Active Older Adults @ Workplace

D2.02 – Requirements Specification and User Story

Project Deliverable

D2.02 Requirements Specification and User Story

Work Package:		WP2
Due Date:		30/04/2015
Submission Date:		30/04/2015
Start Date of Project:		01/12/2014
Duration of Project:		30 Months
Responsible of Deliverable:		IWI-HSG
Version:		0.4
Status:	☒ Final ☐ Draft ☐ Ready for internal Review ☐ Task Leader Accepted ☐ WP leader accepted ☒ Project Coordinator accepted	
Author name(s):	Maedeh Yassaee	Tobias Mettler
Reviewer(s):	INOV, ATOS	
Nature:	☒ R – Report ☐ P – Prototype ☐ O – Other	
Dissemination level:	☒ PU – Public ☐ RE – Restricted	

Revision history			
Version	Date	Author(s)	Changes made
0.1	27/03/2015	IWI-HSG	Creation of the first draft.
0.2	13/04/2015	ATOS	format changes and reorganizing some paragraphs.
0.3	15/04/2015	INOV	
0.4	20/04/2015	IWI-HSG	Revised version based on ATOS and INOV feedback
0.5	29/04/2015	ATOS	Final quality review
1.0	30/04/2015	ATOS	Final version submitted to the AAL CMU

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1. Executive Summary

This report is part of Active@work, an EU funded project. It is about the task 2.02 of work package 2 (WP2) “older adults’ concerns and requirement specification” and describes the whole process of the analysis of requirements, requirements which are needed to develop the system for the Active@work system.

The current socio-economic situation of Europe is forcing the European governments to rise the retirement age and also studies have shown that working beyond traditional retirement age can be beneficial for health. In addition, the fact that senior employees are the valuable asset in an organization because of their vast amount of experiences is not negligible. However one of the most important barriers to get benefit from the elderly employees in the organizations is the lack of innovative solutions that can assist elderly employees to be active and efficient at work like other younger employees without risking their health. Another important service that these innovative solutions can provide is to offer a platform which transfers their valuable knowledge to younger employees. There is also a myth about elderly adult that cannot learn new things easily. But research shows learning is not an age dependent factor, but learning process change by age. The fact that evolutionary technologies affect the current working environment in a short period of time, there is a need to learn new skills so quickly to be competent in an organization. Thus, these assisting solutions also should provide appropriate learning platform align with elderly learning abilities.

The aim of the Active@work project is to assist elderly employees be socially active in order to transfer their valuable knowledge to the next generation, learn new skills easier without providing extra pressure and stress and stay active and effective at work without risking their health.

This report aims to review the state of the art with respect to elderly employees’ needs and the available techniques and technologies that can assist senior employees be active at work. In addition, the report describes a range of relevant use scenarios for the project. The use scenarios describe the process that Active@work system will be used by users to achieve the project’s goal. In order to derive use scenarios that meet the actual working environment needs and constraints as well as the end user needs and constraints a workshop held in Madrid, Spain in February 2015. In that workshop, the project partners contributed to develop the Active@work user story. The user story is a concept which has been used as the primary development artifact in Scrum and Extreme Programming (XP) approaches. Active@work user story aims at providing an overview of how and in what cases the Active@work system will be used by end users. Based on the Active@work user story developed by all the project partners, four main use scenarios derived including: health improvement, working environment improvement, knowledge sharing, operational improvement.

The last part of this document is the translation of elderly employee’s needs and use scenarios derived from Active@work user story into a system’s requirement to have a consistent format. The next step will be evaluating and validating the requirements draft by interviewing end users at Active@work pilots. Additionally to get a broader overview of different end user opinions we will do a survey. The fact that these requirements specification list will be used as the input for the upcoming work packages, formulating them appropriately and systematically is a must for the project success.

In summary, the team identified the functional, non-functional and data requirements of the Active@work system-to-be, that aims to meet end consumer and stakeholder expectations. The outcome of this report (requirements specification list) will be evaluated by potential end users in a next step.

2. Introduction

Active@work is an EU project with the main goal of supporting senior employees to perform their job efficiently without risking their health condition. The Active@work focus is an integrated approach to manage the negative impacts of aging both physiologically and psychologically, while taking the advantage of senior employees' valuable experiences. Elderly employees who are close to their retirement age are concern with realizing some changes in their psychological and physiological systems. Most of the time these changes are not easy to realize from outside and even the person himself ignores these signs and changes. The fact that it is not easy to accept these changes would be the reason of this ignorance. Thus, Active@work as an assistant system has the goal to help the senior employees who are going through this phase of life to spontaneously do their daily duties at work and deal with psychological and physiological demands of normal aging.

The main scientific challenges for Active@work are the management and extraction of useful information from vast amounts of environmental and physiological data, the development of a customized system to influence behavioral change, and developing a solution applicable in differing working environment. In order to meet these challenges, Active@work will investigate: (i) how best to provide the dynamic accurate measurement and data transfer of useful information about end-user, (ii) how best to use physiological and environmental data to improve the senior employees well-being and influence end-users to modify their behavior, (iii) how to arrive at the best business model to convert a promising technology into a useful and cost-effective product, and (iv) how to demonstrate and validate the new methodologies on two case studies in Spain and Belgium.

2.1. Introduction WP2

The objective of WP2 has been three folded: First, to review the current situation with respect to the drivers and barriers to implement the intended system as well as to analyze the market standards and regulation (task 2.01). Secondly, the work package focuses on collecting information from (potential) stakeholders to understand their needs and concerns and to translate these needs into requirements to smoothen the translation of the collected and analyzed needs into the system (task 2.02). Thirdly, consolidate the requirements and evaluate them by senior employees (task 2.03). As such, work WP2 plays a central role in the project as it feeds into all other work packaged throughout the entire duration of the project.

2.1.1. Introduction Task 2.02

Analyzing all the user groups requirements very early in the development process is very helpful to ensure the Active@work solution's success.

In order to achieve the Active@work goal, four main activities for task 2.02 have been defined:

1. to understand the normal aging psychological and physiological characteristics from scientific point of view before talking to senior employees about their needs and concerns in order to cover all the realized and unrealized needs by the actual end users of the Active@work system,

2. to investigate upon the available techniques and technologies that can assist the Active@work project's objective, with the emphasis on novel ICT developments,
3. to review the current situation with respect to the drivers and barriers to improve the working condition of senior employee at working environment,
4. to translate the end users and their context needs into requirements to smoothen the translation of the collected and analyzed needs into software.

In order to do the first activity, the end user characteristics are reviewed and analyzed. The data gathered in this phase could be done by integrating users, but also through secondary data. As it was already mentioned because it is possible to miss some important aspects of the physiological and psychological needs of normal aging if we just derive the needs by asking the elderly adults, we first gathered data through secondary data by reviewing the academic journals. But in order to involve the actual needs on elderly employees, in task 2.03 we will evaluate the use scenarios that have been developed in task 2.02. Thus what we will present in this document is not complete without the end user involvement.

For activity 2, because the Active@work aims at assisting the senior employees to work efficiently without risking their health, the most important task of the Active@work system is to monitor the senior employees' health and their working environment. Thus, understanding the characteristics of health monitoring systems is important. We need also to understand how the health behavior change systems work, because just monitoring senior employees would not be enough to attain the overall goals of this project. When the senior employees' bad habits influence his/her health, there is a need for Active@work system to persuade the senior employees to change their behavior.

Activity 3 has been done with the help of all the project partners including the partners from the Active@work pilots. The required data for activity 3 has been gathered based on contributions of the project partners that attended a workshop held in Madrid, Spain, in February 2015. The workshop has been designed to derive the main use scenarios for Active@work system aligned with the project objectives and the pilots' needs and constraints. The use scenario describes the processes that Active@work will assist senior employees. In order to do that a list of end users and their roles in Active@work system was compiled, described and harmonized. The list of end users and their roles were used to derive the main use scenarios in Active@work system and were associated to the project objectives and pilots.

Finally, with activity 4 we try to translate and synthesis the outcome of the other three activities into Active@work requirements. In a project in which different people with different backgrounds work together in order to develop technology, requirements are a common tool to make sure that there is a successful communication between all parties. While the developed use scenarios in activity 3 describe in detail the needs of the senior employees in a qualitative manner, they are not suitable to start developing a system. Often a single sentence in a use scenario includes several requirements which can both be functional and non-functional in nature, which can be needed in many scenarios or just one. Requirements allow the breakdown of the required system characteristics into the smallest possible category, an item, which can then be delegated to and understood by a developer, checked against and multiplied for other scenarios. At the end of this report the list of high-level requirements is presented. However this list is not finalized without end user's evaluation, which will be covered in task 2.03

The document at hand is organized as follows. Section 2 provides an overview of health monitoring systems, health change behavior systems and normal aging characteristics (activity 1 and 2). Next, we present an overview of our use scenario development. This is followed by explaining the relevant use scenarios for Active@work. Building upon this, we then present the high level requirements of Active@work system translated from the state of the art and Active@work use scenarios.

3. State of the Art

3.1. Personal health monitoring systems

The personal health monitoring systems (PHMS) has been defined as “any electronic device or system that monitors and records data about a health-related aspect of a person’s life outside a hospital setting” (1). The PHMS emphasis is on providing the self-caring services to the individuals. Such services include any stages of care cycle, enabling prevention, early diagnosis and chronic disease management (2). These PHM systems have been used for wide range of purposes including physiological monitoring in healthy people, safety monitoring, home rehabilitation, assessment of treatment efficacy, and early detection of disorders (1, 3). Thus the main goal of these systems is to provide means to self-engage and mange individual’s health status and to minimize any interaction with other health care actors. However legal and societal obstacles, issues related to the real application of wearable devices, inappropriate use of decision support systems and the skepticism of many healthcare professionals resulted in the lack of effective implementations of Personal Health Systems (2).

Required technologies to enable the PHM goal consist of three main building blocks: 1) the sensing and data collection hardware to collect physiological, movement and environmental data, 2) the communication hardware and software to relay data to a remote center, and 3) the data analysis techniques to extract clinically-relevant information from physiological and movement data. PHM technologies are personalized (tailored to the users’ needs), adaptive (responsive to the user and the user’s environment) and anticipatory (anticipating users’ desires as far as possible without conscious mediation). The miniaturization of sensors and electronic circuits based on the use of microelectronics has played a key role in the development of PHM systems. Measuring the physiological aspects like heart rate, respiratory rate, blood pressure, blood oxygen saturation, and muscle activity are the main tasks of these sensors (3). Wearable devices need to be nonintrusive, easy to use, and comfortable to wear, efficient in power consumption, privacy compliant, with very low failure rates and high accuracy in triggering alarms, especially if used for diagnostic purposes (2). Wearable sensors are often combined with ambient sensors when subjects are monitored in the environment (3).

Despite the fact that the personal health monitoring systems can be really useful in helping the senior employees monitor their health while they are at their working environment, there are some challenges in using these systems for that purpose. Trust could be the main obstacle for adopting such systems in working environments. Giving the permission to be monitored by wearable sensors and ambient sensors, would result in feeling that the employee’s privacy is in danger. Thus, the system should provide means that ensures the senior employee’s data is safe and there is no means of abusing the data produced by the system. Another challenge in introducing and adopting such systems in daily work environment is how to motivate the senior employees to continuously use the system. Without any actual use there won’t be any added value. Therefore Active@work system should continuously motivate the end users to use the system and aggregate the system to their life. However accepting the personal health and working environment monitoring systems by end users and motivating the end user to continuously use the system is prerequisite for assuring the system’s success, but not enough. The most crucial fact in order to achieve the Active@work project’s goal is how to convince the senior employee’s to change their behavior when the system

realize any inappropriate habit in life style or working style that results in risking the senior employee's wellbeing and productivity at working environment. Providing sufficient values to change the senior employee's behavior is challenging but a most. In the next section, we will describe how systems should be designed to provide this supplementary value.

3.2. Health behavior change support systems

While personal health monitoring is concerned with collecting end-user data for identifying possible behavioral patterns, health behavior change support systems (HBCSS) are software applications that try to harness the collected data in order to induce an alteration of attitude and/or change in the end-user's behavior toward a healthier life style. HBCSS are been investigated in diverse fields, such as brain research, social sciences, electrical engineering, computer science, or health professions (see Annex 1). HBCSS are applied in many different areas, such as in the promotion of exercise and healthy eating choices (4-6), cessation of smoking (7), monitoring of sleep disorders, or other physical and mental health related issues, as illustrated in Figure 1. With the broad availability of smartphones, tablets, and sensor-based devices, the design of HBCSS has shifted from traditional software applications (apps) to more ubiquitous and social web-based solutions (8).

However, while the technical design has been adapted to the new realities of users, the underlying assumptions and concepts that inform the software design have remained the same since the emergence of HBCSS.

Figure 1: Exemplary HBCSS: (a) app for prevention of dehydration, (b) app for health promotion for an active lifestyle, and (c) app for monitoring smoking cessation.

In order to change the behavior of end-users, HBCSS use different psychological theories to persuade the end-user. The most cited work in HBCSS studies is the seminal book by (9), which introduced the notion of persuasion as part of software design. Early studies have followed the conception that software developers always influence their users in one way or another. In doing so, they have frequently relied upon the *operant conditioning theory* (10), which assumes that a

behavioral change toward healthier lifestyles can be achieved by rewarding favored behavior and by punishing negative behavior. The basic assumption behind operant conditioning theory is that users react based on their experiences of antecedents and consequences, instead of a reflexive reaction to a stimulus. Accordingly, another subliminal assumption is that the end-user—to some extent—is rational in his/her choice and subsequent behavior. Operant conditioning is frequently found in exercise and physical fitness apps, which try to motivate users by giving them "virtual" rewards for a more active lifestyle.

The same "rational man" assumption is shared by the *theory of reasoned action* and *theory of planned behavior* (11, 12), which are also widely used in HBCSS. In both theories it is assumed that behavior is the result of a more or less conscious appreciation of values related to the system's utility and ease of use. Hence, users' attitude and perception are major drivers to an intended behavior, which itself is a precursor of actual user behavior. Over the years, several theoretical additions have been introduced (e.g. the role of social influence, gender, age, experience), which improved the accuracy of predicting technology acceptance and ultimately lead to a unified theory of acceptance and use of technology (13). Overall, the mentioned theories describe little about psychological cues that influence users to change their health-related behavior. Rather, and in line with the dominant technical focus of the identified papers, these theories are useful for predicting acceptance of system features and systems design.

Attitudes, beliefs, and perception of individuals play also an important role in the *cognitive dissonance theory* (14), which also is applied in some of the HBCSS studies. It deals with the fact that many individuals feel uneasy when their beliefs and opinions are inconsistent with their actions. This creates a state of "dissonance", which may become in a certain point of time quite unbearable, motivating a person to actively change his/her behavior in order to restore cognitive consistency. Smoking cessation apps frequently make use of this effect.

Lastly, we found that several studies work with the *goal setting theory* (15, 16). It is based on the assumption that individuals have an intrinsic motivation to reach a clearly defined goal or feel that it is important to change their current behavior. Unlike with the operant conditioning theory, which uses rewards as means for encouraging individuals, goal setting frequently is applied without any additional incentive structure since it assumes that users feel rewarded by the simple fact that they achieved the goal. However, the strength of this motivational effect may vary depending on the difficulty, proximity, and specificity of the goal. Goal setting is often used in diet and fitness apps.

In spite of the fact that recent research has raised serious questions about the human rationality of judgment and decision-making (17), the review of the literature has shown that many of the behavioral theories used in current HBCSS studies are based on the assumption of rational users.

Evidence exists that not only conscious, rational reactions influence behavior, but oftentimes rather unconscious, emotional processes (18). Anger, fear, envy, sympathy, or pleasure are important cues for influencing the behavior of end-users. Accordingly, the identification of design principles that help to systematically elicit emotional responses for facilitating the intended health-related behavior changes could represent an important research theme for the future.

As described before, much research has a strong technical focus and as such is frequently directed toward interface design and subsequently testing acceptance of the developed solution. While interfaces design certainly is an important topic for HBCSS, we feel that there is a need to additionally emphasize what we refer to as “habitual design”, i.e. the procedures and strategies to develop or disrupt habits that may lead to the intended behavioral changes. Habits can be perceived as goal-directed automaticity (19) and as such considerably guide performance of a behavior (20). Habits also have a significant impact on the acceptance of new systems (21). However, little is actually known about the mechanics how to successfully create habits through software design. We believe that this is important as habitual design may not only be crucial for effectively generating the intended perpetual effects (e.g. more physical exercising, cessation of alcohol use, healthier eating), but also for improving long-term acceptance and continued use of HBCSS which takes us to our next research challenge.

Since behavioral changes don’t occur instantaneously, HBCSS only work when the end-user is willing to use the system over a longer period of time. Together with the creation of habitual use patterns it is therefore of utmost importance to also integrate different kinds of stimulatory measures to ensure long-term motivation of users, which to our view seems to be one of the hardest problems to solve as this significantly also depends on contextual influences as described next.

In the reviewed literature we found barely any approaches for contextualizing both technical and social design of the proposed HBCSS. As we mentioned before, contextually anchored research is important in order to (i) attain the intended effects and (ii) to better understand the capacities and limitations of a system. We cannot assume that the implemented measures for persuasion, motivation, reputation or coercion work for all end-users and for all use scenarios. Demographic, cultural, economic, and psychosocial differences may critically influence the effects, and ultimately utility of HBCSS. Both development and evaluation instruments need to take this into consideration and provide flexible mechanisms for adaptation and learning.

3.3. Senior employee characterization

Personal and work life evolves in different phases. As illustrated in figure 2, AAL solutions frequently are placed in one of the last three phases (exit, change and reflection) of a person’s life timeline (22). Phase 7 (exit) is the starting point for people to become more aware of growing old. The Active@work with the aim of helping the elderly adults at their work covers the exit phase of life timeline.

Although, according to the department of Health and Human Services (U.S.) today’s older adults are healthier than previous generations (23) and they do not usually suffer from the serious physical impairments (visual, acoustic, motor and cognitive), the psychological and social issues of normal aging begin to affect the people’s life at this phase. For instance, in their private life they will start losing loved ones: not only are seniors’ children leaving home, but their parents are aging, and their roles might change from being a recipient of care to that of a caregiver. In line with these changes, their living environment is often changed, for example, by moving to a new (smaller) home, new furniture, or by utilizing their home space differently (22). In addition to all these changes in private life, the elderly adults close to retirement or change phase are often concern with changes in their

working environment. With all these transformational issues of life at this phase, a system that can assist elderly adults at this point of their life is really required.

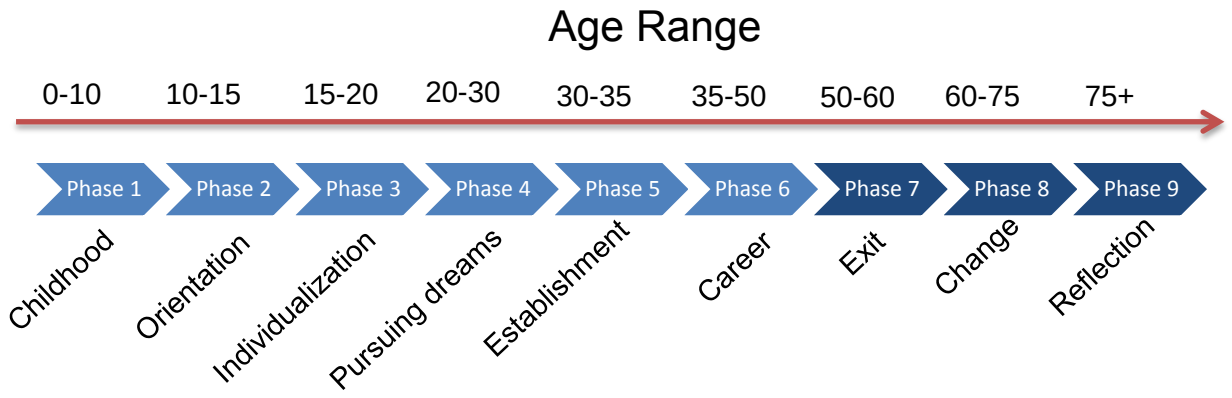

Figure 2: Life phases

The unique physiological and psychological characteristics of this phase of life, like all the other phases, require appropriate attention. For instance, there is a perception that elderly people have difficulties in learning new things (24), but studies show that with an appropriate learning technique that is aligned with elderly learner characteristics they can acquire knowledge about new things in their own way. Thus the approaches that might work for younger people do not necessarily work for older people, which results in a need for tools that are specially designed for this group.

The studies that focus on aging characteristics in general and the elderly employees close to their retirement age in particular, mostly have three different lenses, including: physical, cognitive and psychological.

The first lens which has an emphasis on physical characteristic of normal aging shows different signs of weakening the body which results in visual, acoustic and motor impairment and also fatigue. The other important aspect of aging is the changes on cognitive functions. On one hand there is a decrease in precision and the speed of perception. On the other hand crystalized intelligence grows which results in strategic thinking improvement, sharp-wittedness, considerateness, wisdom, ability to deliberate, ability to rationalize, control of life, holistic perception and language skills improve with age. Research on normal aging by psychologists has shown that normal aging is in line with resisting against any changes in life. It will become more difficult for elderly adults to adapt to the changes. Thus, if changes in their surrounding are necessary, it always must be done step by step. Becoming more emotional is the other important psychological impact of aging. Table 1 classifies and summarizes the elderly adult's characteristics in the exit phase of life in three main categories: physical, cognitive and psychological.

Table 1: Normal aging characteristics

	Normal aging characteristics
Physical (22)	• Visual impairments • Acoustic impairments • Motor impairments • Fatigue
Cognitive (25)	• Crystallized intelligence grows • Fluid intelligence declines • Strategic thinking improves • Sharp-wittedness • Focused attention becomes a challenge • Ability to deliberate improves • Ability to rationalize improves • Holistic perception and language skills improve with age
Psychological (22, 26, 27)	• Tendency to resistance to change • The need of continuity, familiarity and respect plays a major role • Elderly end-users do not want to be regarded as needy and frail • Joyful and emotionally positive experiences become more important as people grow older, enjoyment in addition to mere goal oriented functions should be considered • AAL solutions should be intuitive and encourage natural behavior • Exclusive problem-oriented approaches will unlikely lead to acceptance by the elderly end-users • The need of feeling respect from others (reassurance of worth) • Better able to adjust their behavior according to the situation than younger people. Apparently ageing does not reduce skills related to the tolerance of others, self-knowledge, and knowledge of human nature • Ageing people are known to reject incorrect behavioral patterns and to adopt methods that are useful in day-today activities, both inside and outside of work life

In summary, table 1 reveals that senior employees in many ways are even getting better and stronger. Every phase of life has its own strengths and weaknesses. Nevertheless there is a tendency to focus on elderly weaknesses in designing systems to help them. However in the exit phase, the strengths of senior employees should be identified and acknowledged as well as their weakness in order to utilities them wisely to get the best out of these valuable assets in the organizations. Focusing so much on senior employees' weakness while designing a system to help them stay active and productive at work does not create that much of value neither for employees nor for organizations.

4. Active@work user story

Understanding and analyzing the technologies that can assist and motivate elderly adults to improve their health and be productive at work and studying their personal needs based on the physiological and psychological characteristics of normal aging are prerequisites of designing Active@work system. However we need to have a concrete view of how exactly the Active@work system would help the elderly employees to be active and productive without risking their health at working environment. In order to achieve it, we use the user story concept to describe the use scenarios that Active@work system will help elderly employees. Thus Active@work user story is the concrete description of how the system would interact and assist the end users in order to achieve the Active@work project's goal.

4.1. Definition of "user story"

According to the project's Description of Work (DoW), the project follows the SCRUM agile methodology. In this document, the user story concept is used as the primary development artifact which is part of Scrum and Extreme Programming (XP) approaches. A user story is a very high-level definition of a requirement. Usually the agile life cycle initiates with the inception phase and continuous with construction and transition. The inception phase is about identifying the scope of the system with the help of defining user stories as part of deriving the requirements. During the construction phase the user story can evolve or it is possible to realize that the initial user story was too large to be implemented in a single iteration. However, the construction phase is not the final evolution point, the user stories can even grow or change during the transition phase (http://www.agilemodeling.com). A user story represents the value that a system can deliver to the end users. While traditional requirements (like use cases) try to be as detailed as possible, a user story is a very high-level definition of the requirements. It may consist of one or several use cases. User stories with a user centric approach focus on the benefit, the value or what is important to the user. Thus it defines the who (end user, actor, persona), why (goal, benefit, value) and what (task, action) (28).

4.2. Description of methodology

When describing the Active@work user story, the methodology outlined in figure 3 has been followed in this report.

Figure 3: User story development methodology

In **step 1**, an initial list of end users for each system module (cognitive, Skill/Collaborative modules) is complied.

In **step 2**, an actor refers to either an individual or group of people. Since we want to focus on the end-user, we dissociate ourselves from perceiving technical systems as actors. The actors or end users vary by what they use the system for, how they use the system and their backgrounds. Next, different roles of each actor in different modules were listed.

In **step 3**, the user story was developed for pilot A. In order to develop the user story, different tasks that contribute to the fulfillment and completion of end user needs based on the definition of each roles were gathered. Each task can have several goals. These goals define the required user actions and system actions need to be done in each task. The effect of certain tasks may influence the procedure for other tasks. Another important concept that needs to be address when defining the tasks is the trigger. A trigger is an event or sequence of events that initiate the task. It can be caused by something outside the task domain. Finally, the scenarios are defined based on these tasks. A scenario is a chronologically or thematically arrangement of tasks. In other words: a scenario describes a sequence of tasks (and triggered system and user actions) for a particular kind of user role and particular kind of module. Figure 4 illustrates the main concepts that make a user story and their relationships.

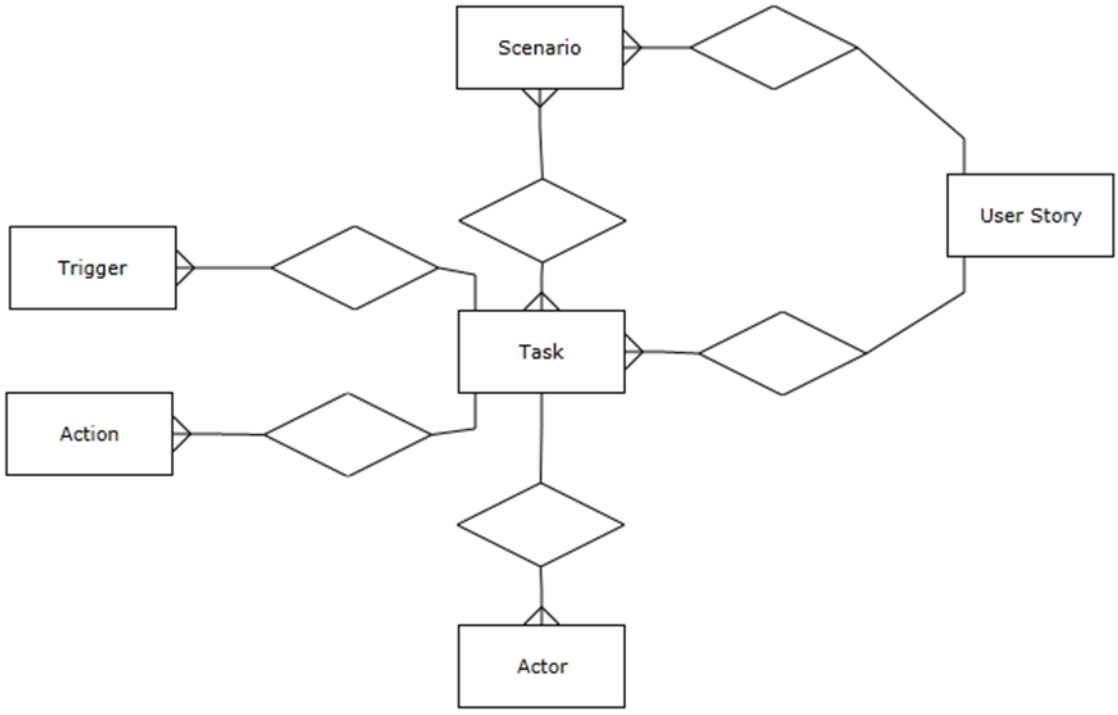

Figure 4: User story ontology

For **step 4**, the pilot B context characteristics discussed and the current version of user stories that were developed in step 4 were analyzed to find any gap that was not addressed in pilot A.

Finally **step 5**, the current version of user stories was revised in order to provide a generic view of the system that can be used in any other context not necessarily in pilot A or B of this project.

4.2.1. Active@work End users and roles template

In order to formalize the textual description of the end user role, the template presented table 2 has been adopted.

Table 2: End users and roles template

Module:	
Actor:	
Role:	

4.2.2. Active@work Task/Action template

In order to formalize the textual description of task and relevant actions for each system module in each specific pilot or overall story, the template presented in Table 3 has been adopted.

Table 3: Task/Action template

Module:	
Role:	
Task:	
Goal:	
Trigger:	
User Action:	
System Action:	

4.3. Background for the Active@work user stories

In order to develop a consistent user story for Active@work that is in line with the needs and challenges that exist in real working environments, we need to actively analyze and understand the contextual factors that have impact on the Active@work success. Getting involve the pilots partners in developing the Active@work user story results in covering the constraints of real working environments and its needs. Thus we have developed user story for Active@work based on two pilots with the help of the pilot's partners and other partners. We then have made a generic user story based on user stories of two pilots. This bottom up approach assures us that we have seen the working environment requirements in designing phase before implementing the system in real world.

One pilot is in a multinational office environment and focus on senior management personnel. The second pilot is in a Belgian leisure park and focus on technical maintenance team. Not only the target groups of end users are completely different and have different needs in each pilot. The

working environments are completely dissimilar as well. The first pilot is an indoor environment with focusing on mental work and the second pilot is an outdoor working environment with physical work. In following paragraph, we have described these two pilots in more detail.

4.3.1. Pilot A (Atos, Madrid, Spain)

The first pilot is a leading international information technology services company, which offers its clients end to end services to integrate business with technology through consulting, systems integration and managed services. Atos headquarters are located in the North-East part of Madrid in a four floors building with meeting rooms in all floors. Surface area around 5000 m^2, total built surface around 15.000 m^2

The end users in Pilot A are 10 senior workers from 47 to 55, who are senior management personnel. These senior management personnel usually are under high level of pressure and the stress in their job. Some of the end users are also frequent travelers which results in also high level of stress. The other challenge of being a frequent traveler is that they cannot be monitored in the office during days. Another important characteristic of working for such a company is the force of learning new skills sets for any new project at hand. The company also provides a new mobile phone and a laptop every 6 month which requires fast learning capacity.

4.3.2. Pilot B (CenterParcs, Belgium)

The pilot B is a leisure park located in Belgium which is designed for people to spend their holidays with diverse options (Indoor or outdoor, for all ages, relaxation or pumping adrenaline, shopping, eating and drinking).

The end users in Pilot B are 6 technical maintenance personnel in the Centerparcs sites. The maintenance personnel are responsible for keeping the infrastructure clean, safe and operational. All the maintenance tasks need to be done in a short time slots so that they do not interrupt the vacation of the visitors.

Having high level of physical and mental workload because of the short timespans in which defects need to be corrected result in high level stress and fatigue for the senior maintenance personnel. These pressures can reduce the senior employee's wok performance and even risk their health condition. In addition the maintenance personnel always require learning new skills when a new infrastructure is replaced by old or broken ones.

In the following paragraphs we will describe the Active@work user story aligned with these two pilots' needs and constraints.

4.4. Active@work user story

The development of the first version of the Active@work user story was done with the contribution of project partners that attended a workshop in Madrid. The workshop was conducted with the main objective of discussing and validating the Active@work user story (see Annex 1 for more detailed information on the workshop). All the project partners contributed to the user story development.

The developed user story after the workshop was documented and visualized with BPMN (Business Process Model and Notation). This graphical notation facilitates the understanding of the user story.

4.4.1. Types of involved end users and their roles

The following list of end users of Active@work and their roles was compiled as a result of the contributions of Active@work partners:

End users

- Senior employee
- Younger employee
- Manager
- General manager / supervisor
- Operational manager / planner
- Responsible for medical issues in a company (company doctor, human resources people, …)
- Administrator

Skill/collaborative development module end user roles

- Trainee (receiver of content/consumer)
- Requestor of content
- Producer of content
- Moderator

Cognitive module end user roles

- Self-health manager
- Team health manager
- Operational manager (efficiency problems)
- Work environment manager
- First respondent

4.4.2. User role description

Table 1: Work environment manager

Module:	cognitive
Actor: Manager	
Role: work environment manager Someone who is responsible for a good, healthy working environment	

Table 2: First respondent

Module:	cognitive
Actor: Employee (junior/senior)	
Role: first respondent Someone who receives requests from environment manager to change the working environment if there is a problem	

Table 3: Team health manager

Module:	Cognitive
Actor: Manager	
Role: team health manager Someone who is responsible for the health of the senior employees	

Table 4: Operational manager

Module:	Cognitive
Actor: Manager	
Role: operational manager Someone who is responsible for the efficiency and performance of the senior employees	

Table 5: Self-wellbeing manager

Module:	Cognitive/skill development
Actor: Senior Employee	
Role: self-wellbeing manager Someone who is responsible for his/her personal wellbeing at work (the psychological and physiological aspects)	

Table 6: Trainee

Module:	Skill development
Actor: Employee (junior/senior)	
Role: Trainee someone who is the consumer/receiver of the content in order to improve a skill or learn new things or solve a task related to a problem in the working environment	

Table 7: Producer

Module:	Skill development
Actor: Employee (junior/senior), manager, external stakeholder who has the relevant knowledge	
Role: Producer of the content Someone who can create a content (learning material, course,…) based on a request	

Table 8: Requestor

Module:	Skill development
Actor: Employee (junior/senior), manager (operational, health, environment, supervisor, moderator)	
Role: Requestor of the content Someone who request for a new content or changing an existing content when he/she sees an opportunity or a need for that	

Table 9: Moderator

Module:	Skill development
Actor: Manager	

Role: administrator/moderator Someone who is responsible for managing the accounts (governing data access), organizing the knowledge structure and reviewing and publishing the content

4.4.3. Active@work user story description

The Active@work user story that has been developed in the workshop has the focus on continuously improving the senior employee's well-being (physiologically and psychologically) while it tries to keep him or her socially active in creation and consumption of valuable and useful knowledge for the whole organization. Thus the whole system at the end would add value to senior employees as well as the other stakeholders.

Figure 5 represents the interaction process of different users with the system and with other users (tasks and actions).

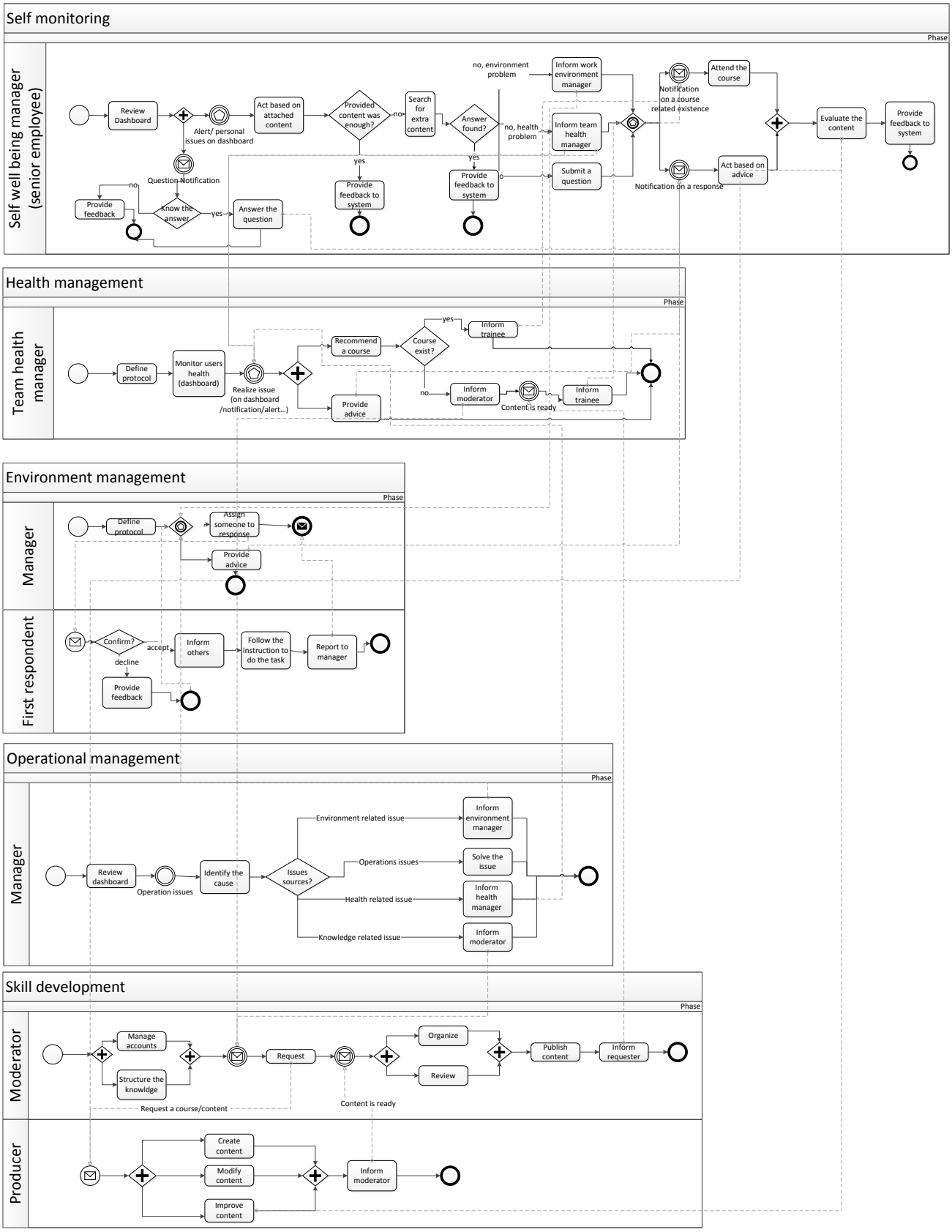

Figure 5: Active@work process diagram

Figure 6 illustrates the **self-monitoring process** of the Active@work system.

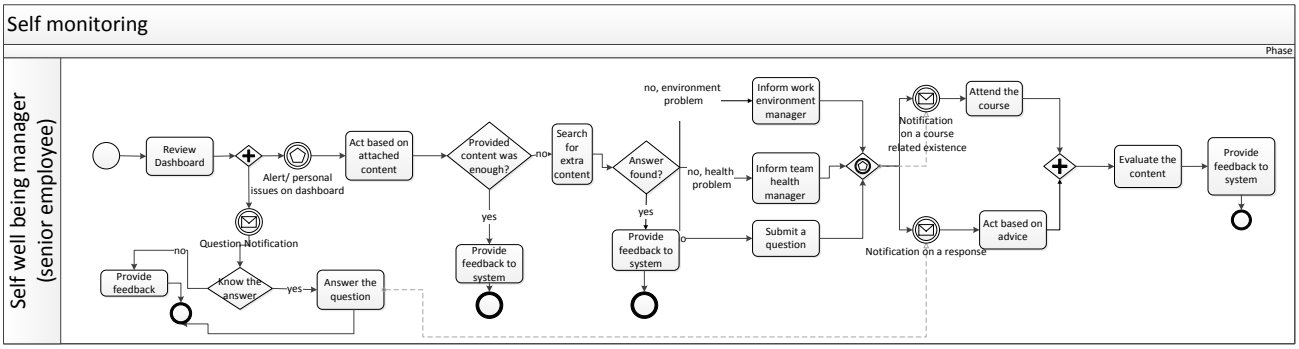

Figure 6: Self-monitoring pool

In the heart of this system is the senior employee, who we call “self-well-being manager” to relate to the fact that every person in principle is responsible for his/her health. The well-being of a senior employee, his/her activities, his/her needs and the characteristics of his/her environment are the main triggers of the other users’ tasks in this system. The “self-well-being manager” process is displayed in the “self-monitoring” pool. The senior employee can start the process of self-monitoring with reviewing his/her dashboard. The next step in this process can be triggered by either an internal or an external event.

As an external trigger, he/she can receive a notification when another employee directs a question to him/her. The question can be in different categories including, health and knowledge related. In this case, he/she receives a question notification. If he/she knows the answer, a response can be submitted to the system, automatically triggering a notification to the person who asked the question that an answer has been provided/is available in the system. If he/she does not know the answer or the question is not relevant to his/her work experiences, he/she can provide a feedback to the system, so that he won’t receive any question of the same category anymore.

Another external trigger is an alert triggered by the system or a message from other users regarding an issue they found relevant for the senior employee. He/she can realize an issue when he reviews his/her dashboard which is an internal event that triggers the process. The external triggers (the alerts or messages) usually should have an attached content that can help the senior employee to act based on that information and solve his/her issue. If the provided content was enough to solve the issue, he/she can inform the system so that the one who realized the issue is informed about the outcome and that the system status is updated (i.e. mark “open issue” as “solved”).

Sometimes this attached content is not always enough to solve an issue. In this case, the senior employee can search for extra content to solve his/her issue. If he/she finds an answer in the system, he/she can again provide feedback to the system (i.e. mark “open issue” as “solved” and possibly point to the answer that additionally helped to solve the issue). But when he/she cannot find any answer to the question, he/she has different options to get an answer. Either, the senior employee can directly contact the one who is responsible for a specific domain. The system predefines three main knowledge domains: health, environmental and (general or task related) knowledge related topics. Another option is to submit a question to the crowd (i.e. unspecific

receiver), so that other colleagues (i.e. a producer of content or other senior/younger employees) might help in answering the question. He/she then would receive a notification once a response to his request is ready. After reviewing the content and acting based on that, he/she can evaluate the quality of the content or response so that the producer can improve the content.

The process of **health management** is represented in figure 7.

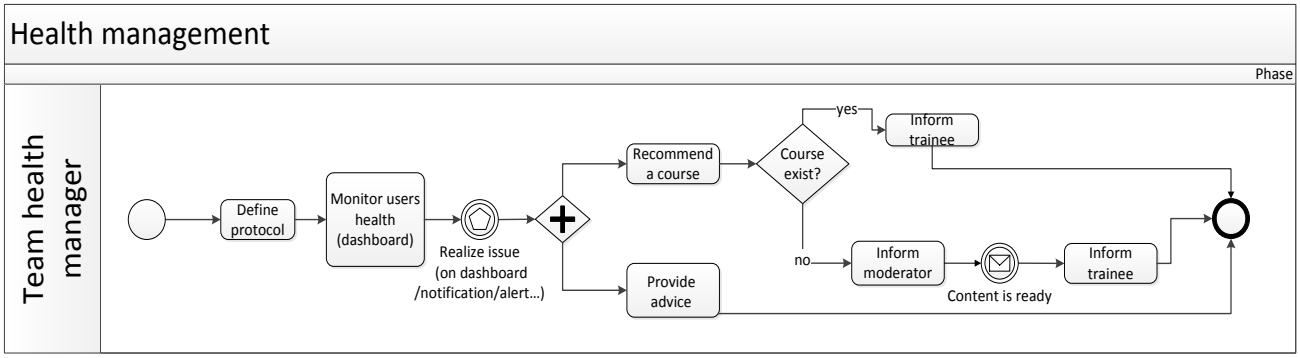

Figure 7: Health management pool

The team health manager as the other involved character in this story is responsible for health issues of senior employees in an organization (company doctor, human resources staff…). In order to fulfill his/her task, first a protocol needs to be defined (risk factor, thresholds, parameters…) in order to create a baseline for alert rules. Then he/she needs to monitor the health status of the senior employee by regularly reviewing his/her health dashboard. While he/she is monitoring the senior employee, he/she might realize an issue regarding the senior employee's health status or receives a request from a senior employee who has a health issue.

When this health related issue triggers the process, the health manager has two options: In case he/she knows how to overcome this issue, the health manager can provide an advice to the relevant person or recommend a course or other information material to the senior employee (note: a course in our user story has not necessarily the traditional meaning, it can be any kind of content that can help the user to solve his issue himself or learn new things that can support him/her in staying healthy and increase work experience and outcome). If the course or relevant content already exists in the system, health manager can just inform the senior employee to attend the course. If the course does not exist in the system yet, the health manager informs the moderator of the skill development pool that there is a need for such knowledge. When the content is ready, the health manager should get informed about it, so that he can recommend the senior employee to attend the course. This process can be terminated when the health manager realizes that the problem is solved, otherwise he needs to iterate this process.

Figure 8 portrays the details of **environment management process**.

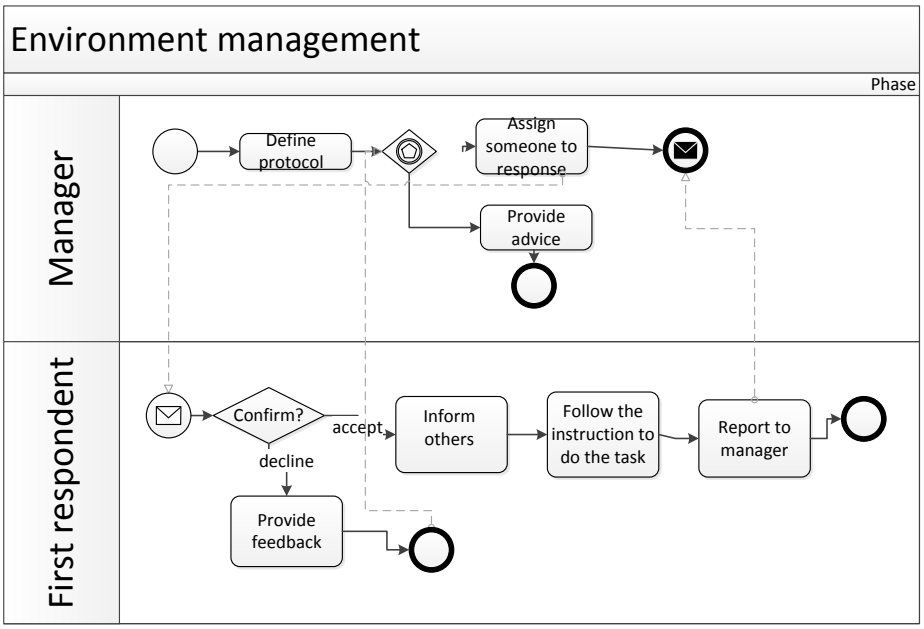

Figure 8: Environment management pool

The environment manager is the person in the organization, who is responsible for a safe and healthy working environment. Like the health manager, the environment manager's first task in such a scenario is to define the protocols and alerts rules. In a next step he/she needs to monitor the working environment with the help of the environment dashboard. When he/she receives a request from a user (senior employee, operational manager…) or an alert from the system, he/she has two options depending on the type of issue: First, the environment manager can directly contact the senior employee and provide advice or alternatively assign someone to resolve the issue (open the window, turn on the light,…). When someone (i.e. the first responder) receives such a task to resolve an issue, he/she has two options: This first responder person can either decline to fulfill the task or accept it. In case of the former, the first responder can provide a feedback to the system so that he won't get any similar task in the future respectively point to another colleague who might be a better match for solving this task. In case of the latter, the system informs the environment manager that the notified person has taken over the task and gets informed again, once the first responder has accomplished his/her task. When the task is accomplished, the system status is updated (i.e. mark "open issue" as "solved").

The figure 9, displays **the skill development process.**

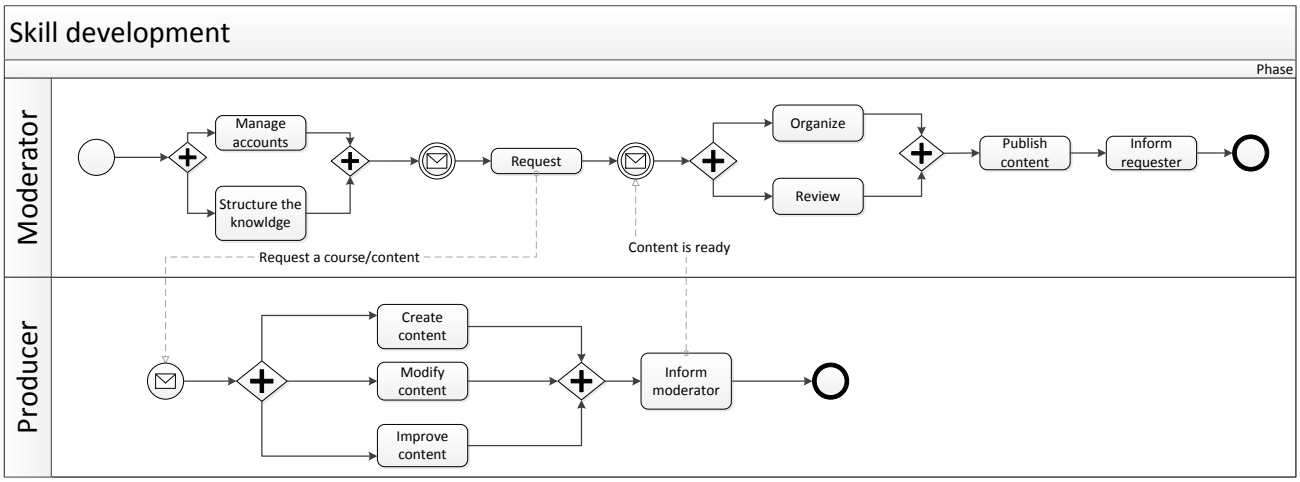

Figure 9: Skill development pool

The moderator is responsible for managing accounts, governing data access and structuring the existing knowledge on the system. When the moderator receives requests or recommendations for new courses or improving the existing knowledge from other users (senior employee, operational managers,…) or he/she identifies a need for modifying or adding content to the knowledge base, the moderator then sends a request to the relevant person who has the required knowledge and is responsible for producing the content. When the producer receives this request, he/she can decline to produce the content or accept it. When the producer accepts the request, based on the nature of the request three different activities are possible: creating a new course, modify or improve the existing course. When the producer is done with this task, the moderator receives a notification that the requested course is ready. Subsequently, the moderation can organize and review the provided content and publish the course if it fits with the established quality guidelines. In this case, the person who asked for the content is notified. The moderation may also notify the health manager or operational manager directly, when he/she realizes that the new course can be helpful to resolve issues related to health or operations.

Figure 10 illustrated the **operational manager tasks**.

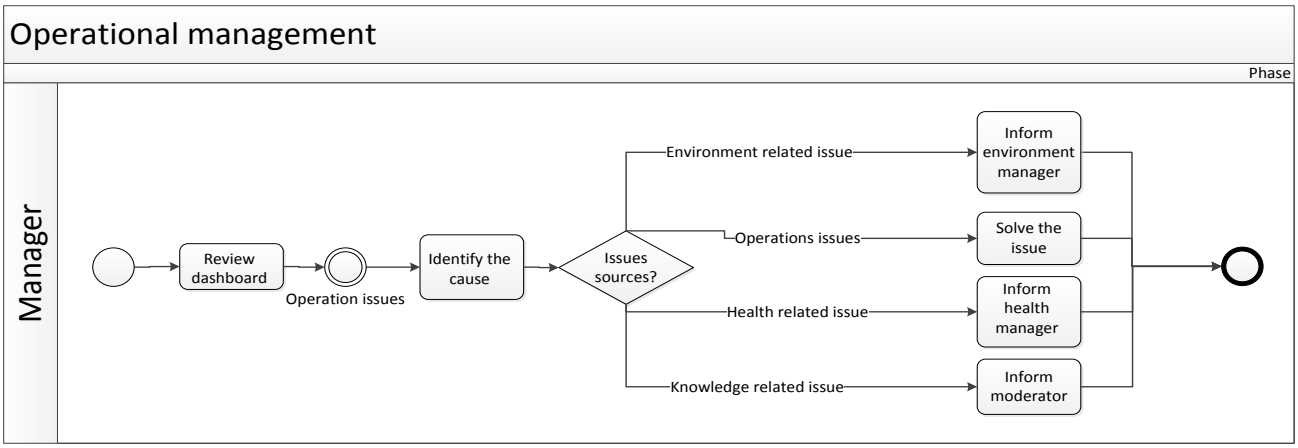

Figure 10: Operational management pool

The operational manager is responsible for detecting and resolving productivity related issues. The operational manager should monitor the senior employees and their working environment to find any issue that result in reducing the employees' performance. When the operational manager finds an issue, he/she first needs to identify the cause. Whether the source of issue is health, environmental or knowledge related, he/she can inform the person, who is responsible for that domain. The system should also suggest problem resolutions, such as gamification or other ways for improving health and performance.

In summary, the overall story of the Active@work project is about trying to improve senior employee's working condition based on four main scenarios.

1. The first scenario is about providing a framework to improve the health condition of the senior employee based on his/her needs and characteristics at work and also in general.
2. The second scenario focus is on continuous improvement of the working environment based on the senior employee's needs and concerns.
3. The third scenario is about providing a setting that assist the senior employee's to share their valuable knowledge with their colleagues and also continuously learn new stuff from other colleagues.
4. The last scenario is about monitoring the operational aspects of senior employees working conditions in order to improve their performance and efficiency.

For each scenario some main triggers that initiate the scenario are listed in table 10.

Table 10 Active@work scenarios overview

Scenario	Trigger
Health improvement	-Elevated heart rate/blood pressure due to stress -Not enough movement -Work pains due to bad posture -Bad eating habits (type/quality of food and time) -Bad drinking habit (type/quality of drinks and time) -Mental fatigue -Physical fatigue -Fall detection -Work related injuries
Working environment improvement	-Temperature -Air Quality -Light quality -Ergonomics -Broken equipment -Missing equipment -Noise -Toxic gases -Temperature/ Humidity/... (review facility performance)
Knowledge sharing	-New duty/task -New device -New process
Operational improvement	-Long meetings

	-Lack of knowledge (about procedures, technology) -Frequent travel (time zone changes, travel fatigue) -Irregular working hours -Fluctuations in work force due to absence -Location -Virtual sensors/KPI workload -Task execution -Equipment, reports issues

5. Requirements

In the following section we will present the derived Active@work system's requirements based on the state of the art and project stakeholders view point. Thus, we call it high level requirement specification. The list of requirements which is presented in this section is not the final version of requirements specification, the consolidated requirements will be presented on deliverable D2.3 Consolidated requirements, pre-evaluation and scenarios..

Based on this preliminary high level equipment specification, we will involve the end users and in next step we will evolve this list.

5.1. Objectives of this document

According to the DoW of Active@work, it is vital to consider what end users require from the Active@work system, e.g. what type of information they would find useful, and their reactions to the possibilities of such a system. To that end the aim of this section is to provide a high level specification of requirements. Identifying the clear, consistent, modifiable and traceable requirements are the main goal of requirement engineering (RE) (29). RE is argued to be a crucial activity in software-intensive system development (30). A system that has insufficient or unaligned requirements will not fit the intended purpose. Therefore, RE process in Active@work identifies system stakeholders, along with their needs and constraints.

Requirements engineering (RE) is the science and discipline of analyzing and documenting requirements ("Systems and software engineering -- Vocabulary," 2010). The IEEE Systems and Software Engineering Vocabulary ("Systems and software engineering -- Vocabulary," 2010) defines requirement as:

1. a condition or capability needed by a user to solve a problem or achieve an objective,
2. a condition or capability that must be met or possessed by a system, system component, product, or service to satisfy an agreement, standard, specification, or other formally imposed documents,
3. a documented representation of a condition or capability as in (1) or (2)
4. a condition or capability that must be met or possessed by a system, product, service, result, or component to satisfy a contract, standard, specification, or other formally imposed document.

5.2. Scope of the requirements

The scope of requirements is considered mainly in line with the scope of user story, which comprises personal health monitory systems and the health behavior change systems. Based on the capabilities of Active@work as depicted in section 2 and 3, the detailed specification of requirements is based on the following types:

- Functional requirements: Things the product must do, that source from stakeholder goals.
- Non-functional requirements: Qualities and properties that the system must have, e.g. performance, reliability, fault tolerance, frequency, priority.

5.3. Requirements Analysis

The work package dedicated to requirements is divided into three subsections, namely:

- State-of-the-art review
- User story description
- High-level specification of requirements

The first step is to identify the state of the art and available technologies to build Active@work. The next subsection precedes the requirements analysis by capturing user stories. Based on the findings of these two tasks, the last task investigates the requirements of end user from Active@work system.

Following that approach, a spreadsheet template (for requirements was established to derive requirements, and to combine them once they were collected. The following fields were specified for each requirement.

- **Requirements Type**: It is useful to specify the nature of the requirement, e.g. functional, non-functional, or data requirement.
  - **FR** – Functional Requirement
  - **NFR** – Non Functional Requirement
- **Requirement Short Description:** Short title for the requirement, enables a brief understanding of the content
- **Requirement Details:** Objective is to capture stakeholder wishes, by describing the intent of the requirement. Details should be written in plain language, and should not have open-ended statements.

5.4. List of Requirements

# Req.	Short description	Detailed description
FR1	Access to questions	The end user shall have access to questions
FR2	Access to responses	The end user shall have access to responses
FR3	Request feedback input	System shall request for feedback when a task is terminated
FR4	Request feedback input	System shall request for feedback when the senior employee receives a question and does not know the answer (e.g. the question was not relevant)
FR5	Allow feedback input	The system shall allow the senior employee to input feedback
FR6	Display well-being information	The system shall display the well-being (health, operational, environment) information to senior employee
FR7	Health related information sharing	The system shall allow the senior employee to choose what aspects of health related information he/she wants to share with health management
FR8	Allow managing accounts	The system shall allow the moderator to manage accounts (e.g. create, modify, delete), assign roles, and govern the data access
FR9	Allow structuring	The system shall allow the moderator to structure the knowledge

	knowledge related data	related data
FR10	Obtain data	The system shall obtain requested data from the database
FR11	Analyze data	The system shall analyze the data to extract information from physiological, movement and environmental data
FR12	Display health information	The system shall display the health information to health manager
FR13	Display environmental information	The system shall display the environmental information to health manager
FR14	Display operational information	The system shall display the operational information to operational manager
FR15	Download information	The user shall be able to download the requested information/report from local database
FR16	Select time period	The user shall be able to specify the time period (e.g. using a calendar) over which he would like to view information
FR17	Print	The user shall be able to print the requested information/report in a specific format in the browser
FR18	Search	The user shall be able to search for a knowledge related information
FR19	Search	The user shall be able to search for a health related information/content
FR20	Search	The user shall be able to search for an environment related information
FR21	Detect anomalies	The system shall detect anomalies (health, environment, operations)
FR22	Retrieve warnings (health related issues)	The system shall obtain the warning messages corresponding to the possible inefficient health related issues
FR23	Retrieve warnings (environment related issues)	The system shall obtain the warning messages corresponding to the possible inefficient environmental related issues
FR24	Retrieve warnings (operational related issues)	The system shall obtain the warning messages corresponding to the possible inefficient operational related issues
FR25	Display warnings (specific activity or appliance)	The system shall display messages and warnings for a specific issue
FR26	Analyze data	The system shall analyze the obtained data
FR27	Send notifications	The system may inform relevant end users through mails, txt and notifications
FR28	Allow cancellation of warning	The user shall be able to cancel the warning
FR29	Request general suggestions	The senior employee shall be able to request general suggestions or help
FR30	Obtain data	The system shall obtain requested data from database
FR31	Request specific suggestions or help	The user shall be able to request suggestions or help for a specific health problem/issue
FR32	Request specific suggestions or help	The user shall be able to request suggestions or help for a specific environment problem/issue
FR33	Request specific	The user shall be able to request suggestions or help for a

	suggestions or help	specific knowledge related topic
FR34	Retrieve response	The system shall retrieve the appropriate responses
FR35	Send notifications	The system shall inform the requester through mails, txt and notifications when a response is ready
FR36	Display response	The system shall display the response on requested information
FR37	Send notifications	The system may inform the user through mails, txt and notifications when a request submitted
FR38	Display request	The system shall display the requested information
FR39	Input advice/response	The user shall be able to input information on the requested advice/response
FR40	Request a specific content	The user shall be able to request a content
FR41	Retrieve response	The system shall retrieve the content
FR42	Send notifications	The system may inform the moderator through mails, txt and notifications when a request for a content is submitted
FR43	Send notifications	The moderator shall inform the requester through mails, txt and notifications when the content is ready
FR44	Select producer	The system shall have a selection menu of the list of available producers
FR45	Request a content	The moderator shall be able to request a content from relevant person (producer)
FR46	Send notifications	The system shall inform the producer through mails, txt and notifications when a need for a content is submitted
FR47	Confirm/cancel operation	The producer shall be able to confirm or cancel the request
FR48	Input content	The producer shall be able to input content
FR49	Modify content	The producer shall be able to modify content
FR50	Delete content	The producer shall be able to delete content
FR51	Display content	The system shall be able to display the content only to producer and moderator
FR52	Upload the content	The producer shall be able to upload the content
FR53	Send notifications	The producer shall inform the requester through mails, txt and notifications when the content is ready
FR54	Organize content	The moderator shall be able to organize content
FR55	Review content	The moderator shall be able to review content
FR56	Request for modification	The moderator shall be able to request a new version
FR57	Send notifications	The system shall inform the producer through mails, txt and notifications when a need for a modification is submitted
FR58	Publish content	The moderator shall be able to change the display status to public
FR59	Request for a task	The system shall have a selection menu of the list of available respondents
FR60	Send notifications	The system shall inform the respondent through mails, txt and notifications when a task is available
FR61	Confirm/cancel operation	The first respondent shall be able to confirm or cancel the request
FR62	feedback	The first respondent shall be able to provide feedback when a task is not relevant
FR63	Display instruction	The system shall display the task instruction
FR64	Report	The first respondent shall be able to inform the environment manager when the task is done

FR65	Send notifications	The system shall request the respondent through mails, txt and notifications to provide an evaluation when a task is performed
FR66	Display evaluation form	The system shall display the evaluation form
FR67	Input the content evaluation	The user shall be able to input evaluation
FR68	Warning/alerts with guidance attachment	The system shall offer information about actions that can help senior employee improve his/her performance and health
FR69	Self-monitoring	System shall provide means for users to track their performance or status. (e.g. daily report on a health improvement task)
FR70	Simulation	System shall provide means for observing the link between the cause and outcome of the senior employee behavior when there is an issue
FR71	Praise	System shall use praise via words, images, symbols, or sounds as a way to give positive feedback for a user. (e.g. automated text-messages for reaching a goal related to learning a new task or improving a health situation)
FR72	Rewards	System shall provide means for virtual rewards to give credit for performing the target behavior.
FR73	Reminders	System shall remind the senior employee of the target situation or an open task
FR74	Real-world feel	System shall provide information of the content producer and provide possibility to directly contact him when a senior employee has a question regarding the content
FR75	Social learning	System shall provide means to share user's experience or feedback when using a content on the system
FR76	Competition	System should provide means for competing with other users. (e.g. stop smoking for a month and win a prize)
FR77	Static and Dynamic Help	System shall assist users when asked or at any time required while interacting with system (31). Where possible, help information should include real-life examples of the sort of information required (32)
FR78	Send notifications	The system shall inform the moderator through mails, txt and notifications when an evaluation form is submitted
FR79	Publish content	The system shall be able to publish the produced content by users
NFR1	Responsiveness	The system shall function in a responsive manner
NFR2	Ease of use	The system shall have easy-to-use design for the consumer
NFR3	Responsiveness	The system shall be responsive in displaying graphics
NFR4	Data accountability	The user shall be able to select the most recent and trustworthy data available for its analysis
NFR5	Reliability (Fault tolerance)	The system shall operate as intended despite the presence of hardware or software faults
NFR6	Reliability (Recoverability)	In the event of an interruption or a failure, the system shall recover the data directly affected and re-establish the desired state of the system
NFR7	Security (confidentiality)	The system shall ensure that data is accessible only to those authorized to have access.
NFR8	Security (Integrity)	The system shall prevent unauthorized access to, or modification of data
NFR9	Security(Non-repudiation)	The system shall ensure actions or events have taken place, so that the events or actions cannot be repudiated later

NFR10	Security (Accountability)	The system shall be able to trace the actions
NFR11	Security assurance	Additional information relating to why it is necessary to request private information, and how the information collected online will be stored, and who will have access to this information should be provided. Virus and spam risks as a result of filling in the online form should also be addressed (32)
NFR12	Compatibility (Co-existence)	The different modules and components of system shall perform their required functions efficiently while sharing a common environment and resources, without detrimental impact on each other
NFR13	Compatibility (Interoperability)	The different modules and components of system shall exchange information and use the information that has been exchanged
NFR14	Maintainability (Modularity)	The system shall be composed of discrete components such that a change to one component has minimal impact on other components
NFR15	Maintainability (Modifiability)	The system shall be effectively and efficiently modified without introducing defects or degrading existing product quality.
NFR16	Usability (User error protection)	The system shall protect users against making errors
NFR17	Tailoring	The system shall provide tailored information for its user groups. (the information shall be tailored to the user personality and usage context)
NFR18	Personalization	Users shall be able to change the graphical layout or the order of information items of their dashboard
NFR19	Consistency	All interactive elements shall be functionally and visually consistent throughout the interface. The layout, information and content should be coherently organized throughout the system (31)
NFR20	Focused interface	The interface design shall be effective, focusing on the object, without presenting unnecessary information (31)
NFR21	Reducing the demand on short memory	System shall provide task relevant information only. System shall not provide parallel information at the same time (e.g. video and text) (27)
NFR22	Invisibility	The sensors shall be embedded in clothes, watches, glasses, etc. (33)
NFR23	Adaptively	The systems shall adapt to the current situation, e.g. they reduce the interface complexity in case of emergencies to reduce the cognitive load (33)
NFR24	Access to data about environment status	The system shall access working environment data of senior employee (e.g. temperature, humidity, toxic gasses, air quality, light quality, noise, missing equipment, ergonomics)
NFR25	Access to data about health status	The system shall access health data of senior employee (e.g. work related injury, fall detection, mental fatigue, physical fatigue, bad eating habit, pains, not enough movement, blood pressure, stress)
NFR26	Access to data about operational status	The system shall access operational data of senior employee (e.g. employees absence, long meetings, working hours, task execution, location, equipment)
NFR27	Store environment data	The input data describing the environment situation in the network shall be stored in a database for future use and analysis

NFR28	Store health data	The input data describing the health situation in the network shall be stored in a database for future use and analysis
NFR29	Store operational data	The input data describing the operational situation in the network shall be stored in a database for future use and analysis
NFR30	Process and analyze data	The data shall be accessed by analysts (e.g. health, operational and environment manager) and put into the appropriate analysis tool.
NFR31	Allow health related protocol input and store	The system shall allow the health manager to input data to define protocols (e.g. risk factor, thresholds, parameters…) in order to create a baseline for alert rules
NFR32	Allow environment related protocol input and store	The system shall allow the environment manager to input data to define protocols (e.g. risk factor, thresholds, parameters…) in order to create a baseline for alert rules
NFR33	Allow operational related protocol input and store	The system shall allow the operational manager to input data to define protocols (e.g. risk factor, thresholds, parameters…) in order to create a baseline for alert rules
NFR34	Allow input and store knowledge related data	The producer shall be able to input knowledge related data and store the data in a saved database for future use
NFR35	Store questions	The senior employee questions or concerns shall be stored in a database for future use and analysis
NFR36	Store responses	The responses shall be stored in a database for future use and analysis

Table 11 Complete list of high-level requirements

6. Conclusion

This document presented the requirements analysis. It was arranged into three tasks/sections:

- The State-of-the-art review
- User story descriptions
- Specification of Requirements

This report started with a state-of-the-art review of current research. In doing so, we reviewed the current situation of personal health monitoring systems and health behavior change systems. In addition, the characteristics of aging were described.

The second part was about the user story descriptions. A range of relevant scenarios have been identified and characterized to improve the health and wellbeing of senior employees at work. In order to do that the different role of end users and their tasks have been identified which together have developed the overall user story. The project partners and stakeholders – who attended a workshop hosted in Madrid – provided the input for formulating the user story. At the end, four main scenarios have been identified including health, knowledge, environmental and operational improvement scenarios. The Active@work user story has been visualized with BPMN notation.

The last part of this document dealt with the high level requirements specification. The goal of the last part of this document was to formulate all the requirements in a consistent way. To elicit and specify the requirements, we used the findings of the state of the art analysis and the user story. Hence, the preliminary list of Active@work requirements is the translation of elderly employees'

needs and concerns derived from secondary data, the analysis of relevant systems to the project's goal (personal health monitoring systems and health behavior change systems and use scenarios derived from Active@work story). However, the list of requirements is not complete without end-users and their actual viewpoints of these requirements. Thus, we need to validate the current list of requirements and use scenarios with asking the end users. The goal of involving the end users at this point is not only validation; we need to find gaps in our current version of the use scenarios and requirements. As the Active@work user story is all about collaboration between different group of end users including elderly employees, their colleagues, company doctor, human resources people, the managers, we need to be aware of any possible conflicts among the needs and motivations of different groups of end users. Realizing and managing these conflicts at the design phase ensures the adoption of the system by end users easier in the next phase. In order to cover the end users willingness to use the Active@work system and designing a system align with end users values, we will conduct a concurrent mixed methods study including qualitative interviews at the site of the pilot partners as well as a quantitative survey in order to get a broader overview of different end user opinions in a next step.

In order to do the qualitative interview; we will define an interview protocoll/guide for conducting semistructured interviews at the pilot partners based on the identified scenarios. Then we will qualitatively analyze the interviews. We will need to use an appropriate method in order to design the interviews and analyze the interviews data, as our goal in this phase is not only to formulate each end user groups requirements in isolation and we have the goal to detect any possible conflicts between the requirements, our method needs to see also these conflicts. For the quantitative evaluation, we will define a questionnaire related to more general aspects of the Active@Work scenarios to obtain a broad opinion of end-users (e.g. conjoint-analysis for prioritizing the high level requirements; or Q-sort analysis for clustering different user groups). Based on our findings we may need to make some necessary changes in our first design proposition (i.e. changing/adding/removing scenarios, better explaining certain points etc.). Then, we will define the detailed specification of the requirements for active@work project.

Both, qualitative and quantitative findings will be subsequently used to prioritize the identified Active@work scenarios and high level requirements. Based on this, we will also be able to better understand crucial barriers and enablers for implementing a health monitoring and health behavior change systems in companies.

7. References

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ANNEX 1: Reports on Exemplary Health Behavior Change Systems

Authors	Title	Journal Title	Year
Azar, KMJ.; Lesser, LI.; Laing, BY.; Stephens, J.; Aurora, MS.; Burke, LE.; Palaniappan, LP	Mobile Applications for Weight Management Theory-Based Content Analysis	American Journal of Preventive Medicine	2013
Banos, RM.; Cebolla, A.; Botella, C.; Garcia-Palacios, A.; Oliver, E.; Zaragoza, I.; Alcaniz, M	Improving Childhood Obesity Treatment Using New Technologies: The ETIOBE System.	Clinical Practice and Epidemiology in Mental Health	2011
Berdichevsky, D.; Neunschwander, E	Toward an ethics of persuasive technology - Ask yourself whether your technology persuades users to do something you wouldn't want to be persuaded to do yourself.	Communications of the ACM	1999
Berkovsky, S.; Freyne, J.; Coombe, M	Physical Activity Motivating Games: Be Active and Get Your Own Reward	ACM Transactions on Computer-Human Interaction	2012
Casey, M.; Hayes, PS.; Murphy, AW.; Glynn, L.; Glynn, F.; Laighin, GO.; Heaney, D	Patients' experiences of using a smartphone application to increase physical activity: the SMART MOVE qualitative study in primary care	British Journal of General Practice	2014
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Chiang, JH.; Yang, PC.; Tu, H	Pattern analysis in daily physical activity data for personal health management	Pervasive and Mobile Computing	2014
Chiu, MC.; Chen, CCH.; Chang, SP.; Chu, HH.; Wang, C.; Hsiao, FH.; Huang, P	Motivating the motivators: Lessons learned from the design and evaluation of a social persuasion system	Pervasive and Mobile Computing	2014
Chomutare, T.; Tatara, N.; Arsand, E.; Hartvigsen, G	Designing a diabetes mobile application with social network support.	Studies in Health Technology and Informatics	2013
Comber, R.; Thieme, A	Designing beyond habit: opening space for improved recycling and food waste behaviors through processes of persuasion, social influence and aversive affect	Personal and Ubiquitous Computing	2013
Cugelman, B.; Thelwall, M.; Dawes, P	Online Interventions for Social Marketing Health Behavior Change Campaigns: A Meta-Analysis of Psychological Architectures and Adherence Factors	Journal of Medical Internet Research	2011
Dorrestijn, S.; Verbeek, PP	Technology, Wellbeing, and Freedom: The Legacy of Utopian Design	International Journal of Design	2013
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Gasca, E.; Favela, J.; Tentori, M	Assisting Support Groups of Patients with Chronic Diseases through Persuasive Computing	Journal of Universal Computer Science	2009
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Authors	Title	Journal Title	Year
JF	workers using interactive, structured, rich-media guidelines on smartphones	Care	
Kaptein, M.; van Halteren, A	Adaptive persuasive messaging to increase service retention: using persuasion profiles to increase the effectiveness of email reminders	Personal and Ubiquitous Computing	2013
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Khaled, R.; Barr, P.; Noble, J.; Fischer, R.; Biddle, R	Our place or mine? Exploration into collectivism-focused persuasive technology design	Persuasive Technology	2006
Khalil, A.; Abdallah, S	Harnessing social dynamics through persuasive technology to promote healthier lifestyle	Computers in Human Behavior	2013
Klaassen, R.; den Akker, RO.; Lavrysen, T.; van Wissen, S	User preferences for multi-device context-aware feedback in a digital coaching system	Journal on Multimodal User Interfaces	2013
Klein, M.; Mogles, N.; van Wissen, A	Intelligent mobile support for therapy adherence and behavior change	Journal of Biomedical Informatics	2014
Koivisto, J.; Hamari, J	Demographic differences in perceived benefits from gamification	Computers in Human Behavior	2014
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McMahon, S.; Vankipuram, M.; Hekler, EB.; Fleury, J	Design and evaluation of theory-informed technology to augment a wellness motivation intervention.	Translational Behavioral Medicine	2014
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Munson, SA.; Cavusoglu, H.; Frisch, L.; Fels, S	Sociotechnical Challenges and Progress in Using Social Media for Health	Journal of Medical Internet Research	2013
Nakajima, T.; Lehdonvirta, V	Designing motivation using persuasive ambient mirrors	Personal and Ubiquitous Computing	2013
Nguyen, H.; Masthoff, J	Towards an architecture for an adaptive persuasive system	Persuasive Technology	2006
Oduor, M.; Alahaivala, T.; Oinas-Kukkonen, H	Persuasive software design patterns for social influence	Personal and Ubiquitous Computing	2014
Ohrstrom, P	Helping Autism-Diagnosed Teenagers Navigate and Develop Socially Using E-Learning Based on Mobile Persuasion	International Review of Research in Open and Distance Learning	2011
Oinas-Kukkonen, H	A foundation for the study of behavior change	Personal and Ubiquitous	2013

Authors	Title	Journal Title	Year
	support systems	Computing	
Orji, R.; Mandryk, RL	Developing culturally relevant design guidelines for encouraging healthy eating behavior	International Journal of Human-Computer Studies	2014
Redstrom, J	Persuasive design: Fringes and foundations	Persuasive Technology	2006
Rodriguez, MD.; Roa, JR.; Moran, AL.; Nava-Munoz, S	CAMMInA: a mobile ambient information system to motivate elders to exercise	Personal and Ubiquitous Computing	2013
Saparova, D	Motivating, influencing, and persuading patients through personal health records: a scoping review.	Perspectives in Health Information Management	2012
Tieben, R.; Sturm, J.; Bekker, T.; Schouten, B	Playful persuasion: Designing for ambient playful interactions in public spaces	Journal of Ambient Intelligence and Smart Environments	2014
van Leer, E.; Connor, NP	Use of Portable Digital Media Players Increases Patient Motivation and Practice in Voice Therapy	Journal of Voice	2012
van Limburg, M.; van Gemert-Pijnen, JEWC.; Nijland, N.; Ossebaard, HC.; Hendrix, RMG.; Seydel, ER	Why Business Modeling is Crucial in the Development of eHealth Technologies	Journal of Medical Internet Research	2011
VanDeMark, NR.; Burrell, NR.; LaMendola, WF.; Hoich, CA.; Berg, NP.; Medina, E	An exploratory study of engagement in a technology-supported substance abuse intervention	Substance Abuse Treatment Prevention and Policy	2010
Vidyarthi, J.; Riecke, BE	Interactively mediating experiences of mindfulness meditation	International Journal of Human-Computer Studies	2014
Wiafe, I.; Nakata, K.; Gulliver, S	Categorizing users in behavior change support systems based on cognitive dissonance	Personal and Ubiquitous Computing	2014
Wohl, MJA.; Parush, A.; Kim, HS.; Warren, K	Building it better: Applying human-computer interaction and persuasive system design principles to a monetary limit tool improves responsible gambling	Computers in Human Behavior	2014
Xu, A.; Chomutare, T.; Iyengar, S	Persuasive attributes of medication adherence interventions for older adults: A systematic review	Technology and Health Care	2014
Zuckerman, O.; Gal-Oz, A	Deconstructing gamification: evaluating the effectiveness of continuous measurement, virtual rewards, and social comparison for promoting physical activity	Personal and Ubiquitous Computing	2014

ANNEX 2: Notes from the Madrid workshop

The workshop was held on the 25th and the 26th of February, 2015, in Madrid, Spain. In attendance were 9 representatives from various stakeholder organizations (ATOS, YAZ, HSG, IOS, SENS and MSIC). The aim of the workshop was to develop a common understanding of the solution, to come away with a shared understanding of what we are attempting to build and why and externalizing this understanding by means of user stories and build confidence that it is complete at a high level for further analysis. The following summarizes the main points and conclusions from the workshop.

Workshop framework

The workshop took place at the ATOS in Madrid, Spain. Participants were divided into three groups to discuss the issues at hand amongst themselves and fill the forms that facilitators prepared in advanced. The discussion and debate was facilitated by the HSG project team.
The workshop was divided into the following sections:

- Organization and objectives of the workshop
- Discussion of high-level assumptions and constraints
- Workshop method introduction
- Pilot A user story (635 Brainwriting Method)
- Pilot B user story (635 Brainwriting Method)
- Consolidation of findings
- Discussion
- Next steps

The first brainwriting exercise was divided into two parts. In the first part, each group was asked to identify the most relevant end user roles. Second, participants were instructed to do the second brainwriting exercise within their groups and reach a consensus on the most relevant task/actions for each role from end users perspectives. The method which was applied to brainwriting exercise was a modified version of 635 brainwriting method. In brief, it consisted of 3 groups supervised by the HSG project team who were required to write down as many ideas as possible on a card/form worksheet within a limited time. The outcome after 3 rounds, during which participants swap their cards passing them on to the team member sitting at their right, is many ideas generated and modified by all the groups. The technique is applied in various sectors but mainly in business, marketing, design, writing as well as everyday real life situations. The final cards were presented to the workshop by the facilitator.
Based on defined and agreed tasks for each module, the next exercise aimed at making scenarios with organizing and sequencing the tasks and making the connections between different tasks in a same module and also different module. This output of this exercise was a board of organized and connected tasks. The figures 12, 13 and 14 illustrate the sample cards that partners filled in each exercise.

Module:	☐ Skill development	☐ Collaborative	☐ Cognitive	Other:
Sub-module:	☐ E-learning tool ☐ Training tool Other:	☐ Mentoring ☐ Idea farm Other:	☐ Dashboard ☐ Alerts ☐ Settings Other:	Other:
Area of application:	☐ Pilot A	☐ Pilot B	☐ VAT	
Actor:				
Role:				

Figure 11 Role Card Sample

Module:	☐ Skill development	☐ Collaborative	☐ Cognitive	Other:
Sub-module:	☐ E-learning tool ☐ Training tool Other:	☐ Mentoring ☐ Idea farm Other:	☐ Dashboard ☐ Alerts ☐ Settings Other:	Other:
Area of application:	☐ Pilot A	☐ Pilot B	☐ VAT	
Role:				
Task:				
Goal:				

Figure 12 Task Card Sample (front page)

Trigger:
User Action:
System Action:

Figure 13 Task Card Sample (back page)

ANNEX 3: Glossary of all important terms

User story	A user story represents a small piece of value that a system can deliver. While traditional requirements (like use cases) try to be as detailed as possible, a user story is a very high-level definition of a requirement. It may consist of one or several use cases.
Task	A unit of work that, when performed, contributes to the fulfillment and completion of a user story. Tasks allow decomposition of stories into manageable fragments.
Actor	Actors are considered in relation to the task world. Actors can take responsibility and ownership for each task, providing estimates and work left to do for completion. An actor refers to either an individual or group of people. Since we want to focus on the end-user, we dissociate ourselves from perceiving technical systems as actors (which is quite common in UML).
Role	Roles indicate classes of actors with a subset of common allocated tasks. An actor can have several roles at the same time. Roles are important to generally understand what an end-user wants and he/she needs.
Action	Action derives its meaning from the task. We differentiate between system actions that are triggered by our VAT and user actions that are evoked by the end-user in order to complete a task.
Trigger	An event or sequence of events that initiates an action.
Scenario	A scenario is a chronologically or thematically arrangement of tasks. In other words: a scenario describes a sequence of tasks (and triggered system and user actions) for a particular kind of user role and particular kind of VAT module or sub-module.