FINAL
PROJECT REPORT

– Template –

Please send this report ELECTRONICALLY to the Central Management Unit (CMU) as well as a copy to the National Contact Persons (NCPs) of the coordinator and project partners

The coordinator of the project must submit this report within 60 calendar days after the final date of the project, on behalf of the consortium.

If you have any additional question,
please contact the AAL CMU at CMU@aal-europe.eu,
or your NCP (see details on www.aal-europe.eu/aal-ncp)

Report date	13/01/2017

PUBLISHABLE PROJECT INFORMATION (TO BE USED BY AALJP)

1A. PROJECT	
Project full title	HEalthy LIfe support through COmPrehensive Tracking of individual and Environmental Behaviors
Project acronym	HELICOPTER
Project No.	AAL-2012-5-150
Project Website	http://www.helicopter-aal.eu/
Project duration	• Starting date: 01/07/2013 • Termination date: 30/09/2016 (3 months time extension)
Coordinator's name and details	Full name: Sandro Girolami E-mail address: sandro.girolami@meteda.it Telephone number: +39 347 3572118

1B. PROJECT PARTNERS					
No.	**Partner organisation name**	**Partner org. acronym**	**Type***	**Project costs: Public grant in Euro**	**Project costs: Partner own contribution in euro**
1	METEDA S.r.l. (coord.)	METEDA	SME	265.000	277.336
2	Università degli Studi di Parma	UNIPR	RTD	280.000	280.011,88
3	SC Vision Systems SRL	VSRO	SME	175006	48656
4	University of Skövde	HIS	RTD	68327	68771
5	Laboratorio delle Idee S.r.l.	LABIDEE	SME	107.171	107.171
6	Municipality of Skövde	SKOVDE	END USER	45.497	45.081
7	Copenhagen Institute of Interaction Design	CIID	SME	186.659,46	198.284,85
8	Coöperatie Slimmer Leven 2020	SL2020	END USER	€ 307.543	€ 102.500
9	International Business School, Jönköping University	JIBS	RTD	151,62	75,81

1C. PUBLISHABLE PROJECT RESULTS SUMMARY *(1 PAGE)*

The HELICOPTER project aimed at developing an integrated health monitoring approach, in which direct monitoring (through clinical sensors) is coupled to indirect monitoring, based on behavioral monitoring exploiting environmental and wearable sensors. The HELICOPTER service thus focus on merging telemedicine and home-based monitoring techniques in a common, convergent framework.
With reference to telemedicine approaches, such a hybrid solution allows for a more continuous and less intrusive monitoring, may relieve part of the end-user burden and yields an increase in the dimensionality of the clinical view. The main idea is that of exploiting the integrated view coming from the heterogeneous sensor network to infer early symptoms of many common diseases. To this purpose, “diagnostic suspicion” models have been devised and implemented, in which sensor data are continuously analyzed, seeking for anomalies and meaningful trends in basic behavioral indicators (e.g., sleeping or toilet patterns, physical activity,…). I.e., the system does not rely on pre-defined thresholds to define “normal” behavioral ranges, but adaptively adjust reference to the actual end-user profile, continuously updated on actual behaviors.
Sensor data are arranged in a hierarchical fashion, with less intrusive sensors being more frequently involved and clinical sensors (which call for end-user cooperation) being activated on demand, or on a less frequent schedule. All data are then fused in a multi-dimensional model (one for each diagnostic suspicion sought for), based on a probabilistic view and tuned by discussion with clinical specialists. The system therefore supports caregivers decision, drawing their attention with “suspicions”, but not replacing them in the actual diagnostic task. The target group includes elderly people suffering (or being at risk of) several and widespread age-related diseases: a list of eight diseases has been taken into account (hypoglycaemia, hyperglycaemia, cystitis, heart failure, depression, reduced physical autonomy, prostatic hypertrophy, bladder prolapse) with a reduced set tested in pilot environments and a much wider potential diseases set suitable for the approach. A number of technology improvements have been introduced: the data analysis section relies on innovative machine-learning techniques and on disease-specific Bayesian Belief Network models; the sensor network include specific features aimed at behavioral analysis. In particular, environmental sensors (e.g., a chair occupancy sensor) have been given user-identification capabilities, exploiting proximity-based mechanisms through interaction with wearable devices. This allows to extend the approach to home environments populated by more than one person.

45 people and their living environments were involved in pilot testing, including singles as well as couples. This was sufficient to test and validate technical features, and to provide hints for design improvements. In order to assess the actual performance in health management, a much larger scale test is actually needed, which will be pursued after the project end.
Once fully validated, user-perceived benefit should include an increased safety feeling, reduced burden and stress related to clinical self-checks, and self-evaluation feedbacks. Social and economic impact should come from increased sensitivity to early symptoms of diseases, expected to result in more effective and less expensive prevention and care strategies.
Therefore, time to market may vary: the main HELICOPTER service will preliminarily require such an extensive (in time and size) clinical validation, and will therefore require consistent time (likely a couple of years) to be ready for being marketed. Some project outcomes (e.g., sensors, models, web services) may find a more straightforward exploitation in different areas, both within and outside the AAL scope. Engineering of such products may require a shorter time, so that potential market opportunities may open sooner.
With reference to the exploitation plans, the project coordinator will implement actions on his main

(national) market, to begin with. A small-scale launch is expected, in order to cope with easier market tuning and adaption. Scaling up is then planned, also based on market share the coordinator already holds in related segments.

CONFIDENTIAL PART OF THE REPORT

2. DELIVERABLES SUBMITTED AND MILESTONES ACHIEVED DURING THE PROJECT

In this section, please provide details in case your project deviated from the Description of Work *(work plan) with respect to delivery dates, achievement of milestones or changes in planned outputs; please indicate whether and to whom (AAL NFA/NCP) the changes have been communicated.*

A three-months time extension was requested (letter from the coordinator to AAL-CMU and NCP's, sent on May 18, 2016) and authorized by AAL-CMU (communication from AAL officer on June 2, 2016). Consequently, the updated description of work accounted for postponement of a few deliverables and milestones. Namely, D5.3 and D5.4, originally planned for (final) month 36, were postponed to month 39, as well as related milestones M5 and M6.

Has the project been finalised in line with the Description of Work?	**YES ☑**	**NO ☐**	**PARTLY ☐**
IN CASE OF DEVIATION*, PLEASE EXPLAIN:*			
Has the project achieved its expected results as described in the Description of Work?	**YES ☑**	**NO ☐**	**PARTLY ☐**
IN CASE OF DEVIATION*, PLEASE EXPLAIN:*			

3 A. PROJECT RESULTS - SCIENTIFIC/TECHNICAL PROJECT RESULTS

Provide a summary of the confidential results, including:

- The progress per work-package
- The performance of the project consortium (added value of cooperation, added value and performance of each partner etc.)
- Scientific/technical achievements during the course of the project
- End-user services developed during the course of the project
- Other confidential information

All workpackages progressed as planned. In particular, a strictly user-centered design approach was followed: based on general ideas introduced in project proposal, WP2 (User-Centered Design Research) worked out a more specific and detailed service view, based on interaction with users. An intense and articulated fieldwork was carried out, based on interviews, experience prototyping and subsequent analyses. At the consortium level, outcomes were discussed in order to shape actual HELICOPTER services. This allowed to develop the basic idea of “automatic triage”, consisting of continuous monitoring of behavioral symptoms suitable for triggering a set of “diagnostic suspicions”, related to many common age-related diseases. With respect to telemedicine, main improvement goals regards reduced intrusivity, better continuity and wider observation perspective. Since the approach relies on the adoption of environmental and personal sensors, much attention was devoted to usability and acceptability of such devices: user interaction was designed in details, with engagement and trust goals in mind. Outcomes from WP2 fed WP3 and WP4: in WP3 several lines developed in parallel, concerning the development of customized sensors (introducing relevant functions such as energy expenditure evaluation and, most notably, accounting for the identification of users when interacting with environmental sensors, which makes the solution suitable for a multi-user scenario), the design and realization of customized sensor covers (to make them fit more nicely in the home scenario) and of an innovative interaction tool, based on a physical “poster” communicating with the user in a straightforward and intuitive fashion; also the cloud-based infrastructure was developed, and web/tablet/smartphone application were developed, tailoring them to the intended target (primary end-user, caregivers, professionals). In WP4, data analytics was considered, designing and implementing behavioral models needed to translate raw data coming from the sensor systems into “diagnostic suspicions”. In this WP, first the task of detecting behavioral anomalies was tackled, accounting for variability of human behaviors through machine-learning approaches. Then, anomalies were linked to diagnostic suspicions by means of probabilistic models, based on Bayesian Belief Networks. The latters were designed upon clinical knowledge and tuned against preliminary usage data. Models were casted in a device-independent fashion, and systematically queried by the cloud-based supervision system. A sensor hierarchy was introduced, in order to limit more laborious clinical checks (or to perform them on demand). Then, WP5 dealt with field testing of the HELICOPTER technologies. After preliminary actions, involving recruitment and training of pilot support teams, actual technology deployment started on January 2016: also thanks to close cooperation between pilot and technical partners, the home system proved to be operative with no major hassles. Some design iteration were needed, to deal with feedbacks from users and lessons were learnt for future commercial deployment. Actual services were introduced a few months later, to allow for training data analytics systems and for completion of actual user interfaces. A few iterations were then needed for tuning and debugging purposes. The complete system was then able to run in its final configuration in the last 5 project months. Results of the pilot were satisfactory from the technical viewpoint: all components were eventually demonstrated and improved through field testing. The test was inherently less meaningful in assessing clinical merit of the proposed approach: pilot time and size were actually not suitable for a full validation of the approach. Of course, this also resulted in a somehow less rewarding experience

for involved end-users, which emerges from “up and downs” review from end-users. Nevertheless, it is worth to be stressed that the design cycle was completed as planned and that a relevant amount of real-life data was obtained, which are currently providing the basis for project scientific exploitation and follow-up.

The consortium cooperated in an effective way, with all main stakeholders and actors having their say in the service design and implementation phases. As required by an inherently interdisciplinary and multi-faceted project, partners brought a wide range of cultures and sensitivities in the discussion. This made sharing of ideas and concepts a little more demanding (also due to different national regulations), but in the end resulted in a well-balanced approach, in which technical and human concerns jointly drove the overall project strategy.

A number of technical/scientific papers were generated by the project activity, this demonstrating relevance of the project outcomes to the reference scientific context. Also the service view, although not fully validable in the given frame, provided promising hints for further developments toward a clinical-scale trial and commercial exploitation.

3 B. PROJECT RESULTS – BUSINESS MODELS & INDICATORS

Product/service: the main project outcome consists of the “Automatic triage” service concept. Based on simple and unobtrusive home devices and on cloud-based data analytics, it provides continuous monitoring aimed at early detection of behavioral symptoms, possibly indicating occurrence of a pathological condition. Besides such a main concept, potential byproducts include new sensor technologies (introducing user-identification capability into environmental sensors) and innovative interaction devices (poster), suitable for a wider application range.

Benefits: the HELICOPTER system should provide advantages over conventional telemedicine services by adding a further information layer to the health assessment framework. Behavioral monitoring, although of course less accurate than clinical measurements, provides a wider and more continuous picture, introducing complementary informations at little or no impact on the end-user lifestyle. This also makes the approach suitable for extensions toward people with cognitive impairments and related monitoring issues. Moreover, although not exploited in the pilot test, the sensorized environment could enable additional services (e.g., safety functions).

Added value: the “automatic triage” concept is inherently innovative, and no direct competitors are currently available on the market. Although further validation and refinement steps are needed, we believe this could be a valuable add-on to existing telemedicine practices, featuring great personalization and adaptability possibilities. The embedded data analytics strategies relieves the caregiver from the need of interpreting raw data, providing him with synthesized, expressive indicators, but still leaving him interpretation and decision tasks. This will allow for smooth integration within existing care practices.

Future distribution of product/services: METEDA, as main business partner in the project, will mostly deal with initial distribution, just after a more thorough clinical validation will be carried out. The starting strategy will rely on existing METEDA’s network in its main market areas, involving local GPs and public/private home care services. In the longer run, further exploitation channels could be activated: in particular, the data analytics services are not strictly bounded to a specific hardware (sensors) scenario, and could be extended to many different scenarios, involving more general service

providers (such as telecom service providers).	
Please answer the questions below, if possible:	
What is the **targeted range of manufacturing/service costs** per product/service unit (€, € per month etc.)?	500-1000 € (home kit) 10-30 € (monthly fee)
What is the **estimated size of the targeted market** in Europe for your product/service (in €)?	100.000.000,00 /year*
In your business model, **who will pay** for the product/service (you can tick more than one box): ☑ End user (older person) ☑ Informal carers ☐ Formal care providers ☑ Public subsidies ☐ Insurance ☐Other (add if necessary) ☐ not yet decided	
In your business model, **who will take the decision about purchase** of the product/service (you can tick more than one box): ☑ End user (older person) ☑ Informal carers/family ☑ Formal care providers ☐ Public subsidies ☐ Insurance ☐Other (add if necessary) ☐ not yet decided	
At what **stage of development** are you with your product/service (e.g. research, pilot, real life trial etc.)?	pilot
When will your product/service be **ready for market**?	2019
What type of **further research/development** is necessary to finalize the product (technical, adoption, market research etc.)?	Large-scale trial Device engineering and industrialization
What **further investments** are necessary to launch product on the market?	Costs of the above development 1.800.000,00
With reference to certification issues, the HELICOPTER system is open to commercial devices, already featuring relevant certifications. This holds especially true for clinical sensors, possibly requiring medical grade certification. Environmental sensors exploited in the pilot tests have been developed and customized at UNIPR, to introduce new features. Although the system is open to commercial devices capable of ZigBee networking, successful pre-compliancy tests for CE certification have been already been carried out for home and wearable devices. Of course, actual CE certification will not be the responsibility of the research partners, and will be taken care of by linked business parties (university spin-off).	

* *this figure comes from a conservative evaluation, based on demographic data and known prevalence figures (related to age-related diseases taken into account).*

3 C. PROJECT RESULTS – END USER INDICATORS

In the section below, please provide the information you have gathered during your project on primary, secondary and tertiary end-users[1] of your product/service. Note that secondary end-users can be formal and informal carers (see footnote). For the indicators cited below, please provide information if available; any other qualitative or quantitative information on beneficiaries can be provided instead.

Mostly primary end-users (elderly people) was involved, living in their own homes. Two pilot sites were implemented in Eindhoven (NL) and Skövde (SE). In total, 45 users were involved, distributed as follows:

	Singles	Couples	Persons
NL	9	13	35
SE	2	6	10
Total	**11**	**19**	**45**

Participating caregivers (project partners) were part of the pilot support teams. Users were selected based on age class (65+) and on recruitment criteria, including home features and technology propensity, among others. No person suffering from serious clinical condition was involved.
Due to the limited size and span of the pilot population, diversity in health conditions and socio-economic background was necessarily limited. On the one end, this was inherently needed for trusting model statistics; on the other one, however, this resulted in narrowing the exploration scope.

3 D. PROJECT RESULTS – OTHER INDICATORS

Patents, which are the direct result of the project work	n/a
Contirbution to **standards**, which are the direct result from the project work	n/a
Publications (scientific or other), which are the direct result from the project work (please provide details)	8 scientific papers were published, with further ones being currently under evaluation or to be submitted.

1 Definition of end-users in AAL Joint Programme:

- *Primary end-user is the person who is actually using an AAL product or service, a single individual, "the well-being person". This group directly benefits from AAL by increased quality of life.*
- *Secondary end-users are persons or organisations directly being in contact with a primary end-user, such as formal and informal care persons, family members, friends, neighbours, care organisations and their representatives. This group benefits from AAL directly when using AAL products and services (at a primary end-user's home or remote) and indirectly when the care needs of primary end-users are reduced.*
- *Tertiary end-users are such institutions and private or public organisations that are not directly in contact with AAL products and services, but who somehow contribute in organizing, paying or enabling them. This group includes the public sector service organizers, social security systems, insurance companies. Common to these is that their benefit from AAL comes from increased efficiency and effectiveness which result in saving expenses or by not having to increase expenses in the mid and long term.*

Other **dissemination activities**	n. 10 Presentation at the national and international conference and workshops n.8 Scientific video and web publications
Type and size of audience reached by dissemination activities	Physicians, Nurses, Regional Politicians, Researchers, Entrepreneurs, Engineers

4. FINANCIAL INFORMATION - OTHER COMMENTS

Please check appropriate box:

The financial part of the project ☑ is in line with (or) ☐ deviates from the partner's Grant Agreements & Work Packages plans (personal efforts, other costs, etc.)**?**

In case of deviation, please give a short explanation:

Other comments related to financial part of the project:

It is to be remarked that, for what concerns Italian partners, procedure related to Grant Agreement signature and subsequent funding release suffered from extreme delay. The grant agreement was actually signed on February 16, 2015 (i.e., at project month 20) and first (partial) money was eventually received on October 11, 2016 (i.e., beyond the project end).

Such a condition was particularly critical due to the relevant involvement of the Italian partnership in the project initial phases, related to technology design and implementation. Moreover, most of the technology cost related to pilots was borne by Italian partners: such costs had to be sustained well before the funding release (and the grant signature as well). This means that most activities and expenses were carried out by Italian Partners on their own, with no timely support from the National Agency and no clear/sure view of the funding process schedule.

Needless to say, this made the position of Italian partners truly uncomfortable and made achieving the planned goals much harder than necessary.

5. AAL JP PROGRAMME

The HELICOPTER consortium experience with AAL programme is positive overall: we appreciate mostly relative conciseness of the paperwork and fast interaction with central AALA offices.

Interaction with officers and reviewers was helpful and always constructive.

The search for user-driven, "close-to-market" solutions was particularly challenging in the HELICOPTER case, and we found it difficult to fit the overall project size (in time and money) to the implementation of the extensive trials needed to prepare market exploitation.

The two-layers regulation framework (involving both European and National boards) results somehow tricky and introduced noticeable differences in constraints for participating partners. This also yielded redundant reporting work, with most partners having to report twice for the very same

activity (not necessarily with consistent rules and formats).

6. UPDATED PROJECT PARTNERS' CONTACT DETAILS[2]					
NO.	PARTNER ORGANISATION NAME	CONTACT PERSON		EMAIL ADDRESS	TELEPHONE NUMBER
		NAME	LAST NAME		
1	METEDA S.r.l. (coord.)	Sandro	Girolami	sandro.girolami@meteda.it	+390735 783021
2	Università degli Studi di Parma	Paolo	Ciampolini	paolo.ciampolini@unipr.it	+393346669195

[2] Please insert here, for every partner organization participating in your consortium, the updated email address and telephone number of the main contact person. These persons might be contacted after the closure of the project for statistical enquiries related to impact assessment.

3	SC Vision Systems SRL	Risnoveanu	Cornelia	rcornelia@vision-systems.ro	+40 368 401680
4	University of Skövde	Jonas	Mellin	jonas.mellin@his.se	+46500448321
5	Laboratorio delle Idee S.r.l.	Massimo	Mustica	massimo.mustica.g@gmail.com	+393933366003
6	Municipality of Skövde	Carina	Berg	carina.m.berg@skovde.se	+46500498411
7	Copenhagen Institute of Interaction Design	Raffaela	Rovida	r.rovida@ciid.dk	+45 3555 1100
8	Coöperatie Slimmer Leven 2020	Marcel	de Pender	m.depender@slimmerleven2020.com	+31407512426
9	International Business School, Jönköping University	Vivian	Vimarlund	vivian.vimarlund@hj.se	+46725866180