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Abstract

<p>The final report is intended for public distribution and comprises a comprehensive summary of results, conclusions and the socio-economic impacts of the project. The report shall be formatted to be printed as a standalone paper document. This report should address a wide audience, including the general public. It describes the work carried out to achieve the project's objectives; the main results, conclusions and their potential impact and use (including the socio-economic impact and the wider societal implications of the project).</p>
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1 LLM Publishable summary

What is LLM?

Long Lasting Memories (LLM) is an EU project that has implemented an integrated ICT platform which combines state-of-the-art cognitive exercises with physical activity in the framework of an advanced ambient assisted living environment, while respecting ethical and legal boundaries. By combining cognitive exercises and physical activity LLM delivers an effective countermeasure against age-related cognitive decline, as well as and cognitive impairment seen in the early stages of degenerative brain diseases, thus actively improving the quality of life of the elderly and significantly prolonging the time they can remain independent at home.

LLM Service



Figure 1: LLM service

The LLM service is designed to comprise of three existing interoperable components which perform complementary and interactive tasks to provide the system's services:

- The **Physical Training Component (PTC)** is based on the **Fit For All** system developed by the Lab of Medical Informatics of the Aristotle University of Thessaloniki (LLM partner No.1). Fit For All is a game platform that can help elderly people to exercise and maintain their physical status and well being through an innovative, low-cost ICT platform, such as the Wii Balance Board.



- The **Cognitive Training Component (CTC)** is designed to support cognitive exercises provided by specialised software. Two CTC components have been selected:
 - **BrainFitness** (by PositScience), a state-of-the-art product in the United States. It speeds up and sharpens auditory processing - the listening system of the brain. By improving the quantity and quality of what the brain takes in through sound, it drives an overall improvement in thinking, focus, and memory.



- **Gradior** (by INTRAS, LLM partner No.7), a program which offers a structured evaluation and neuropsychological rehabilitation system. This system permits cognitive training and the recovery of higher cognitive functions in people who show cognitive deficit / deterioration with few technical requirements for the therapist or the professional that supervises the performance of the elderly individual.
- The **Independent Living Component (ILC)** is based on the **eHome** system, which is a network of distributed, wirelessly-operating sensors connected to an embedded system (the e-Home central unit) combined with an easy to use information and communication interface for the elderly . It includes features such as intelligent learning of normal and exceptional patterns of behaviour (dangerous situations or indicators for emerging health problems), relevant alarms, voice and video telephony and senior specific internet access . eHome is a an outcome of a project funded by the Austrian Research Promotion Agency (FFG).

Target Groups

The LLM service can be installed in individual homes, day care centres, or formal medical settings, enabling personalized and monitored physical and cognitive training of its users. Meanwhile, users are able to take advantage of features of an independent living solution. The following are the types of users of the LLM service:

- Older people in general, and older people living independently inside an LLM environment, utilising its Ambient Assisted Living (AAL) services (normal or with cognitive problems, see below) .
- Visitors to day care centres: healthy elderly people as well as patients with Mild Cognitive Impairment (a pre-dementia stage characterizing ~20% of people >65 years-old) and patients in the early stages of Dementia due to various causes (Alzheimer's Disease, Vascular Dementia, Parkinsonian Dementias, etc).
- Hospitalised users, who may use the AAL environment while following the cognitive training and may also use the physical training component as complementary to their physiotherapy sessions.
- Actors directly interacting with the end-users: These are close relatives and friends of the end users, formal and informal care persons and care organisations and their representatives.
- Providers of end user support services, i.e. "professionals" acting as de facto "prescriptors" of the service and public administrations promoting and backing public-private-partnerships and funding initiatives under the corresponding National Programmes.
- Decision-makers, supporters and other stakeholders: They include all those who have, in one way or another, an interest in seeing the LLM service or outputs in the market, and include private or institutional investors, government bodies, social security managers, insurance companies, industry bodies and technology providers, professional networks, CSOs and NGOs, etc.

Project Pilots

LLM service was tested and validated in 4 EU Member countries (Austria, Greece, Spain and Cyprus). LLM pilots were held in up to five consecutive rounds of testing of 3 months each (exercising periods of 8 weeks and pre and post intervention testing). Testing was focused upon elderly volunteers who provided feedback to help improve the solution to meet user expectations. Testing was conducted in accordance with relevant regulations for the protection of the participants; all test protocols utilise good ethical practices and comply with European and national legislation.

Greece: In **Thessaloniki**, pilots run under the scientific co-ordination of Aristotle University of Thessaloniki (AUTH, LLM partner No.1). The LLM intervention was first installed and run in one room located at the buildings of the **Greek Association of Alzheimer Disease and Relative Disorders – St. Eleni**. However, the following few iterations of the trials also used different sites as follows:

-6 Municipality-operated social (community) centres (**Kalamaria**: 1st Open Protection Centres of the Elderly (1st KAPI), Kifissias Open Protection Centres of the Elderly (2nd KAPI Kifissias); **Sykies**: 1st Open Protection Centres of the Elderly (1st KAPI Sykies), Neapoli 1st Open Protection Centres of the Elderly (1st KAPI Neapoli), Neapoli 2nd Open Protection Centres of the Elderly (2nd KAPI Neapoli); **Thermi**: Tagarades Open Protection Centres of the Elderly (KAPI Tagarades).

-2 **parish community centres** of the Holy Bishop of Thessaloniki (<http://www.imth.gr/>): St Nicolaos & St Dimitrios Church at Harilaou; St George's Church at Neapoli.

-**Chariseio** Elderly Care Foundation

-Psychiatric **Hospital of Katerini** (<http://www.psynpo.gr/>)

-LLM was also on display at one (1) private gym for dissemination and marketing purposes.

-Collaborators: General University **Hospital** of Thessaloniki **AHEPA** (http://www.ahepahosp.gr/en_index.asp); in specific, the Cardiologic Clinic of General University Hospital of Thessaloniki AHEPA has provided free cardiology examinations to LLM Participants. Similarly, the General **Hospital** of Thessaloniki “**Ag. Dimitrios**” (<http://www.oagiosdimitrios.gr/>), and in specific the Cardiologic Clinic of the hospital has provided clinical tests to LLM participants. Finally, Greek trials were benefited from a loan of equipment kindly offered to LLM by Nintendo Hellas (<http://www.nintendo.gr/el-gr/Default.aspx>); the technological support of Nintendo Hellas was crucial for the LLM pilots.

Piloting in **Athens** took place in municipal and other societal facilities selected for their access to the target population. In Athens pilots run under the scientific coordination of the Cognitive Neurology –Extrapyramidal Disorders Unit of the **1st and 2nd Neurology Department**, Medical School, University of Athens (partner No.13) which is a specialized unit for in and out-patient comprehensive evaluation of patients with MCI and different causes of dementia (e.g. Alzheimer's disease, Vascular dementia, etc) and movement disorders (e.g. Parkinson's disease). Athens trials run in the city of Athens and two of its suburbs: 1) at a specially adapted locus in the **University Campus** in Athens, 2) the Day Care Center of a non-profit organization for care in elderly people in **Glyfada “IASIS”** 3) in the Day Care Centers of the Athens Association of Alzheimer's Disease and Related Disorders (**AAADR**) and 4) the primary care medical center of the **municipality of Holargos**.

In addition to the above 15 home installations were run in Athens, Thessaloniki and elsewhere in Greece.

Austria: The Municipality of Schwechat (LLM partner No.12) evaluated the LLM service in the “**Living Lab Schwechat**” in cooperation with the research institute CEIT RALTEC (LLM partner No.5). In Schwechat the LLM system was tested by five people with a focus on the deployment of the service in private households. All test participants live alone in their private homes where they perform the LLM training – consisting of physical and cognitive exercises – independently. Most of the features the independent living component offers are designed to provide additional support and safety for exactly this group of people. The LLM systems in Schwechat are thus deployed and evaluated with the highest possible range of functions.

Spain: INTRAS (LLM partner No.7) tested the LLM solution in three provinces of the region of Castilla-León (Zamora, Valladolid and Salamanca), which is the Spanish region with a high percentage of elderly people and in the city of Vigo. The LLM services involve 200 patients in 3 Memory Clinics, an Alzheimer's Center and 3 Residential Facilities. INTRAS, having developed its own software for memory training (GRADIOR), tested the physical component with both the BrainFitness software and the Gradior software. The BrainFitness was tested in one of the Memory Clinics and one Residential Facility while the Gradior was tested in the other 2 Memory Clinics, 2 Residential Facilities and the Alzheimer's Center. Pilot sites included: Memory Clinics, **Valladolid & Zamora; Alzheimer Reference Center, Salamanca; Residential Facility, Valladolid; Residential Facility, Zamora; Residential Facility, Vigo**.

Cyprus: University of Cyprus (LLM partner No.14) acted as pilot location for the LLM solution in Cyprus. The pilot locations were the Clinics and day care centres founded and supervised by the Cyprus Institute of Neurology and Genetics, as well as, a combination of senior centres, elderly nursing homes, and individual homes. The Independent Living Component (ILC) was installed in one house (room) located in **Pafos** area. The CTC intervention was performed in the two social services centre, in Nicosia and in Pafos area, in a comfort room equipped with 10 personal computers (PCs) and an equal number of headphones in groups of 10 participants maximum in each service centre. The second room was equipped with both the PTC equipment.

Lessons Learnt

The LLM project has provided a comprehensive approach to validation of the integrated solution, including technical, usability, marketability, and scientific aspects. A methodical evaluation process has been applied to arrive at the overall conclusion that commercial LLM deployment is feasible and that the potential for a

sustainable business model is high. Key lessons learnt and their implications for the future development and deployment of LLM include:

Technology

- Broad distribution will require rigorous planning and testing to ensure availability of appropriately localized systems, including variable availability of hardware components.
- A formal product management approach is required to identify and prioritize technical and features/functions of the LLM service to support the future product development process.
- Organisational and technical infrastructure is required to achieve a supportable technical deployment, and to ensure systems are aligned with data protection regulations.

User Acceptance

- Participants were extremely positive in their responses (across all measures) of LLM. Approximately 84% of the participants who provided feedback described LLM as being easy to learn and use.
- Training with the LLM program made 94% of the participants feel mostly positive (they felt it was fun, they liked it, they felt cheerful after training with it, they felt refreshed and calm).
- 95% of participants believed that exercising through LLM was beneficial for them, most felt LLM was amusing and they enjoyed their sessions with it and LLM met their expectations. The majority of participants felt quite satisfied with LLM.
- In large part this positive user acceptance has led to the intention of several LLM partners to continue providing LLM services to users in the piloting environments for some time after the project's end (AUTH, NKUA, INTRAS, and UCY).
- Users have provided, throughout the project's term, specific feedback that has enhanced usability over the course of the project, and which will be examined to further improve the system in moving into a commercialization phase.

Scientific

- Combined physical exercise and Cognitive Training (full LLM), leads to significant improvements in both episodic memory (the capacity to learn and retain new information) and working memory (the capacity to hold and cognitively manipulate new information) in the elderly.
- Longer training durations and more training sessions induces stronger improvements of long-term memory function. Based on this we recommend a continuous training regimen which is associated with long-lasting memory improvements.
- Follow up measurements (which continue) are encouraging; they indicate that LLM effect lasts for 6 months; then users need to repeat LLM before 1 year elapses to continue to reap positive impacts.

Publication Plan:

LLM will seek top level publications in the following journals: Neuroscience & Biobehavioural Reviews (two review articles are in preparation); articles focusing on different aspects of the results in the Annals of Neurology, the Journal of Alzheimer's Disease, Biological Psychology, the International Journal Of Psychophysiology, Health Policy, JAMIA, IEEE Trans Inf, Tech Biomedicine and other technical journals.

Sustainability model & Contact info

The strategic impact of the LLM project lies on its ambition to proposing an innovative ICT solution towards the benefit of older people and especially those suffering from age-related cognitive decline. The feedback showed a great interest of public authorities and private institutions. Furthermore, quality aspects of the service and its benefits to elderly people were measured during the trials. Analyses of results demonstrate that seniors maintain their mental capacity and in most cases there seems to be an improvement between the pre- and post-neuropsychological assessments. Preliminary results also revealed that LLM is both useful and effective in terms of usability and adaptability to the users' needs. LLM will be marketed in two offerings, either as a full package (ILC+CTC+PTC) or a light one (CTC+PTC), in order to be able to address a wider market range, of care centres and homes that can afford a cheaper version of LLM service and do not need the independent living component.

Interested Citizens may visit [the LLM web site](#) or contact the [LLM partner in their country](#), or visit our [Linked in group](#), our [Facebook group](#), our [Youtube channel](#) and our [Slideshare channel](#).

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2 Overall objectives and achievements

The strategic objectives of the LLM project provided the basic orientation of all project development and their level of achievement was the main management tool. Specific indicators were designed to monitor the progress and success of each objective.

Piloting LLM service at a European scale with the aid of the CIP funding, comprised the stepping stone on which the LLM consortium can reach a wider market and aim for extensive service deployment.

Objective 1

LLM **managed to integrate three (3) ICT solutions** that were running independently in local markets, delivered it into an innovative ageing well/independent living support service for the elderly, and **were technically accepted** by all pilot sites.

LLM service was **localised in four (4) languages** (French, Greek, Spanish and German) and **fully run** in five (5) pilot sites in four (4) countries,

Objective 2

LLM accomplished to demonstrate the significant impact potential of its service in four (4) different countries and **directly reached and impacted 1846 users** (elderly people) participating in the trials, while around **80500 elderly, carers and their families, were impacted locally**, through dissemination and their indirect involvement, especially inside the care centers.

LLM has accomplished to **reach forty two (42) Homes** and **thirty six (36) care centers**.

This significant impact potential of LLM is justified, by using a clinical intervention trial protocol and specific scientific metrics, which indicated **a significant improvement of the elderly involved in the pilot regarding their quality of life related to cognitive, motor and social function indices and autonomy**.

Interviews directly with carers involved in the pilots have also indicated the **improvement of carers' quality of life**, directly by managing more easily the daily exercise and training of the elderly.

Objective 3

LLM project achieved to verify the technical, organisational and legal feasibility of LLM service along the complete value chain of stakeholders, involved through a dedicated Network of Interest maintained through the project lifetime.

All relevant national and European requirements were met, through the recognition of the ethical and legal aspects, related to geriatric care, enabling the solution to be able to be delivered competitively across the EU.

More than 350 Stakeholders were registered in the project Network of Interest (medical and health-care providers, researchers, investors, government bodies, insurance companies, industry and technology providers, etc) who share a common interest related to the LLM project and with whom we have exchanged information and results from the project and discussed its goals, objectives and business potential.

IPR rights clarified and assured through specific agreements with the technology providers (IPRs costs are calculated in the financial forecasts), a wider consortium agreement securing pre-existing knowledge and internal agreements in the local business plans.

LLM system is now commercially available in four (4) languages, with a specific price and technical support in five (5) countries.

Objective 4

The project has managed to verify the sustainability, scalability and applicability of LLM services across Europe through:

- the total acceptance of all partners engaged in the project to **continue for full deployment, through five (5) local business plans and one (1) business case**, in six (6) countries in total.
- a flexible and reasonable **pricing model and five (5) business models** adaptable to the local needs and replicable to other EU countries
- the **interest of around fifteen (15) health/care organisations ready to test the service after the end of the project**, with a forecast of **around nine (9) of them to become our first customers**.
- The **interest of around forty three (43) Stakeholders** (care centres, health organisations, public authorities and hospitals) of our network of interest to deploy the service in the next years

3 Main results

The overall results of the project, deriving from the pilot validation and the scientific and usability evaluation of the LLM solution, and the important feedback from the involved stakeholders of the LLM Network of Interest, has provided to the consortium the confidence that **LLM deployment is feasible** and the appropriate **positive influence** to proceed to its business sustainability.

Consortium activities and Partners complementarity provided the opportunity to validate the LLM deployment potential in three (3) different perspectives: technological, scientific and business.

The evaluation process included a clinical intervention protocol, dedicated usability and user satisfaction questionnaires, interviews, open discussions and several small scale surveys, with the following valuable human resources of the LLM project:

- **A large variety of stakeholders** (private and public) that have been involved especially through the project network of interest (medical and health-care providers, investors, government bodies, insurance companies, etc).
- **The older people** involved in the pilots, that have very generously provided their time and commitment to use and validate LLM service.
- **Care personnel** involved in the pilots that have provided a large support and feedback in a daily basis, helping significantly to improve the pilot processes.

3.1 Technological

The integration of the three components, CTC, PTC and ILC and their corresponding applications was successfully accomplished. Therefore a server based infrastructure was developed which allows an easy integration of new kinds of application modules, requiring minimum adaptation efforts.

Technical large scale testing of the LLM system was conducted twice in a laboratory environment on the two versions of the overall system that was released during the project lifetime.

Additionally, the usability testing of LLM service through the pilot trials has shown that: around 84% of the participants in the evaluation process, rated the LLM as being easy to learn how to use, warm & friendly user environment, the instructions were clear and both the physical and the cognitive components were well adapting to the users' needs.

3.2 Scientific

Affective evaluation of LLM

Training with the LLM program made 94% of the participants feel mostly positive (they felt it was fun, they liked it, they felt cheerful after training with it, they felt refreshed and calm).

95% of participants believed that exercising through LLM was beneficial for them, most felt LLM was amusing and they enjoyed their sessions with it and LLM met their expectations. The majority of participants felt quite satisfied with LLM.

It is an innovative and very enriching experience that helped them also work several emotions:

- Control of fear facing new situations / Confidence
- Helps approaching failures and successes / Enthusiasm
- Safety through training / Satisfaction
- Working with computers strengthens self-esteem

Satisfaction

There was an overall satisfaction of achievement, for being part of a flexible, rigorous and entertaining programme that offers a new way to approach their problems, that it really catches users' attention.

78% of the participants felt LLM was amusing, they enjoyed their sessions with it and it met their expectations. The majority of participants felt quite satisfied with LLM.

All staff members believed that the participants seemed to enjoy their training with LLM, that it is beneficial for them and that LLM is useful in training elderly people cognitively as well as physically.

Independent Living

On average, users reported that:

- training with LLM made them feel they can control their health better
- they would be able to use it at home without help
- In Home installations, some agreed that LLM made them feel more autonomous
- some of them, especially when performing physical training alone at home, felt more safe knowing that a fall down would lead to an immediately generated alarm calling for help
- the user interface was very easy to learn and handle
- The ILC's information features were seen as a very attractive goodie (e.g. RSS-feed, weather forecast)
- nearly all participants would like to have the system when it comes to a final product

Social Integration

The vast majority (96,5%) of the participants at Day Care Center Installations believed that training with LLM improved their social life.

Most users at Home Installations believed that LLM enriched their means of communication and it made them feel closer to their families a little more than before.

Exercising at care centers revealed competition between the elderly on their cognitive and physical exercise performance, which was an incentive for them to be engaged, reduced the drop out percentage and improved their social interaction.

Cognitive and physical benefit

The overall statistical data of measuring cognitive and physical parameters has shown that this non-pharmacological intervention to improve cognitive abilities in elderly people (healthy subjects or patients with mild cognitive deficits or early stages of dementia) had impressive results both qualitatively in certain brain functions affected by aging and psychological state of participants.

Overall, we demonstrated that the full LLM training, consisting of combined physical exercise and Cognitive Training, leads to significant improvements in both episodic memory (the capacity to learn and retain new information) and working memory (the capacity to hold and cognitively manipulate new information) in elderly people.

Longer training durations and more training sessions induces stronger improvements of long-term memory function. Based on this we recommend a continuous training regimen which is associated with long-lasting memory improvements.

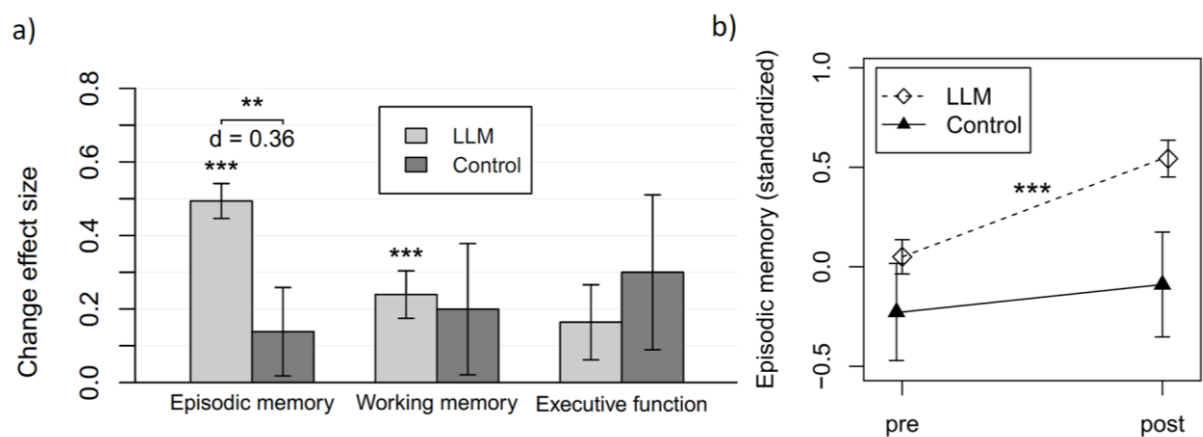


Figure 2: LLM intervention effects on latent cognitive functions. a) Bars represent change effect sizes (post-test minus pre-test, divided by the pre-test standard deviation of the total sample) for the Long Lasting Memories group (LLM) and the passive control group (Control). Net ES d is presented for statistical significant group \times session interaction effects. b) LLM and Control group comparison of standardized pre- and post-scores of episodic memory performance. Arrows represent SE. Statistical effects are marked by asterisks: * $p < .05$; ** $p < .01$, *** $p < .001$

What scientific data show, is that if we could delay the onset in the dementia in the population by 5 years, we would reach a 50% reduction in the cases of Dementia. In this way the improvement of cognitive abilities in the elderly people is highly welcome.

3.3 Sustainability outcomes

The diversity of the European Local Markets makes it difficult to establish a common market selection and strategy, not only due to very different sizes but also to the non-existence of some niches in those Local Markets. On the other hand, the unique selling proposition of LLM empowers LLM business opportunities beyond competitors across all Europe. To manage these issues, the LLM Consortium has proposed a new orientation to its business model, in order to achieve the needed flexibility to adequately reach the market.

Several local business models are envisaged in five (5) countries, some of them promising, some of them already proven to be valid, differ across Europe: either a collaboration agreement for selling across a country with already settled providers (case of Spain) and the creation of spin-offs coming out of the University (Cyprus, Greece and Germany) and the nonprofit research institute (Austria).

The strategy of local business plans has allowed even partners that initially felt out of the business because of their academic profile and because they were not directly involved in running a pilot in their site (e.g. UULM), to rethink their situation and find out how to make business out of the project outcomes.

In this respect, all consortium partners, private, public and non-for-profit ones, have shown their commitment for deploying the LLM services and sustain them locally, by designing their own local business plans.

Even if conditioned by a difficult financial environment, LLM exploitation shows a good potential. Going to the market with the full or the light LLM service, seems feasible, even if it takes longer and kicks-off with a lower profit than initially foreseen. Under current circumstances of economic crisis and reduction of public spending, even the fact of attempting to intrude the market can be considered a successful challenge in itself.

Pilot evaluation has shown that:

- On average, pilot users believed that it is worth paying for LLM, that they would wish to continue using it, while the majority of them have recommended LLM to friends/relatives
- Half of the participants of trial sites in day care centers would prefer to use it at home (to avoid mobility issues), although the other half preferred visiting the day care centres thereby enjoying socializing with other people while training with LLM.

In parallel, the overall market analysis and business plans from identifying customers, proposing marketing strategies to foreseeing sustainable business models has been communicated with the project NoI stakeholders, providing a clearer and more focused view to the consortium.

The received feedback that motivated and helped in the final decision making of the overall partners business plans, can be seen below (in a best practice recommendation format):

- Advise on replicability of LLM service to other member states
- Acquire the commitment of technology providers that will continue to support the service after the end of the project.
- Allow for as lower prices as possibly achievable to make it affordable
- Split the offering of LLM into two packages CTC+PTC and CTC+PTC+ILC
- Provide scientific consulting services when dealing with customers with cognitive deficits (subjects with Mild Cognitive Impairment or Mild Dementia)
- Improve LLM system technologically and increase support and marketing resources with the first income acquired.
- Penetrate the market by building strong relationships with the Care service organisations and public social policy organisations

4 Potential impact and use

4.1 Socio-economic impact

The EU-population is ageing. Old age can bring with it certain risk factors for mental health and well-being, such as the loss of social support from families and friends and the emergence of physical or neurodegenerative illness, such as Alzheimer's disease and other forms of dementia.

LLM has proved, through its technological, scientific and business results that it is promoting healthy and active ageing, one of the EU's key policy objectives by offering the LLM service to:

- Improve the cognitive and physical status of the elderly.
- Support of elderly people's day-to-day activities: with the ILC to identify emergencies and call for help and accommodate everyday home activities
- Support social interactions: directly by enabling the incentive of competition between the elderly on their cognitive and physical exercise performance in day care centres; the latter was also recorded as a key motivation factor, as well.

LLM invited policy makers and stakeholders to take action on mental and cognitive health of older people and managed to:

- Promote the active participation of older people in community life, including the promotion of their physical activity and educational opportunities,
- Provide measures to promote mental and cognitive health and well-being among older people receiving care (medical and/or social) in both community and institutional settings,
- Provide the means to support and decrease the burden of carers.

The strategic impact of the LLM project lies on its ambition to propose an innovative ICT solution towards the benefit of older people and especially those suffering from age-related cognitive decline. The initial feedback of received during the LL project lifetime showed a great interest of public authorities and private institutions that will be continuously pursued through extensive dissemination activities, as an effort to further promote future business models based on public-private partnerships.

4.2 Wider societal benefit

4.2.1 For the Senior citizens

Current project progress shows that the LLM service has the capacity to improve the quality of life of older people and their families:

- by allowing older people to remain at their homes, which is their most convenient and frequent request

- by providing a safe and cosy environment for living with the eHome AAL solution
- by supporting them in remaining mentally, physically and socially active for a longer period of time through the cognitive training process
- by ameliorating the effects of cognitive decline through the training process
- by a monitoring system effectively addressing the fears and anxiety that seniors' relatives feel when they leave their parents alone.

4.2.2 For third parties

The involvement of relatives and carers was different but definitely strong in each of the piloting scenarios. The relatives had a more significant role in private home installations, in contrast with caretakers which were more implicated in formal care LLM service deployment.

In both cases, what was evident was the improvement of their quality of life, as the LLM service managed to increase the effectiveness of current care systems and process, by decreasing their burden and effort, by:

- allowing older people to remain in their homes, which is their most frequent request and receive the care services, without the need for their families and carers, thereby reducing the costs and increasing their independency feeling,
- rendering them socially active for a longer period of time through the cognitive and physical training process, thereby reducing the carers' effort and need and letting the elderly train and interact by themselves, without the supervision of carers,
- ameliorating the fears and anxieties that older people's relatives feel when they leave their parents alone with the usage of the monitoring system

The project has provided evidence that the LLM service increases the effectiveness of care systems. Seniors are commonly set under constant observation (intensive care) as a countermeasure to physical weakness (which may result in accidents like falls) or mild dementia, which has the risk that they will put themselves into danger by mistake.

Not only does LLM counteract these reasons by stimulating the physical endurance and cognitive ability of the elderly, but it also provides a constant monitoring and assistive system. This results into less need for the physical presence of a professional caretaker and hence less costs for the families and care systems in the long run. Meanwhile, LLM, as a care system, was able to focus on the people where intensive care is an absolute necessity and not a precautionary measure.

4.3 Potential use

Apart from all consortium partners, private, public and non-for-profit ones that have shown their commitment in deploying LLM services and sustain them locally, by designing their own local business plans, there is also the potential for wider use of the LLM service in other EU countries.

This has been accomplished with the replicability of the LLM business model, which is designed to be able to address several different market opportunities, each of them deserving a specific approach and can be handled in a different way, by a commercial partner, according to its strategy and position on its domestic market.

LLM is proposing business models that are replicable in any other country regardless of the initial consortium, and by extension to any country sharing the same background in terms of demography and technical infrastructures. These business models are valid for current LLM partners, as well as, for any future partners.

5 LLM beneficiaries



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6 Main Dissemination activities

The dissemination activities carried out by the consortium during the project period are the following:

Project website: The LLM web site (<http://www.longlastingmemories.eu>) has been developed as one of the main dissemination tools. It includes videos, project information, articles, flash presentations. It also serves as the hub through which the user groups are able to find and access the outcomes of the project.



Network of Interest: The LLM network of interest comprises a community of people (medical and health-care providers, researchers, investors, government bodies, insurance companies, industry and technology providers, etc) who share a common interest related to the LLM project. The idea behind the NoI is to exchange information, ideas and thoughts about the LLM project, its goals, interests, objectives and business processes with the aim to:

- focus dissemination activities to those that might have maximum benefits and to those who might influence LLM project outcomes and later product marketing commercialization.
- involve SMEs and industrial partners to the piloting phase, not to miss the opportunity to bring the service to the market.

The LLM consortium initiated a discussion with a number of 360 individuals who comprised the initial NoI – interested parties in the field (i.e., day care centres, clinical centres for people with mental disabilities, insurance companies, public authorities or elderly people or their relatives, etc). Positive feedback from this process was received from all target groups which in general expressed their interest in the results of the project. A number of at least 20 contacts from the NoI will be used for follow up activities based on the local business plans.

LLM updated brochure and poster: A project brochure has been developed and printed. It has been distributed at various conferences, meetings and discussions. The brochure provides an overview of the project, contact and website details, reflects the

benefits and quality of the LLM project, as well as highlights the strength of the project consortium and the support of the CIP and the European Commission. The consortium regularly updated the LLM brochure and the LLM poster in order to be more targeted to end-users informing about the latest results of the project.

LLM videos (youtube channel): The consortium has produced several videos regarding the LLM activities and platform. All LLM related videos are available on the LLM youtube channel under: <http://www.youtube.com/user/llmdissemination>.

LLM presentations: All LLM related presentations are available on the LLM slideshare channel under: <http://www.slideshare.net/llmdissemination>.

LLM and social media: We created a Long Lasting memories “linked-in group” (<http://www.linkedin.com/groups?mostPopular=&gid=3644805>), a Long Lasting Memories Facebook group (<http://www.facebook.com#!/pages/Long-Lasting-Memories/166455816714659>) and a twitter account (<http://twitter.com/llmproject>) informing about the project outcomes and results.

LLM 1st workshop: The 1st LLM-workshop held in Athens on the 20th of May 2010. The introductory workshop familiarised a selected audience, encompassing medical and health-care providers, investors, government bodies, insurance companies as well as industry and technology providers with preliminary results of the development, integration, and pilot planning efforts. The workshop consisted of three main sessions with intermittent coffee and lunch breaks allowing room for face-to-face discussions with interested parties. The first sessions concerned the presentation of the LLM service. The second session described in detail the pilot trials and presented arising legal and ethical issues. The third session completed the workshop by a hands-on demonstration of the service.

Videos and presentations of the workshop are available on the project’s website: <http://www.longlastingmemories.eu/?q=workshop1st/>.

LLM Paris workshop: LLM consortium participated on the 18th and 19th of October 2010 in two different workshops held in Paris held during Semaine Bleue 2010 (national week dedicated to the retirees and the elderly in France).

- Joint T-seniority/LLM workshop, 18 October 2010: E-seniors together with the T-Seniority project team organised the logistics and programme of the joint T-seniority/LLM workshop, held on the 18th of October 2010 in Villejuif, near Paris. This workshop attracted a large number of visitors who were made aware of the respective projects and could exchange on issues pertaining to new home technologies addressed to ageing seniors and to modern gerontology, of which LLM.
- Exergaming conference 19 October 2010: Cognitive, physical and even psychic training were the subject of this conference dedicated to serious health games. It presented the most adequate frame and showcase for LLM which associates both cognitive and physical training in the same system. Key LLM people had the opportunity to address future potential qualified stakeholders or customers. In particular, preparing for the 19 October conference has lead to gaining a

comprehensive view on what LLM's potential competitors are and what practical developments are being done on the use of games for fighting the loss of autonomy.

More information can be found on the project's website under:
<http://www.longlastingmemories.eu/?q=content/2nd-workshop>

A variety of LLM presentations and dissemination activities during the 7th Panhellenic Conference on Alzheimer's Disease and Related Disorders (16-20 February, 2011). Wide range of target audience (LLM stakeholders) was reached that overall increased the awareness about the LLM service while demonstrating the LLM platform live at the organised and dedicated exhibition booth.

LLM Discussion Workshop focused on “Ageing brain and training: neuroscientific evidence”, held within the 2011 International Conference of the Society of Applied Neuroscience (SAN2011; www.san2011.org); The workshop was sponsored by the LLM project and it was Organised by Franka Gloeckner (ULM University, DE), Panos Bamidis (Aristotle University of Thessaloniki, GR), and Winfried Schlee (ULM University, DE). It contained neuroscience oriented presentations of LLM partners as well as other scientific teams and it was one of the attractions of the SAN2011 conference. The workshop was well attended by some 50 conference participants and was also linked with a distinctive invited lecture by Henry Mahncke of PositScience (USA; owner of Brain Fitness Cognitive Training Software) on “Brain Plasticity Based Training Programs - Theory, Data, and Practice”. Some of the workshop presentations are invited for a special issue currently organised in the International Journal of Psychophysiology (Elsevier) by Guest co-editors Profs. John Gruzelier (UK) and Panos Bamidis (GR).

http://www.san2011.org/index.php?option=com_content&view=article&id=61&Itemid=68

LLM final workshop: The Final LLM workshop entitled "Driving Innovation in Psychosocial Care: Addressing Cognitive Deterioration in the Ageing Process" was held in Salamanca, at the 13th of December 2011. A selected audience was invited and informed about the LongLastingMemories project, introduced to the technical components, showed the scientific basis and demonstrated preliminary scientific results as well as presented business aspects. Three lectures and 2 workshops were followed by a round table discussion to promote an exchange between the members of the project, scientists, stakeholders and end-user organisations. Additionally, other projects (DIEGO, e-SALUD, Seniorchannel, ATIS4All, SOCIABLE, SOFTCARE) in the aging research field were presented to inform about the most current innovations for the elderly.

More information can be found on the project's website under:

<http://www.longlastingmemories.eu/?q=content/final-workshop>

The final Greek LLM Workshop was held in Thessaloniki on the 26th of March 2012. A selected audience was invited to inform about the Long Lasting Memories project, introduce to the technical components, show the scientific basis and demonstrate preliminary scientific results as well as present **business aspects** (introducing LLM to the Greek market) and raise further awareness of the project. The audience was composed of

scientists, medical doctors, potential stakeholders, service providers, project members and partners.

More information can be found on the project's website under:

<http://www.longlastingmemories.eu/?q=content/greek-workshop>

Concertation Meeting on DTV for Inclusion and Accessible DTV: LLM participated in this meeting which took place on the 8th February 2011 at Fraunhofer FOKUS in Berlin. Our involvement in this meeting was to learn from existing practices and experiences on provision of services through DTV. Participating audience involved developers, scientists and the consumer electronics industry. Synergies were found with two projects Vital Mind (VM) and T-Seniority, on using existing experience on technologies that can be utilised from these projects and deliver LLM services through DTV. Cooperation with Vital Mind is based on investigating the provision of cognitive and physical training through broadcasting iDTV using Set to Box (STB) but also through HTML pages on HbbTV using CE_HTML. LLM project is really in close contact with T-Seniority and still investigating the possibility for providing LLM service through a similar platform like T-Seniority.

Currently LLM technology team is designing to deliver LLM service (outside the scope of the LLM project) through the DTV channel, investigating the possibility to either develop a web based applications using all types of browsers or through a dedicated API.

- Web based LLM service problems for example is the billing model and the offline capability, but it can be accessible from different devices, although the quality experience is not the same.
- LLM service as an APIs problem for example is that you spend efforts for something that plays only in one device.

Participation in conferences, workshops and seminars:

- The European Ambient Assisted Living Forum 2009
- AGE Joint Workshop Towards a New Ageing Vision: AGE- European Commission, DG Information Society and Media.
- Open source in European Healthcare - Crossing the borders (OSEHC2010).
- 3rd International Conference on Pervasive Technologies (PETRA 2010).
- 5th International Carers Conference (July 2010).
- Conference, SPR 2010, Portland (USA) - ERN across adulthood and in pathological aging – contributions of cognitive function and age.
- 4th German AAL - congress, Berlin
- 13th International Congress on Medical Informatics in Cape Town, MEDINFO 2010; Integration of Cognitive and Physical Training in a Smart Home Environment for the Elderly People

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- 3rd ACM INTERNATIONAL CONFERENCE ON PERVASIVE TECHNOLOGIES RELATED TO ASSISTIVE ENVIRONMENTS, PETRA 2010 in SAMOS
 - 12th International Conference on Computers Helping People with Special Needs - ICCHP (Vienna, July 2010)
 - 3rd Panhellenic and 2nd European Scientific Nursing Conference,
 - International Psychogeriatric Association Conference (2010)
 - SICBM 2010,
 - Neurosymposium Ulm 2010
 - XII Mediterranean Conference on Medical and Biological Engineering and Computing 2010 (organizer of the conference and participation with a stand)
 - Serious Games, Education and Economic Development (SGEED-2010) - “LUDUS” conference
 - Information announcement about the LLM project at the Declaration of Amsterdam of the World Congress on Information Technology 2010.
 - LLM project participated with a stand in the 7th Panhellenic Conference on Alzheimer's Disease and Related Disorders in Thessaloniki. Workshops organized during the conference:
 - 17/2/2011: Brain Neuro-imaging and dementia: the role of emotions, cognitive training and physical training
 - 18/2/2011: Technological advancements in dementia
 - 19/2/2011: Fit For All: physical training in LLM
 - 19/2/2011: Emotion and cognitive function in the elderly
 - ISISEMD (Intelligent System for Independent living and Selfcare of seniors with cognitive problems or Wild Dementia) Workshop in Rome (under the aegis of the Third International Symposium on Applied Sciences in Biomedical and Communication Technologies, ISABEL '10)
 - 10th IEEE International Conference on Information Technology and Applications in Biomedicine in Corfu, Greece
 - eChallenges e-2010 Conference & Exhibition (27-29/10/10 Warsaw Poland).
 - The Society of Applied Neuroscience (SAN) meeting, Thessaloniki, May, 2011, (<http://www.san2011.org/>).
 - XVI Congress of Pshygeriatrics actualization, Barcelona, May, 2011.
 - ICT Proposers Day 2011, Budapest, May, 2011.
 - 5th International Conference on Pervasive Computing Technologies for Healthcare, Dublin, May, 2011, (<http://pervasivehealth.org/2011/>).

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- 15th Congress of the European Federation of Neurological Societies, September, 2011, Budapest, Hungary
 - 11th European Conference for the Advancement of Assistive Technology (AAATE 2011), Maastricht, September, 2011, (<http://www.aaate2011.eu/>).
 - 15th International Psychogeriatric Association (IPA) Congress, Hague, 2011, (<http://www.ipa-online.org/>).
 - 3rd European AAL-Forum, Lecce, September, 2011, (<http://www.aalforum.eu/>).
 - VII National Social Care Congress, Vittoria- Gasteiz, October, 2011.
 - 11th Congress of Portuguese Geriatric Association (APG), Porto, November, 2011.
 - 39th Congress of European Association of Geriatric Psychiatry (EAGP), Porto, November, 2011.
 - Neuroscience conference, Washington, November, 2011
 - The International Telecare & Telehealth Conference, November, London, 2011.
 - Final LLM workshop, Salamanca, December, 2011.
 - XXV Reunión de la Asociación Castellano y Leonesa de Psiquiatría, December, Ponferrada, Spain, 2011.
 - 5th German AAL-congress, Berlin, January, 2012.
 - 27th International Congress of Alzheimer Disease, London, March, 2012, (<http://www.adi2012.org/es/home.aspx>).

Submissions of articles in scientific publications and journals:

- Book chapter: Kolassa, I.-T., Glöckner, F., Leirer, V., & Diener, C. (2010). Neuronale Plastizität bei gesundem und pathologischem Altern [Neuronal plasticity in healthy and pathological aging]. In: Was ist Alter(n) – Medizin, Technik, Umwelt. Häfner, H., Schlicht, W. (Eds.). Springer-Verlag.
- Vlahou, E., Billis, A., Konstantinidis, E., Mouzakidis, C., Kolassa, I.-T., Schlee, W., Glöckner, F., Arampatzis, S., Economou, N., Protopapas, A., & Bamidis, P. (2010). Long Lasting Memories: A Unified Solution for Mental and Physical Health of Senior Citizens. Serious Games, Education and Economic Development (SGEED), Ioannina, Greece.
- Publication of a poster- of LLM-service at the ICCHP 2010 conference (12th International Conference on Computers Helping People with Special Needs (Vienna, July 2010).
- Evdokimos Konstandinidis, Antonis Billis, Walter Hlauschek, Paul Panek, Panagiotis Bamidis (2010): Integration of Cognitive and Physical Training in a Smart Home Environment for the Elderly People; in: Proceedings of the 13th World Congress on Medical Informatics “Medinfo 2010”.

- A piece of news about the LLM activities at INTRAS' internal newsletter "ESPACIO INTRAS" (N°61), at page 12. In this new edition, it is disseminated the results of the workshop and the meeting in Paris.
- Poster presented at the International Psychogeriatric Association Conference: 24-29 September 2010, Santiago (Spain). Title: "Clinical trial design about usefulness of technologies for physical and cognitive stimulation. Long Lasting Memories Project". Authors: Juan Luis Muñoz, Victoria De-Vena; Jose Porto; Abdel Solis; Yuri Ruiz; Raquel Losada; Vontas Apostolos; Pablo Gomez-Conejo, Manuel Franco.
- A. Billis , E.Konstantinidis, C.Mouzakidis, M.Tsolaki, C.Pappas and P.Bamidis. A game-like interface for training seniors' dynamic balance and coordination, XII Mediterranean Conference on Medical and Biological Engineering and Computing 2010, Springer, ISBN: 978-3-642-13038-0, pp 691-694.
- V. Moutzi, C. Wills and A. Koumpis Integrated services for the elderly: An ambient assisted living solution against cognitive deterioration with physical activity XII Mediterranean Conference on Medical and Biological Engineering and Computing 2010, Springer, ISBN: 978-3-642-13038-0, pp 780-783.
- Publication of the press release about "An integrated solution for physical and mental health and independent living of elderly people - European Union, Aristotle University of Thessaloniki & Greek Association of Alzheimer Disease" under the "<http://www.dramina.gr/>" Newspaper, with regards to the participation of senior citizens to the trials of the Research Project LLM.
- Poster presentation about modern treatment at the early stage of dementia at the 3rd Panhellenic and 2nd European Scientific Nursing Conference, Ioannina, Greece.
- P. Bamidis, M. Alborg, V. Moutzi, A. Koumpis. Synergy between social and health services under an Ambient Assisted Living environment for the elderly under publication by IEEE.
- "eHome – living with assistive technology" – poster presentation of eHome as the independent living component of LLM, published in VDE-Verlag 2011, ISBN 978-3-8007-3323-1, 4th German AAL-congress, Berlin.
- W.Hlauschek, P.Panek - Contribution to "Integration of Cognitive and Physical Training in a Smart Home Environment for the Elderly People" Proceedings of the 13th World Congress on Medical Informatics "Medinfo 2010", ISBN: 978-1-60750-587-7.
- Poster presentation at Conference, SPR 2010, Portland (USA) entitled: "ERN across adulthood and in pathological aging – contributions of cognitive function and age".
- Schlee, W., Leirer, V., Kolassa, S., Glöckner, F., Elbert, T., & Kolassa, I.-T., Development of Large-Scale Functional Networks over the Lifespan. Neuroscience conference 2011, Washington, D.C., USA.
- Thurm, F., Scharpf, A., Liebermann, N., Kolassa, S., Elbert, T., Luchtenberg, D., Woll, A., & Kolassa, I.-T. (2011). Improvement of cognitive function after physical

movement training in institutionalized very frail older adults with dementia. *Journal of Gerontopsychology and Geriatric Psychiatry*, 24(4), 197-208.

- Schlee, W., Leirer, V., Kolassa, S., Thurm, F., Elbert, T., & Kolassa, I.-T. (2012). Development of Large-Scale Functional Networks over the Lifespan. *Neurobiology of Aging*. Early online.
- Maftai, M.*, Thurm, F.*, Leirer, V.M., von Arnim, C.A.F., Elbert, T., Przybylski, M., Kolassa, I.-T., & Manea, M. (submitted). Antigen bound and free β -amyloid autoantibodies in serum of healthy adults. *equally contributing.
- Maftai, M.*, Thurm, F.*, Schnack, C., Tumani, H., Otto, M., Elbert, T., Przybylski, M., Kolassa, I.-T., Manea, M. & von Arnim, C.A.F., (in prep.). Increased levels of circulating β -amyloid immune complexes in serum and cerebrospinal fluid of Alzheimer's disease patients. *equally contributing.
- Maftai, M.*, Thurm, F.*, Schnack, C., Tumani, H., Otto, M., Elbert, T., Przybylski, M., Kolassa, I.-T., Manea, M. & von Arnim, C.A.F., (in prep.). Increased levels of circulating β -amyloid immune complexes in serum and cerebrospinal fluid of Alzheimer's disease patients. *equally contributing.
- Published Abstract in "European Journal of Neurology" Poster presentation in the 15th Congress of the European Federation of Neurological Societies, September, 2011, Budapest, Hungary

Other dissemination activities include:

- Participation in the EC Concertation Meeting on DTV for Inclusion and Accessible DTV (Topic 1: Applications running on TV displays in support of elderly independent living)
- Presentation acknowledging LLM in the MSc "Informatics in Life Sciences", School of Medicine, Univ. of Patras, GR
- Presentation of LLM in the MSc "Medical Informatics", School of Medicine, AUTH, GR
- Presentation of LLM to participants of the course "Tele-education of healthcare professionals in dementia topics"; the course is organised as open lectures by the Panhellenic Institute of Neurodegenerative diseases and the Greek Association of Alzheimer's Diseases and Relative Disorders" for 2010- 2011
- Presentation of LLM to senior citizens in the Harilaou Area, Thessaloniki
- News item at in.health.gr informing about LLM trials (Top Greek Health Portal)
- News item at Business Woman Online informing about LLM trials (Greek Magazine - Wide Public and experts in health care)
- News item at Hygeia online informing about LLM trials (Greek Health Portal)
- News item at Tromaktiko.gr informing about FitForAll platform and LLM solution (top Greek news blog)

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- News item at Real.gr informing about FitForAll platform and LLM solution (Greek news portal)
 - Video of the LLM-pre pilot at the senior's centre Schwechat
 - Demonstration of the LLM-service at the AAL demo apartment at the seniors' centre Schwechat
 - Real life demonstration of the LLM-service at the summer event at the seniors' centre in Schwechat
 - LLM-video and ILC/eHome demo at Fair "Messe Leben und Freizeit in Schwechat"
 - Interview for newspaper article on LLM ("Software soll Senioren im Alter geistig fit halten" – Der Standard)
 - Press release on LLM-pilot in Austria (OTS_20110323_OTS0162) - Long Lasting Memories - ein Trainingssystem für ältere Menschen
 - Presentation of the project at Evangelic Center of Geriatric Medicine Berlin (EGZB) (Behavioural interventions for brain health)
 - Preparation and submission of a manuscript "Development of large-scale functional networks over the lifespan".
 - Preparation and submission of a manuscript "Age-related changes in neural functional connectivity and its behavioral relevance".
 - Preparations for and web dissemination of a presentation of the LLM platform and organisation of an LLM sponsored workshop at Symposium at the Society of Applied Neuroscience (SAN) 2011 (scheduled for 5-8 of May, 2011).
 - Presentation in a Workshop about aging and genetic factors (30-31.03.11, Villa Eberhardt; Ulm).
 - Preparation and submission of a manuscript "Improvement of Cognitive Function after Physical Movement Training in Institutionalized Very Frail Patients with Dementia – A Pilot Study".
 - Interview for newspaper article on LLM, April 8th, 2011; Vienna / Austria, „Software soll Senioren im Alter geistig fit halten“ – Der Standard.
 - Article in Magazine Dependence and social care. SAR Foundation, Barcelona, July 15 2011
 - Publication in a radio, program "Desayunos de la Cope – El aperitivo", : 20 October 2011 and 12 December 2011, Valladolid, Spain
 - Demo of LLM physical and cognitive training as part of a TV-clip of CEIT RALTEC's activities broadcasted on regional TV-station SW1 and available as video-stream.