' walking + 4' jogging + 4' walking + 4' jogging + 2' walking
	Thursday	9' walking + 5' jogging + 4' walking + 4' jogging + 4' walking + 4' jogging+ 2' walking
	Sunday	9' walking + 5' jogging + 4' walking + 5' jogging + 4' walking + 5' jogging+ 5' walking + 5' jogging+ 5' walking
Level 3	Tuesday	8' walking + 5' jogging + 4' walking + 5' jogging + 4' walking + 5' jogging + 4' walking + 5' jogging + 2' walking
	Thursday	8' walking + 5' jogging + 4' walking + 5' jogging + 4' walking + 5' jogging + 4' walking + 5' jogging + 2' walking
	Sunday	8' walking + 6' jogging + 4' walking + 5' jogging + 4' walking + 5' jogging + 4' walking + 5' jogging + 2' walking

Level 4	Tuesday	8' walking + 7' jogging + 3' walking + 6' jogging + 3' walking + 5' jogging + 4' walking + 5' jogging +2' walking
	Thursday	8' walking + 7' jogging + 3' walking + 6' jogging + 3' walking + 5' jogging + 4' walking + 5' jogging + 2' walking
	Sunday	8' walking + 7' jogging + 3' walking + 6' jogging + 3' walking + 5' jogging + 4' walking + 5' jogging + 2' walking
Level 5	Tuesday	6' walking + 10' jogging + 3' walking + 9' jogging + 4' walking + 9' jogging
	Thursday	6' walking + 10' jogging + 3' walking + 9' jogging + 4' walking + 9' jogging
	Sunday	6' walking + 12' jogging + 3' walking + 10' jogging + 4' walking + 10' jogging
Level 6	Tuesday	5' walking + 12' jogging + 3' walking + 12' jogging + 3' walking + 10' jogging
	Thursday	5' walking + 12' jogging + 3' walking + 12' jogging + 3' walking + 10' jogging
	Sunday	5' walking + 15' jogging + 3' walking + 15' jogging + 3' walking + 10' jogging
Level 7	Tuesday	5' walking + 15' jogging + 2' walking + 15' jogging + 2' walking + 10' jogging
	Thursday	5' walking + 15' jogging + 2' walking + 15' jogging + 2' walking + 10' jogging
	Sunday	5' walking + 18' jogging + 2' walking + 18' jogging + 2' walking + 15' jogging
Level 8	Tuesday	5' walking + 16' jogging + 2' walking + 15' jogging + 2' walking + 15' jogging
	Thursday	5' walking + 16' jogging + 2' walking + 15' jogging + 2' walking + 15' jogging
	Sunday	5' walking + 20' jogging + 2' walking + 18' jogging + 2' walking + 15' jogging

Level 9	Tuesday	5' walking + 25' jogging + 2' walking + 20' jogging
	Thursday	5' walking + 25' jogging + 2' walking + 20' jogging
	Sunday	5' walking + 30' jogging + 2' walking + 25' jogging
Level 10	Tuesday	25' jogging + 5' walking + 25' jogging
	Thursday	25' jogging + 5' walking + 25' jogging
	Sunday	35' jogging + 5' walking + 25' jogging
Level 11	Tuesday	32' jogging + 3' walking + 25' jogging
	Thursday	32' jogging + 3' walking + 25' jogging
	Saturday	25' jogging + 5' walking + 20' jogging
	Sunday	40' jogging + 2' walking + 28' jogging
Level 12	Tuesday	50' jogging
	Thursday	55' jogging
	Saturday	45' jogging
	Sunday	60' jogging

2.2 User interface requirements

This sub-section presents results of Task 2.2 – User interface requirements. The aim of T2.2 was to analyse user interface requirements by interviewing end-users and by holding user focus group meetings. In this task we tested the home-fitness idea and motion based interfaces to gather the requirements and recommendations for the designers. This work will continue during the design phases of the project.

2.2.1 Introduction

The approach taken to identifying user interface requirements involved three main aspects: 1) interviews with individuals, 2) brainstorming with representative elderly users in focus groups, and 3) study of similar available approaches.

Explizit AB interviewed four physiotherapists (2 Swedish and 2 British) on their view of using existing commercial platforms when using the equipment for rehabilitation for elderly. They most often answered that the hardware was good enough but software that had been clinically tested and really could be used as a stand-in for traditional rehabilitation training was not available. The platforms today are developed and used for entertainment and not for fitness activity or health screening/monitoring on a level that was acceptable for the physiotherapist that were interviewed.

2.2.2 Home-fitness idea acceptance

All of the Swedish users like the project idea, and think it is very important for elderly people to keep both physically and mentally active and fit. They are very interested in their own fitness and wellbeing. All of the users would consider doing exercises in front of a TV if they can see the benefit of the exercises - if it is "fun" and motivating. They also see an advantage from being able to see their results in terms of fitness.

In discussion meetings, the following points were raised:

- One of the most important tasks of designing a usable home-fitness system for the elderly is to design it so the users overcome the threshold of starting to do exercises, and to make the exercises fun so that they see the advantages of exercising.
- How the results are shown is also important and how this can help the elderly feel motivated to exercise.
- Ethical issues are important to them, mostly as regards their privacy. They want to know who is going to have access to their personal data apart from themselves. The ideal situation for them would be that doctors, nurses and their physiotherapist have access and can if necessary advise or take care of an acute situation. The physiotherapist could evaluate their exercises and correct them.
- During this discussion it was also suggested that it would be advantageous with a healthcare centre that is only for elderly and that could be connected to the ELF@Home system.

2.2.3 Motion based interface requirements

One important point that was raised during the focus group meetings was that it must be possible to use some project equipment outdoors. It could, for example, be like a watch attached to the arm that can give the user information and measure physical status. Another example that was raised was a T-shirt, but that solution also had some negative effects such as it gets dirty, you have to remember to put it on, you have to wear the same one every day, etc.

Some of the users want to exercise socially in groups but others would rather do it mostly by themselves. The most preferable would be to be able to do both. One idea was to include a social event into some of the exercise programmes, for example during a structured walk with others.

The visualisation of the results must be easy and quick to understand, with the user getting useful information from the displays.

In the focus groups we have also discussed how the results could be used. The results should be used to create awareness of what you do during the day (in the form of physical activity) and to be aware of your physical condition and how it is affected by your activities. As one user expressed it "I get to know my body, how it works and what is best for it".

The results could also be used to discuss health status with friends and family, but not as a competition with other users. It is important that the results are presented in a positive way even though a value is outside the normal value.

The Swedish users were asked if they were willing to wear a chest band that holds the sensors when outdoors, and they were willing to try that. They suggested that the best way to present the result in this case would be with vibrations. A voice that presented the result was also suggested but the drawback with that is that if you are walking with someone when you get some information from the chest band it could be embarrassing.

The idea of a sound signal was also raised and discussed. The weakness with that was seen to be that you might not hear it if you listen to music in your ear phones.

The preferred solution would be for the user to wear a watch that can both measure and display the information. That would also be the most unobtrusive solution. It should be possible to see the results both on the TV, when in the home, and on the watch when outside.

2.2.4 Sensors requirements: maintenance, usage, etc.

The following were initially identified as requirements for biomedical sensor use:

- Simple to use.
- Secure and private.
- More than one user able to share the same equipment.
- Little or no maintenance for the end user.
- Long battery life with charging as infrequent as possible.
- Easy to recharge when needed.

3 Technical requirements

3.1 Requirements summary

This section describes technical requirements for the ELF@Home solution. The analysis of the requirements will be developed in Task 2.5 General Architecture Design (T2.5). The following table summarize the complete list of technical requirements.

Table 30: Technical requirements

Id	Requirement	WP	Importance	Comments
TR1	Multiuser support	WP3,WP4,WP5	Medium	User identification and multiuser support.
TR2	Biomedical sensors support	WP3	High	Support for the integration of multiple biomedical sensors. Use of communication standards and data representation formats.
TR3	Security and privacy	WP3,WP4,WP5	High	Protect data according to Data Protection Laws.
TR4	Component isolation and interoperability	WP3,WP4,WP5	Medium	Ensure integration and interoperability. Allow system components to work independently to customize solution to users.
TR5	Standards support	WP3,WP4,WP5	High	Data representation and communication between components should use standards when possible.
TR6	Limited connectivity support	WP3,WP4,WP5	High	Operation of the system with non-reliable and mobile data connections in order to support people living in remote areas.
TR7	Simplified installation and configuration	WP3,WP4	Medium	Hardware components of the solution should work out of the box without further configuration by the user. Software should be preinstalled and no user intervention should be necessary.
TR8	Simplified maintenance	WP3,WP4	High	Hardware components should require minimum maintenance such as battery replacement or charging.
TR9	Remote assistance support	WP4	Low	Software components should implement the required functionality to allow third parties to remotely help users.

3.2 TR1 – Multiuser support

This technical requirement can be also conceived as a user functional requirement. The focus in this section is in the requirements for the technology to support user identification.

Different system modules should support user identification in order to allow multiple users in the same home to use the ELF@Home solution. User identification should be based in a unique physical or logical identifier avoiding the use of multiple solutions.

Three main components of the system should support user identification:

- Bio-medical sensors: multiple users in the same home can share medical sensors.
- Activity sensor: each user in the system will be provided by an individual activity sensor. Activity sensor can be shared by users if a user identification mechanism is provided to configure the sensor according to the user profile.
- Fitness assistant: multiple users in the same home can share the same equipment (TV) to get access to the fitness assistant.

3.3 TR2 - Bio-medical sensors support

Considering the need of measuring the health status of the user, the ELF@Home system should be able to support several types of bio-medical sensors used in clinics on daily basis. The system should be able to acquire medical variables from different devices but using standard communication protocols and data formats when possible. Medical sensor integration should satisfy the following restrictions:

- The sample methods should be taken according to given instructions to secure a reliable value.
- Multiple users in the same home can share medical sensors.
- All medical sensors should be CE marked.
- All medical sensors should use a standard wireless transmission technology to send data values to the system.

3.4 TR3 – Security and privacy support

All the data collected by the system should be transmitted and stored securely and allowing access only to granted users. This requirement should be taken into account in data transmissions from sensors to the intelligent service platform and between this platform and the Fitness Box. Figure 1 shows an initial diagram of the ELF@Home system in order to describe the information acquired, stored and processed by the system.

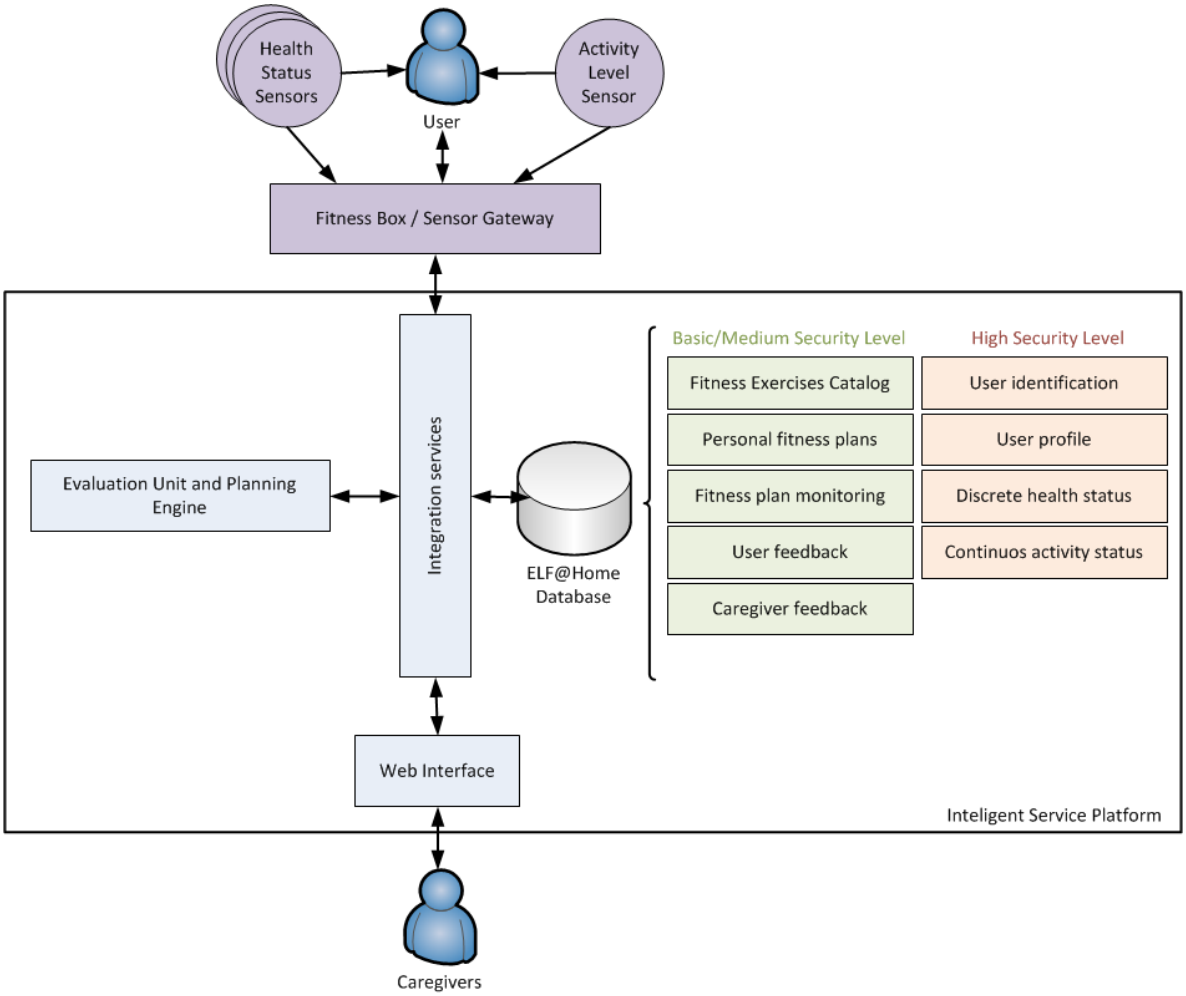


Figure 1: Data, data flows, actors and users of the ELF@Home system

The ELF@Home system will use the following information as shown in Figure 1:

1. User identification: User name, email, address, associated RFID card, associated activity sensor ID.
2. User profile: Date of birth, gender, chronic diseases.
3. Discrete health status: blood pressure measures over time, heart rate measures over time, weight measures over time.
4. Continuous activity status: activity level signal as an accelerometer signal acquired every second (or other high rate frequency).
5. Fitness exercises catalogue: set of fitness activities available in the system.
6. Personal fitness plans: set of fitness activities recommended to a specific user.
7. Fitness Plan monitoring: data concerning user performance during fitness workouts (number of exercises done, repetitions of each exercises, time of the workout, exercises completed properly, exercises not completed).
8. User feedback: data about user opinions (exercises liked or disliked).
9. Caregiver feedback: information provided by formal caregivers about the personal fitness plan generated by the system and the performance of the user over time. Caregivers have the possibility to make changes on the proposed fitness plan.

There are two kinds of users accessing the information:

1. End-user. Elderly people will have access to all their information stored by the system. Users will use the medical sensors and the activity level sensor to send to the system information about their

health status. The fitness assistant (TV interface) will also provide feedback to users about their health status after the successful user identification.

2. Caregivers. The Web interface will allow professional and informal caregivers to evaluate user's health status. Professional users and informal caregivers should be authenticated in the system in order to get access to this information. End-users should authorize caregivers to have access to their information.

The following table summarizes the information used in the system, how it is produced and who can access it.

Table 31: Data types with their origin and access rights

ID	Information	Production	Access
1	User identification	Manually introduced by the end-user when a user signs up in the ELF@Home service.	End-user Caregiver Software in the Intelligent Service Platform (ISP) Fitness Box to provide feedback to the user after successful identification of the user.
2	User profile	Manually introduced by the end-user or a caregiver.	End-user Caregiver Software in the ISP
3	Discrete health status	Produced by medical sensors (CheckUp Care) when the user decides to use them or when the user is asked to use them.	End-user Caregiver Software in the ISP Fitness Box to provide feedback to the user after successful identification of the user.
4	Continuous activity status	Produced automatically by the activity sensor while the device is worn by the user.	End-user Caregiver Software in the ISP Fitness Box to provide feedback to the user after successful identification of the user.
5	Fitness exercises catalogue	Manually introduced by the developers of the system.	Software in the ISP
6	Personal fitness plan	Automatically produced by the ISP software and manually reviewed by the caregiver taking into account user profile.	End-user Caregiver Software in the ISP Fitness Box
7	Fitness Plan monitoring	Automatically produced by the Fitness Box software while the user is doing fitness in front of the fitness box	End-user Caregiver

			Software in the ISP
8	User feedback	Manually introduced by the user through the Fitness Box TV interface.	End-user Caregiver Software in the ISP
9	Caregiver feedback	Manually introduced by the caregiver through the Web interface.	End-user Caregiver Software in the ISP

During the project development some employees of the consortium partners will also have access to the information in databases in order to carry out research tasks.

Deployment of the ELF@Home system at European level requires the data storage system to obey the data protection laws on every country and to obey the European directives on data protection. Different kinds of information have different security requirements:

- Information from number 1 to number 4 has to be considered as high security level information according to most European Data Protection Laws (at least from the point of view of Spanish and Swedish laws).
- The rest of the information could be considered as medium security level information.

The following initial restrictions apply to high security level information:

- Medical information from Sweden should be stored in Sweden, however it can be accessed by parties in other European countries for the purposes of the trials, given consent by the user and ethical approval by the relevant committee in Sweden.
- Medical information from Spain could be stored in any European Union country.

3.5 TR4 - Component isolation and interoperability

The system should be composed of a set of independent components according to the functional requirements. In order to allow the customization of the ELF@Home solution to different scenarios, system components should be able to work as isolated components. Communication and interoperability between components should be based on a general communication mechanism, for example a web-services layer (REST/SOAP). No direct communication between components should take place. This requirement will allow the ELF@Home system to be customized to user needs by providing only the components needed by users according to their life conditions. For example, the system should be able to work without the use of the activity sensors or biomedical sensors in cases where there is no need to monitor outdoor activities or the health status of the user.

3.6 TR5 - Standards support

Data representation and communication between components should use standards when possible. All parts of the system dealing with hardware devices integration of health data should consider this requirement. For example, data acquisition from bio-medical sensors could be based on the Bluetooth Health Device Profile (HDP) and the representation of health data in the intelligent service platform could be based on the HL7 Electronic Health Records Profile standard. The use of standards will ensure the interoperability of the solution with several hardware vendors and the integration of the system with other health systems (health insurance systems or public health services).

3.7 TR6 - Limited connectivity support

Communication between the client-side (sensor devices and fitness box) and the Intelligent Service Platform should support limited connectivity and low bandwidth communication connections. This requirement is especially important in order to deploy the ELF@Home system in rural areas or areas with the lack of a broadband communication infrastructure. In the general, scenario system components should be able to communicate using mobile data networks. This requirement will also allow the deployment of the solution in places where there is not communication networks preinstalled (i.e. the user does not have an Internet connection at home).

3.8 TR7 - Simplified installation and configuration

Hardware components of the solution should work out of the box without further configuration by the user while software should be preinstalled and no user intervention should be necessary. Any configuration and personalization required should be based on user identification.

3.9 TR8 - Simplified maintenance

Hardware components of the ELF@Home solution, mainly bio-medical sensors and the activity sensor, should require minimum maintenance. Battery replacement or battery charging should be very infrequent. It is advisable that batteries last without charging at least one year.

3.10 TR9 - Remote assistance support

Although components of the system should work autonomously, the ELF@Home system, especially the fitness box, should support a remote assistance mechanism to allow professional operators to connect to the user fitness box and to help users using the system.

4 Conclusions

This report lists and explains in detail the requirements for the future ELF@Home system. Requirements were divided in two categories: functional requirements and technical or non-functional requirements. Functional requirements were established by primary and secondary/tertiary end-users while technical requirements were defined by partners after studying functional requirements.

The approach taken to identifying users' functional requirements involved three main aspects: 1) interviews with individuals, 2) brainstorming with representative elderly users in focus groups, and 3) information obtained from medical experts. In Task 2.1 we established the functionalities of the complete service by taking into account end users opinions, as well as medical and enterprises expertise. The results consist of the use case catalogue, a specification of medical requirements, the fitness exercises catalogue, and the medical variables catalogue. In Task 2.2 we analysed user interface requirements by interviewing end-users and by holding user focus group meetings. In this task we explored the home-fitness idea and motion based interfaces to gather requirements and recommendations for the designers (technical partners). In turn the designers proposed different designs for each part of the interface to the elderly, in order to get their advice and feedback.

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Appendix I Exercise motivation of elderly people

This appendix is focused on information material concerning the exercise motivation of elderly people. There are materials developed at Innovationsmanufaktur as well as scientific studies and articles.

I.1 Poster "Fight the Inner Demon"

As a result of a poll and other preliminary studies, the poster "fight the inner demon" was realized at Innovationsmanufaktur. This poster is a first graphical approach to understanding the complex issue of exercise motivation for the elderly and its importance for the innovation process.

From our perspective, this has become necessary as the classic, centuries-old perception of health as the absence of sickness propagated by medical science is outdated. Rather, following the WHO's definition, health has to be interpreted as physical, mental, and social well-being. The most promising approach to general well-being is a fair amount of sports or exercise combined with healthy nourishment.

Intellectually, most people know that. However, there is quite a big discrepancy between the percentage of people who plan to exercise more and those who actually do so. This illustrates perfectly the might of everyone's weaker self, their "inner demon". Especially among the elderly, the percentage of active people declines appreciably. Therefore, it is even more important to identify how this target group's exercise motivation develops and how exercise at that age can be stimulated systematically.

Apart from physicians' advice to exercise more, the goal has to be to stimulate the intrinsic motivation to do sports in order to develop more directed strategies to conquer one's "inner demon". The newly designed poster therefore correlates attitudes towards health with barriers (the weaker self) and motivators (conquering that inner demon). As an extension of the insights into motivation in the last chapter, the best agers are divided into three groups: the couch potatoes or no-gos, the postponers or wanna-gos and the sanitary theorists or go-gos. The following descriptions are based on a study by Innovationsmanufaktur:

Table 32: The three groups of best agers

They:	Possibilities to conquer their weaker self:
Sanitary Theorists	
▪ confidently handle their health ▪ become increasingly lethargic and comfortable in old age ▪ have generally no problems to live healthily ▪ put independence, family and reputation at the center ▪ are open towards health technology and auto-diagnosis	▪ many social contacts ▪ daily routines
Postponers	
▪ often decide to do something for their health but never become active ▪ find countless excuses why sport is not possible at a given moment ▪ are Bon Vivants, feel fit and healthy ▪ have almost no prevention ▪ have a tendency to slide into a risk group	▪ type-related attractive offers ▪ give a better understanding of progress ▪ offers integrated into their living environment
Couch Potatoes	
▪ do no more than what is absolutely necessary ▪ neglect their health/perceive it as sufficient ▪ have little personal responsibility	▪ rewards ▪ persuasion ▪ elimination of high entry thresholds ▪ give a better understanding of well-being ▪ link to positive experiences

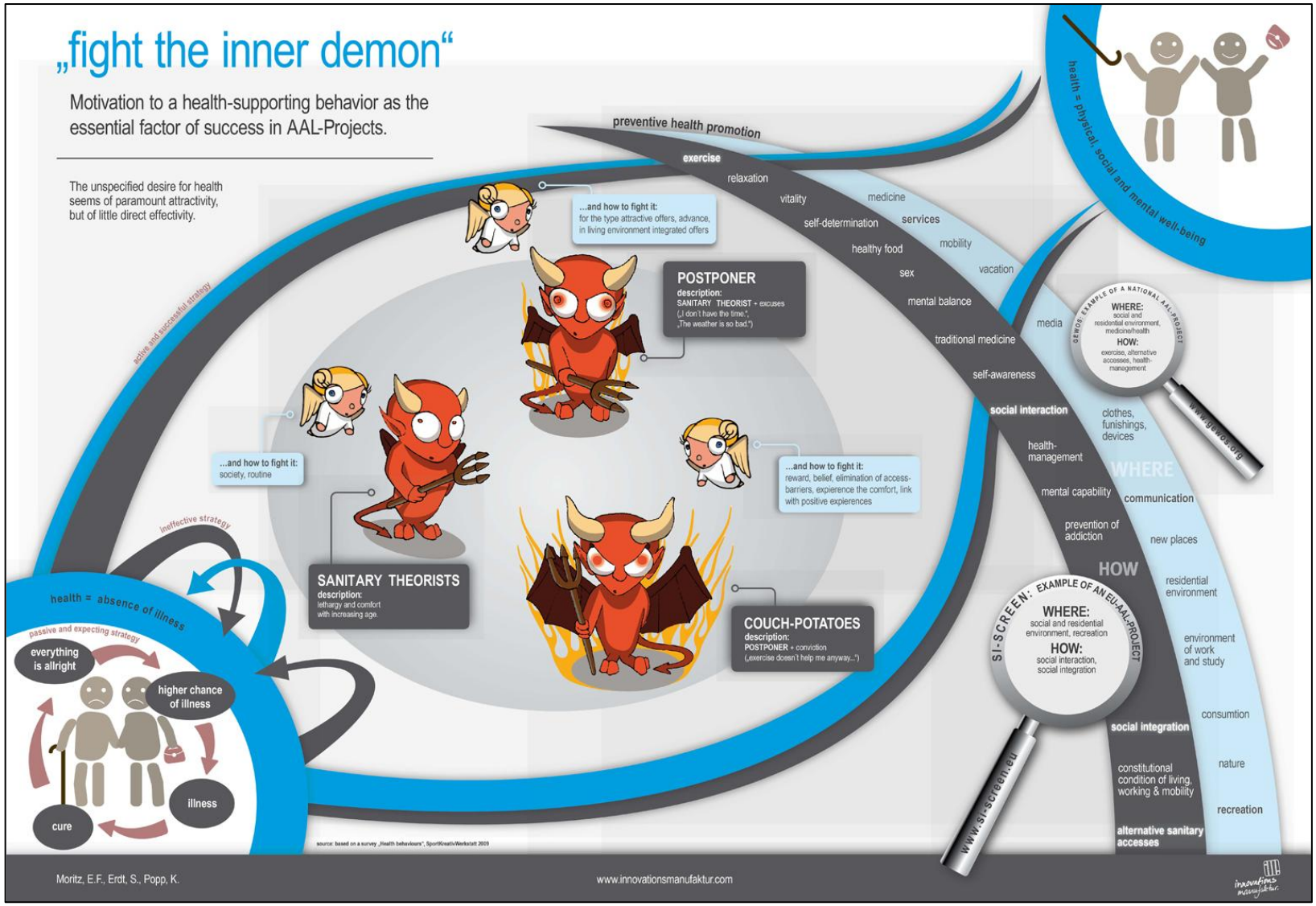

Figure 2: Poster – “fight the inner demon” (source: Innovationsmanufaktur GmbH)

I.2 Health typology

The picture hereinafter shows a health typology: seven different health types were defined depending on their willingness to invest money in their health and their personal responsibility for constitutional measures. The data comes from a big survey realized at Innovationsmanufaktur with more than 150 people and is based on the movement types of the fit for fun study in 2004 and the health types of the psychonomics study in 2006.

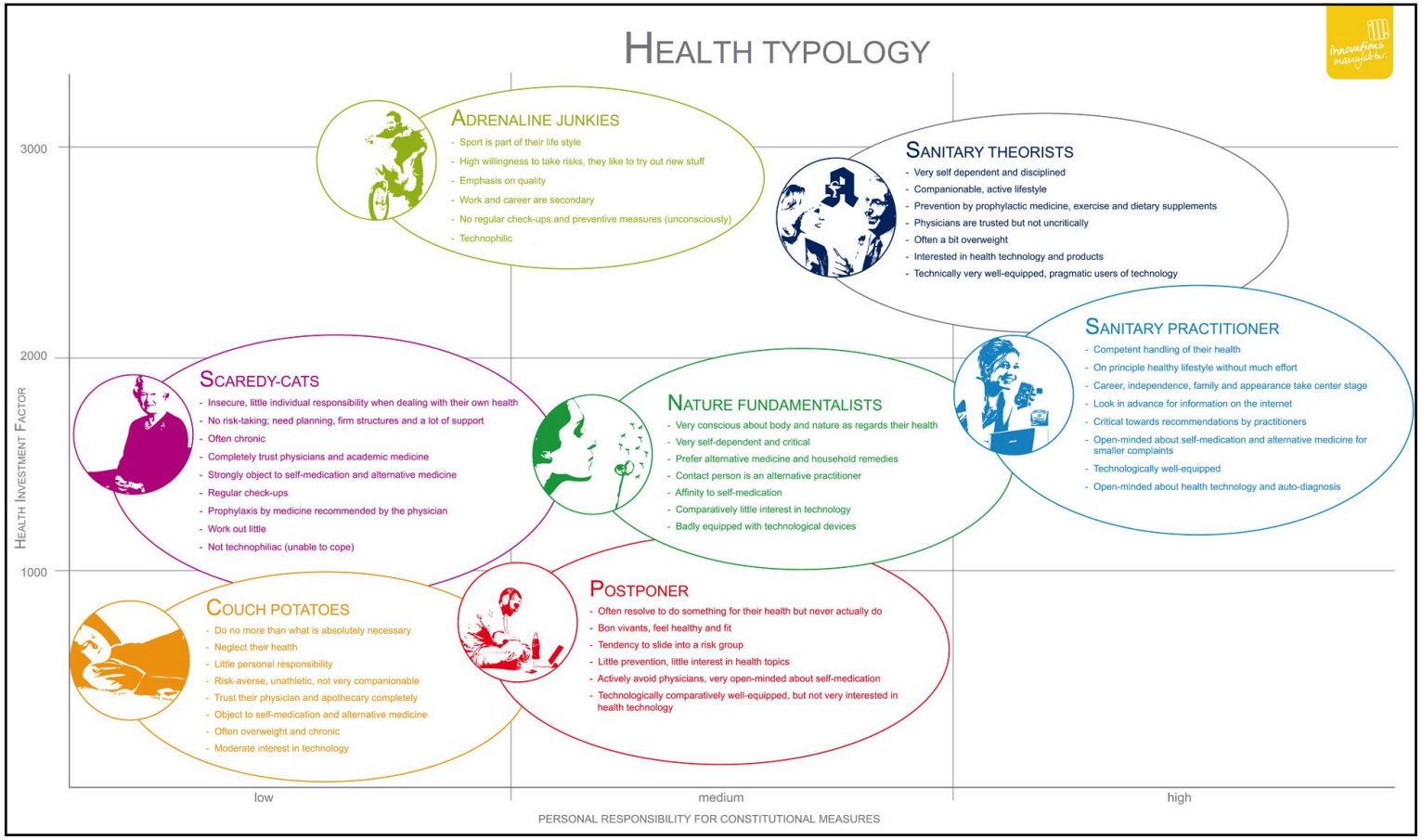

Figure 3: Health topology (source: Innovationsmanufaktur GmbH)

I.2.1 Overview over potential exercise motivation factors

Below you can find an overview regarding movement motivation factors developed at Innovationsmanufaktur. There, you can find different movement motivation factors grouped into six topics (outdoor, fun, games, health, beauty and communication) and their overlaps and relationships to each other.

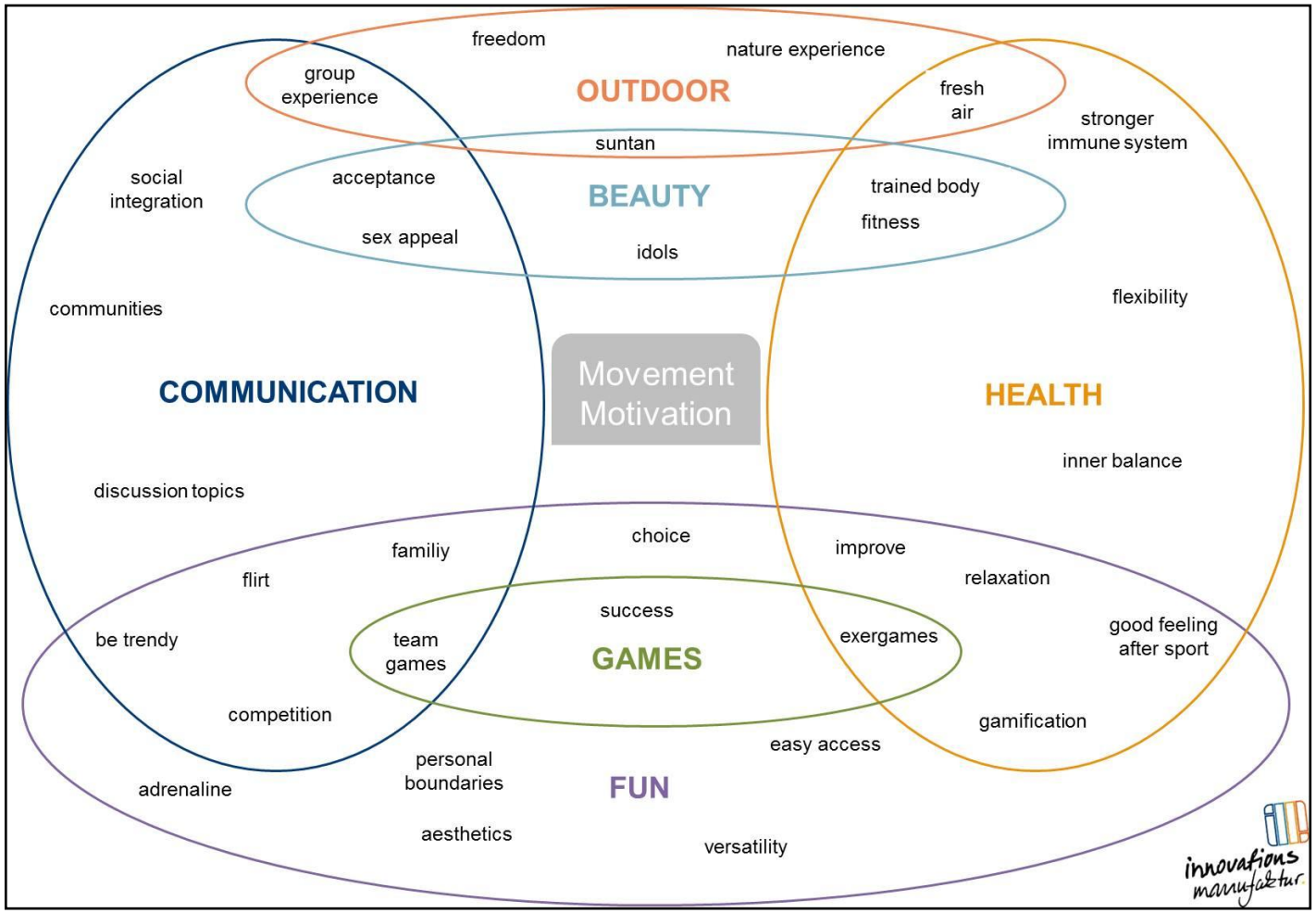

Figure 4: Overview over potential exercise motivation factors (source: Innovationsmanufaktur GmbH)

I.2.2 Results from user studies at Innovationsmanufaktur

In this study, over 220 people aged older than 40 were interviewed in Germany and Spain concerning their health behaviour and their sports habits.

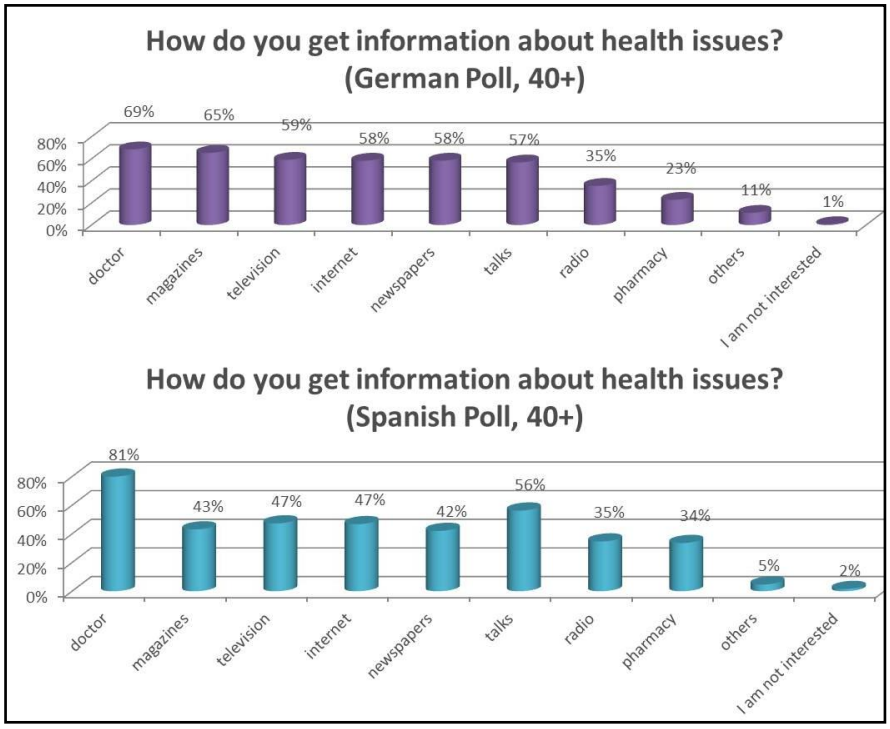

Figure 5: Health behaviour of German and Spanish people

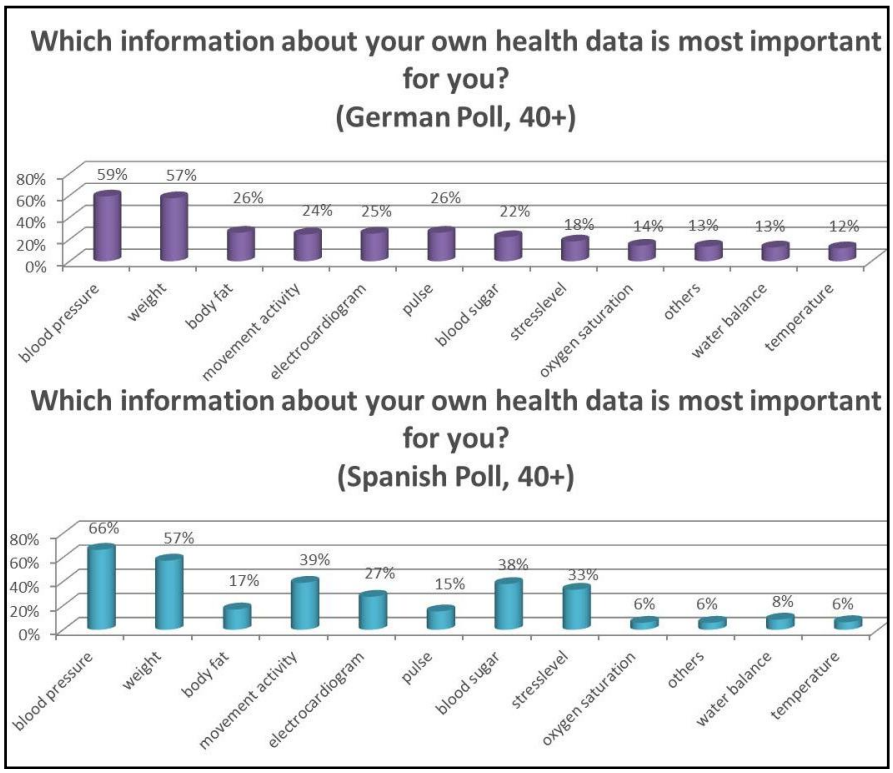

Figure 6: Health behaviour of German and Spanish people

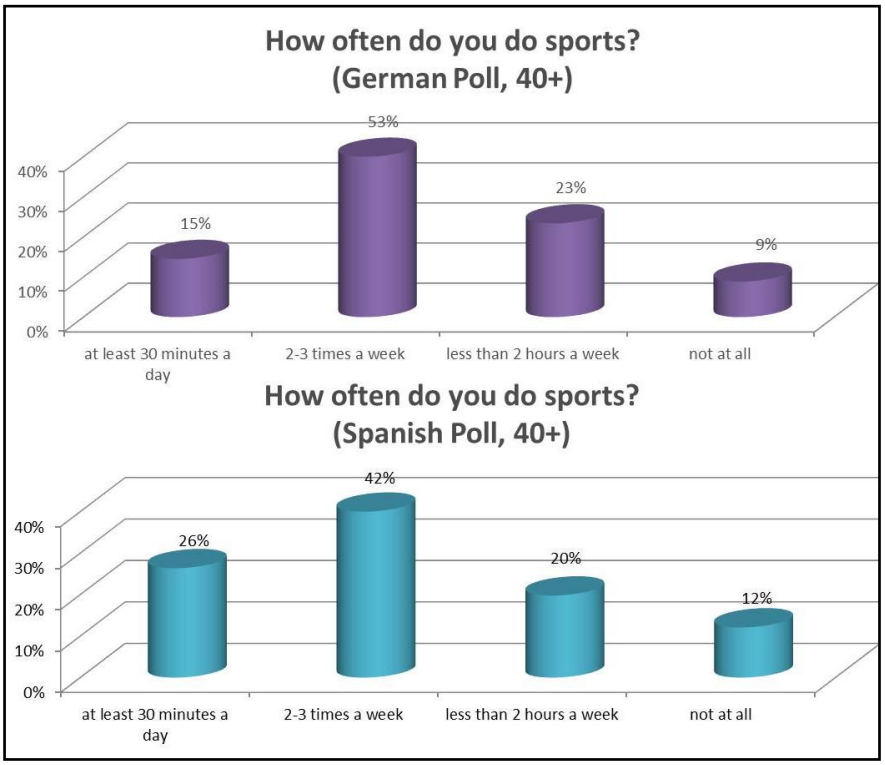

Figure 7: Sport habits of German and Spanish people

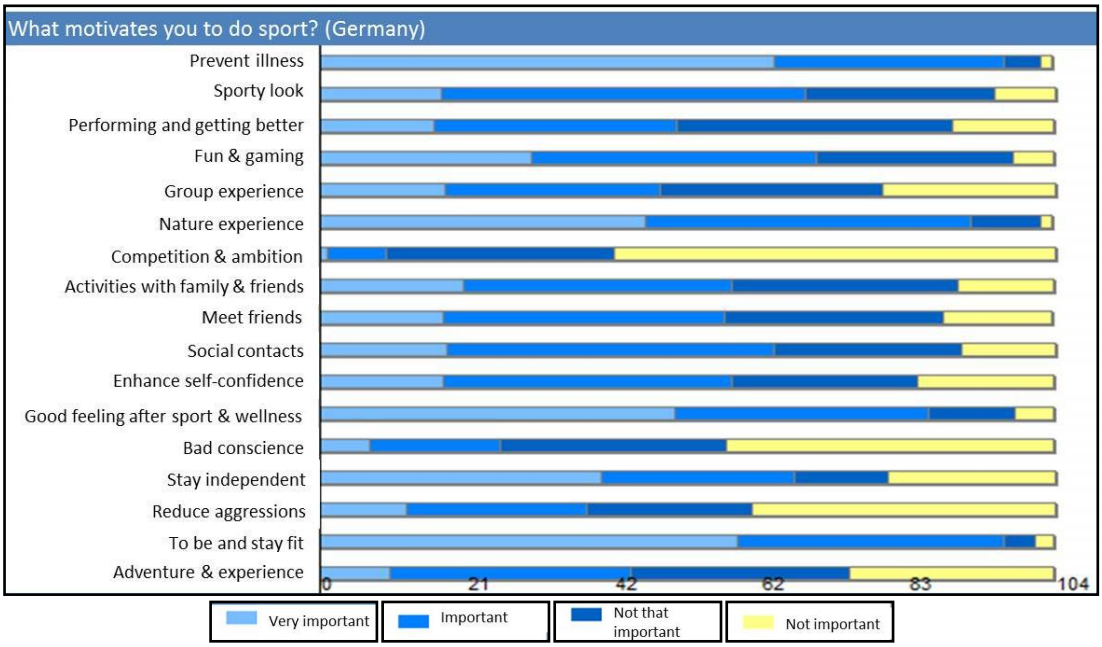

Figure 8: Sport motivation of German people

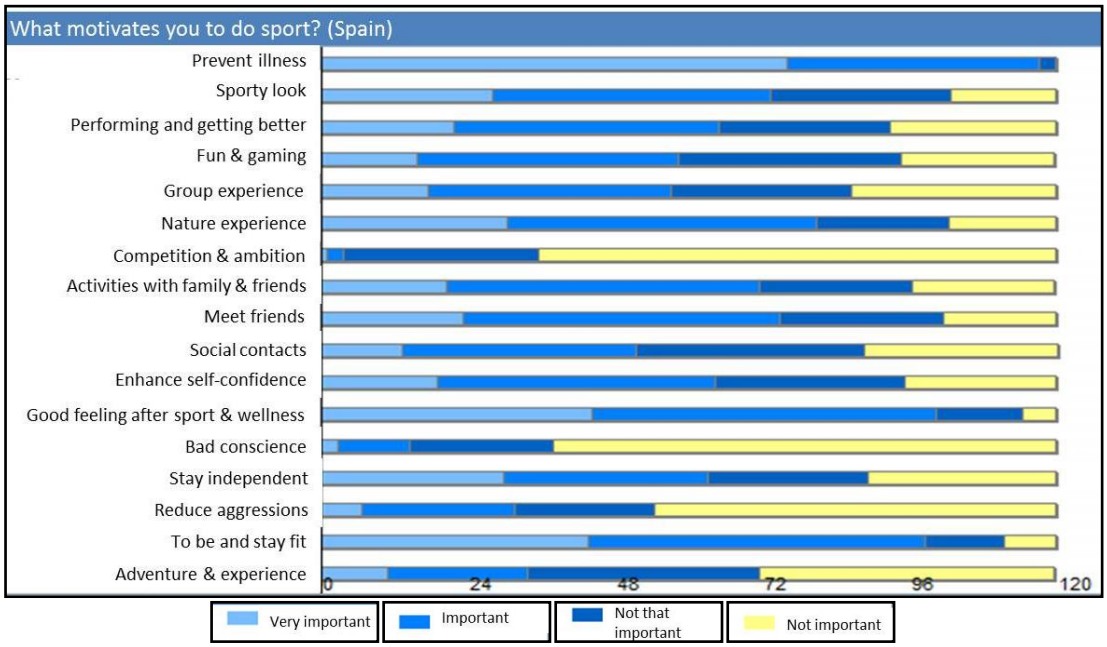

Figure 9: Sport motivation of Spanish people

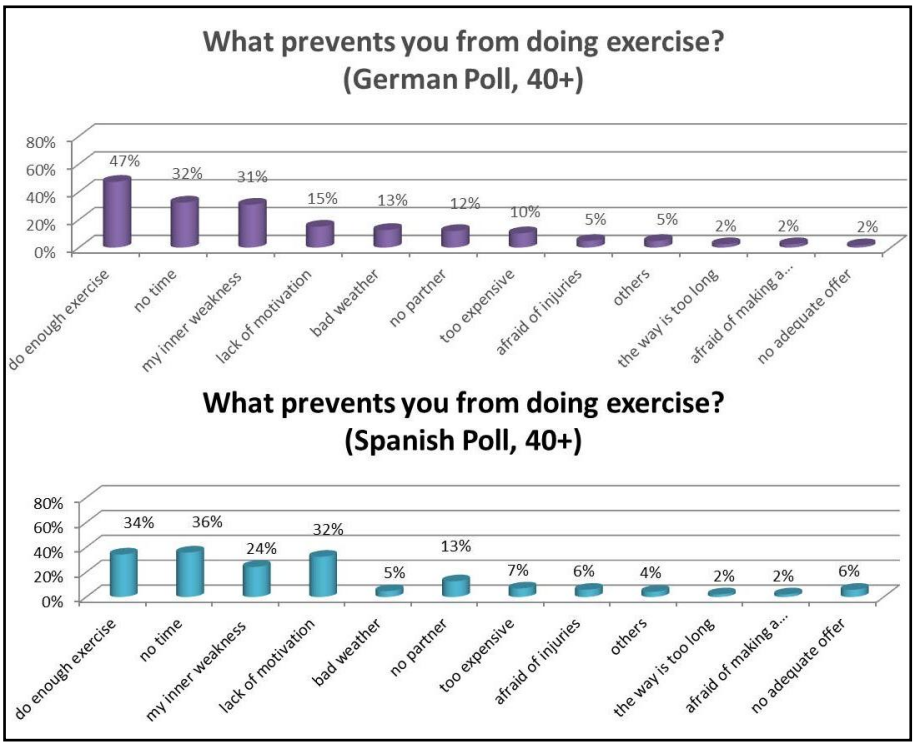

Figure 10: Sport barriers of German and Spanish people

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