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**Nature of Deliverables:

R=Report

P=Prototype

D=Demonstrator

O=Other

PROJECT PERIODIC REPORT

Grant Agreement number: 611650

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List of Beneficiaries

No	Participant organisation name	Short name	Country	Project entry	Project exit
				month	month
1	Consiglio Nazionale Delle Ricerche	CNR	IT	1	36
2	Università di Pisa	UNIFI	IT	1	36
3	TSB Real Time Location Systems SL	MYSPIERA	ES	1	36
4	AIT Austrian Institute of Technology GmbH	AIT	AT	1	36
5	Fundació per a la Universitat Oberta de Catalunya	UOC	ES	1	36
6	The Extracare Charitable Trust	Extra	UK	1	36
7	Imaginary Srl	IMA	IT	1	36
8	De Montfort University	DMU	UK	1	36
9	Age Platform Europe AISBL	AGE	BE	1	36
10	SI4LIFE – Scienza e impresa insieme per migliorare la qualità della vita srl	SI4LIFE	IT	1	36
11	Accord Housing Association Ltd	Accord	UK	1	36

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1. PUBLISHABLE SUMMARY

1.1 Summary description of project context and objectives

The DOREMI Project context and Scientific and Technological objectives, for Period 1, were:

- Development of an unobtrusive monitoring environment keeping track of the daily activities of the elderly people at risk of malnutrition, sedentariness and cognitive decline according to the “active ageing lifestyle protocol”(MS1, M8) established by the specialist.
- Final Selection of the sensors (MS2, M9) according to parameters identified in the protocol.
- Preliminary data set collected from the selected sensors available for the data driven model (MS3, M12).

The Scientific and Technological objectives, for Period 2, have been:

- Development of a preliminary version of the WSN environment, of Smart environment for Context awareness and of gamified environment system (MS4, M18) with involvement of WP3, WP4 and WP5.
- Development of sensors prototypes ready for the validation activities, WSN environment and auto configuration system (MS5, M24) under WP3.
- Development of the social and gamified environment ready to be integrated in DOREMI system (MS7, M24) (WP5).

The Scientific and Technological objectives, for Period 3, have been:

- Final release of the Smart Environment for Context Awareness (MS6, M33) under WP4.
- Validation of DOREMI platform in the living lab (MS8, M28) and in pilot sites (MS9, M36) under WP6.
- Assessment of DOREMI output on Health Care System of EU27 (MS10, M36) under (WP7).

1.2 Work performed since the beginning of the project and the main results achieved so far

- Period 1

The work performed, in the first year project activities, was strategically directed to the achievement of the first three milestones of the project MS1 (M8), MS2 (M9) and MS3 (M12).

Considering the relevant dependency of the technical development work packages (WP3, WP4 and WP5) with the main scientific model and target user work package (WP2), the scientific and technical coordinators have agreed to follow a WP interaction approach based on an iterative instead of a sequential method.

The main result of this constructive interaction was the common definition and design, agreed by both clinical and technical partners, of the Active Ageing Lifestyle Protocol of the DOREMI project (WP2). The design of the DOREMI protocol and the selection of the main items from the various protocols taken from the literature, had taken in full consideration opportunities and constraints offered by the gamification environment and monitoring environment that will have to finally automate the process of monitoring and assessment of the target user daily improvements compared to the level of impairments registered at the baseline. Work in WP2 has foreseen three main phases:

1. Discussion and agreements on the main protocols to be selected and studied from the literature in the scientific areas of cognitive (main impairment), nutritional, physical activity, social interaction (from real life and virtual perspective). This work was reported in D2.1.

2. Planning and agreement on the DOREMI monitoring environment and the parameters, activities, behaviours and actions to be selected as main representative and useful to monitor the progress and improvements of the target subject. This work was reported in D2.2.
3. Organization and systematization of all the testes and procedures defined in D2.1 and D2.2 and the design of the entire validation process of DOREMI environment. This work was reported in a draft version of D2.3.

WP3 was focused on the development of WSN environment and the auto configuration system. These elements were developed gathering requirements in coordination with WP2 and WP4. In particular, in WP3 it was:

- selected most appropriate sensors and devices and started designing and development of sensors and devices foreseen in the project (bracelet) or integrated in commercial solutions (smart carpet).
- performed a data collection and retrieval layer necessary for data processing and interoperability with the smart environment.
- started the initial design and development of auto configuration system and the integration of sensors in WSN environment.

WP4 worked on the identification of computational learning tasks of Activity Recognition and its requirements investigating machine-learning solutions for both explorative and predictive data analysis.

In particular, WP4 has:

- contributed to the design of high-level DOREMI system architecture throughout a close integrated activity between clinical requirements and technical specifications.
- released a requirement analysis and a specification of the services implemented by the smart environment system, an analysis of the computational methodology adopted for the activity recognition and reasoning components.
- produced a summary of the guidelines for the collection of annotated training data in WP6.

Object of WP5 was the development of the overall gamified active ageing support environment for older users.

In particular, WP5 work was focused on:

- definition of gamified active ageing protocol
- collaboration with medical partners for identification of main structural elements of DOREMI protocol.
- design and development of the game-based environment.
- development of a preliminary set of cognitive games prototypes.

WP7 was focused in this first year to define the communication strategy of the project.

Main activities were:

- development of dissemination plan, with particular attention to the design and development of DOREMI website and portal useful for the on-line engagement of DOREMI stakeholders.
- development of exploitation plan focused on a market analysis to quantify the market segments of DOREMI solution.
- development of IPR strategy of the DOREMI consortium.

- Period 2

During the second year of project, the work was directed to the achievement of the three milestones of the project: MS4 (M18), MS5 (M24) and MS7 (M24).

The progress towards the achievement of these milestones passed through a devised and well-coordinated execution of tasks and sub-tasks under the relevant WPs, namely WP3, WP4 and WP5.

For period 2, WP2 activities were prolonged further on the planned closure (M12) with the main purpose of defining technical and methodological aspects of the Active Ageing Lifestyle Protocol: for this activity a continuous work of information exchange between medical and technical partners was required. The Active Ageing Lifestyle Protocol of the DOREMI project has reorganized and systematized all the tests and procedures described under WP2. For its fundamental role in DOREMI experimentation, Active Ageing Lifestyle Protocol required a deep work of analysis and resolution of three main points:

1. The choice of the most accurate test for measurement of Mild Cognitive Impairment (MCI).
2. The criteria and technical tools to be used to quantify Social Interaction through the DOREMI Gamified environment.
3. The design of the statistical evaluation process that will be applied on the collected data.

This work was described in D2.3; for reasons described above, the planned submission date (October 2014, M12) was delayed until March 2015 (M17).

WP3 was focused on the development of WSN environment and the auto configuration system. These elements were developed gathering requirements in coordination with WP2 and WP4. In particular, WP3 products were:

- DOREMI wristband: device which provides indoor location, step counter, full access to 3-axis accelerometer data and heart rate measurement. This device let to perform caloric consumption assessment, the activity recognition or the pattern detection.
- Smart carpet: a device for an easy and precise measurement of weight and balance.
- Environmental sensor network: a set of presence detector and door contact sensors installed to effectively assess the socialization aspects of the user when is at home.
- Indoor location network: a set of reception devices that enables precise indoor location and a communication infrastructure for the DOREMI wristband.
- DOREMI gateway: a central element to concentrate all the data coming from user's house and forwarding it to remote DOREMI servers.
- DOREMI middleware and integration layers: a software tool to connect all the data sources to a common communication platform and make available these data to all the DOREMI subsystems.
- Auto configuration system: an effective system to manage several DOREMI system working and the same time and a way to declare all the published data and make it accessible by other applications.

WP4 has worked on the identification of computational learning tasks of Activity Recognition and its requirements investigating machine-learning solutions for both explorative and predictive data analysis.

WP4 achievements concerned:

- pre-processing, cleaning and segmentation of noisy streams of environmental and personal sensors within DOREMI middleware integration.

- exploratory data analysis to identify patterns of user habits from traces of indoor mobility.
- supervision of short-term human activity recognition/estimation for estimation of parameters, such as calorimetric expenditures, balance skills and patterns of social indoor visits.
- aggregation and reasoning over activity recognition and games data across different time-scales to automatically assess compliance of the users with the DOREMI lifestyle protocol.
- visualization of the user parameters of interest for the DOREMI lifestyle protocol to the general practitioner through the Dashboard component.

Object of WP5 was the development of the overall gamified active ageing support environment for older users.

In particular, WP5 work produced:

- final development of the game-based environment.
- development of final version of cognitive games prototypes.
- development of final version of social games prototypes.
- development of final version of exergame prototype.

The focus of the WP6 is the validation of the DOREMI system both at lab and pilot site. The main activities, performed during the second year of project were based on:

- collection of data produced by smart carpet functionalities for evaluation of balance assessment and validation of Activity Recognition models.
- collection of data produced by DOREMI wristband for caloric consumption assessment and first validation of Activity Recognition models.
- validation and testing sessions of game prototypes and gamified environment.
- pilot site preparation, with recruitment and enrolment of participants.
- pilot site preparation, with discussion of technical details for installation of DOREMI system.
- integration of components developed by different partners under WP3-WP4-WP5 and the validation of the context-awareness system at Living Lab (Valencia).

WP7 was focused in this one and a half year to define the communication strategy of the project.

Main activities were:

- development of the competitive analysis of the alternative products to DOREMI and understanding of market positioning for its components and whole solution.
- refinement of tools for dissemination activities.
- participation to events for dissemination and exploitation activities.
- Period 3

During the third year of project, the work was directed to the achievement of the three milestones of the project: MS6 (M33), MS8 (M28), MS9 (M36) and MS10 (M36).

The progress towards the achievement of these milestones passed through a devised and well-coordinated execution of tasks and sub-tasks under the relevant WPs, namely WP4, WP6 and WP7.

Main results of this period were:

- the release of SMART environment for Context Awareness, at the basis of DOREMI platform. with its validation in Living Lab (Valencia)
- the final validation of DOREMI platform at pilot sites in UK and Italy.

WP4 has worked to complete the development of the system, which has been integrated and tested both in isolation as well as integrated within the rest of the DOREMI system.

Main activities were:

- pre-processing, cleaning and segmentation of data streams of environmental and personal sensors
- exploratory data analysis to identify patterns of user habits from traces of indoor mobility, allowing to detect alterations and anomalies in the user daily behaviour
- supervised short-term human activity recognition/estimation from available temporal streams of sensor data, allowing estimation of user parameters (calorimetric expenditures, balance skills and patterns of social indoor visits)
- aggregation and reasoning over activity recognition and games data across different time-scales to automatically assess compliance of the users with the DOREMI protocol
- visualization of the user parameters of interest through the Dashboard component

The focus of the WP6 is the validation of the DOREMI system both at lab and pilot site. The main activities, performed during this last year of project were based on:

- collection of data produced by smart carpet functionalities for evaluation of balance assessment and validation of Activity Recognition models.
- collection of data produced by DOREMI wristband for caloric consumption assessment and first validation of Activity Recognition models.
- validation and testing sessions of game prototypes and gamified environment.
- pilot site preparation, with recruitment and enrolment of participants.
- pilot site preparation, with discussion of technical details for installation of DOREMI system.
- integration of developed components and the validation of the context-awareness system at Living Lab (Valencia)
- evaluation of DOREMI platform during UK and IT Trial
- data analysis, evaluation of KPI, validation of the platform

The main activities of WP7 were focused on evaluation of DOREMI products exploitation and on impact assessment of DOREMI solution on EU health care system.

Main activities were:

- analysis of the alternative products to DOREMI and understanding of market positioning for its components and whole solution.
- Exploitation plan, IPR
- dissemination activities.
- participation to events for dissemination and exploitation activities.

Significant results of WP4 have been:

Development and deployment of a Smart Environment for Context Awareness system that has been put in operation during the UK and Italian DOREMI pilots.

As result of the Task 4.2 activities, implementation and refinement of the techniques used for the long-term monitoring of the users' habits.

As part of Task 4.3, completion of the deployment of the supervised activity recognition system, which has been released as a JAVA API as part of Deliverable D4.2.

As part of Task 4.4, the final versions of the DOREMI dashboard and of the DOREMI reasoning system have been deployed.

Significant results of WP6 have been:

As part of Task 6.1, completion of data collection and preparation activities to be conducted in the pilot centres.

As part of Task 6.2, WSN and Context aware system have been validated in the living lab

As results of Task 6.3, Social and Gamified environment developed in WP5 has been validated in a virtual lab

During Task 6.4, DOREMI platform fully validated in the living lab has been employed in the pilot sites and refinements completed. The collected data have been statistically evaluated and results fully described in Deliverable D6.6

Significant results of WP7 have been:

- Dissemination activities, culminating with the DOREMI final conference held in Brussels
- Agreement on IPR sharing among Consortium partners.
- Interviews with stakeholders in order to assess exploitation options.
- Collection of information from pilot participants to assess exploitation options (through questionnaires).
- Estimation of DOREMI costs and potential profits.
- Final exploitation plan and individual exploitation plans for DOREMI exploitable results (ER) developed by partners in charge of each result.
- Collaboration with PERSSILAA and NU-AGE projects for improving active and healthy ageing.

1.3 The expected final results and their potential impact and use (including the socio-economic impact and the wider societal implications of the project so far)

According to the prescription of the EIP AHA working group on the Action Plan A3: “Prevention and early diagnosis of frailty and functional decline, both physical and cognitive, in older people”, applying ICT and e-health to services is expected to be effective in the prevention and treatment of functional/cognitive decline, and to increase the independence and self-reliance of older people. This may result in better quality of life and a reduction in the use of health care services due to increased independent living.

DOREMI expected final result is a platform made of 3 modular building blocks. The modularity includes not only the possibility of a “combination” of all the three building blocks or only two of them (within the monitoring environment the building block n°2, will always have a pivotal and foundational role as explained in the appropriate paragraph), but also a possibility of combination and activation of selected services within each building block, depending on the market segment addressed, the budget availability of the buyer, or the main functional or behavioural aspect that the customer wants to monitor and improve (e.g. giving more relevance to physical activity and socialization or physical activity and diet, or any other possible combination).

DOREMI ‘Building Blocks’:

1. **Social and gamified environment:** Games whose primary purpose is not necessarily entertainment, but where the goal is to engage, train, motivate, educate users. Games are used to stimulate and encourage compliance with active ageing lifestyle ‘protocols’, which have been assigned by specialist. The motivational games for physical and social activity are

associated to sensors (the monitoring environment) to track daily activities and collect relevant parameters for self-evaluation of lifestyle protocols and reports for specialist. The cognitive games are not associated to any sensor and the score level of the user measures the performance. The diet games are associated to a diet application reported in the monitoring environment (provided by the third party software producer METEDA, together with the DOREMI consortium now pursuing an exploitation alliance). All the games will run in specific tablet applications to increase the level of usability, user experience and interaction thanks to the touch screen.

2. **Monitoring Environment.** The monitoring environment is made up of environmental, wearable sensors, a diet app, a smart carpet aimed at collecting, in the less psychologically and physically intrusive manner in order to respect to the privacy and self-esteem of the subject monitored, either raw data and more elaborated information from a set of sensors (e.g. Internet of Things paradigm) or from applications running on the tablet (Internet of People paradigm), where the user is reminded to enter the data.
3. **Context-aware smart system.** The context aware smart system is made up by i) Human Activity Recognition (HAR) models needed to recognize and contextualize the user's daily activities monitored by the sensor and their relevance for the DOREMI protocols ii) a reasoning system that aggregates the output from the serious games and activity recognition components, and to predict the most appropriate lifestyle protocol given the specificity of the environment and of the user.

The initial estimation of the potential market for DOREMI solutions and services, impacts two typologies of health care systems that are considered as most promising in terms of a potential market. They are:

- Countries with a continental health care systems, where the most promising markets would be Germany, France and Belgium. Together they represent more that 30% of the overall European population, with about 30 million individuals aged 65+ that constitutes the biggest market for DOREMI products, especially if it is considered that the higher aged population in these countries has a low level of HLY (between 5 and 10 as described in paragraph 4.3), a significant degree of media literacy and a high percentage living alone (see also paragraph 4.3).
- Nordic, NL and UK countries, representing the second best market for DOREMI products with about 15 millions of individuals aged 65+ years, only considering the most relevant countries that belong to this type of health systems such as UK, The Netherlands, Denmark and Finland. Also for this market the higher aged persons have a low level of HLY, a significant level of media literacy and a large part of them living alone.

DOREMI final exploitation plan has been developed, establishing the above-mentioned countries (Italy, Spain and the UK) as the main target of DOREMI exploitation, at least for the initial phase. Since according to interviews with stakeholders, there exists an interest in DOREMI but the willingness to pay is low, a combination of payers could be a suitable option. More concretely, the stakeholders that could be more predisposed to pay for DOREMI are Health and Social Care organizations, public authorities and CCGs. Elderly might contribute with small payments. Regarding the pricing model, different mechanisms were explored, and it was concluded that the most feasible ones are a purchasing price plus a monthly or annual subscription that will provide sustained revenues; a Premium model with additional levels in the games; and, possibly, advertising.

Since DOREMI is not a marketable product yet, it will take some time until the whole solution can be commercialized. The exploitation plan listed the required changes to transform the solution into a marketable product and it was also emphasized that it would be convenient to conduct further trials to provide more evidence on its effects. Finally, individual exploitation plans for each exploitable result were also presented.

Furthermore, an Impact Assessment has been conducted. Its results showed how DOREMI could bring benefits to EU countries in the form of savings in hospitalization costs and reduced mortality.

However, it also revealed that DOREMI cost per user should be decreased to ensure that benefits per capita stay above costs.

1.4 The address of the project public website

<http://www.doremi-fp7.eu>

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