Innovative, Adapted Online Services that Can Support the Active, Healthy and Independent Living of Ageing People. A Case Study

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Abstract: - Demographic ageing will heavily impact society and economy all over the world. eHealth plays a key role in strengthening the role of information in improving health, including a view to adopting a healthy lifestyle, to ensure effective exploitation of accumulated knowledge to the benefit of all involved.The broader penetration in everyday life and consumerization of digital technology has made it more accessible for older people with IT literacy, sometimes defined as Silver Surfers. In this context, the paper gives information about ProActive Ageing project which aims to build up an integrated platform for online services that support the active and independent living of ageing people. The case study presents the "Centre for Active Ageing" module that implements innovative methods of personal development, knowledge sharing and learning, adapted to the needs, diversity, and understanding of ageing persons. Its implementation solution based on the WordPress content management system and specific integration issues at the ProActive Aging platform level are addressed. An explored solution for identity management using the blockchain technology is put forward. Information provided by this module meet the qualities that gives it a high quality standard, namely: opportunity, timeliness, accuracy, completeness, availability, validity, different ways of presentation. belongs to the new types of health education applications that include the motivation of the users regarding the educational content, the development of new skills and cognitive abilities due to digital information.

Key-Words: - active and independent ageing, eHealth, integrated platform, WordPress, cloud computing, blockchain technology

1 Introduction

Demographic ageing will heavily impact society and economy, for which we are still not well prepared. There is not only an increased longevity of population, but also an expansion of the number of older people at very advanced ages. (see Fig.1)
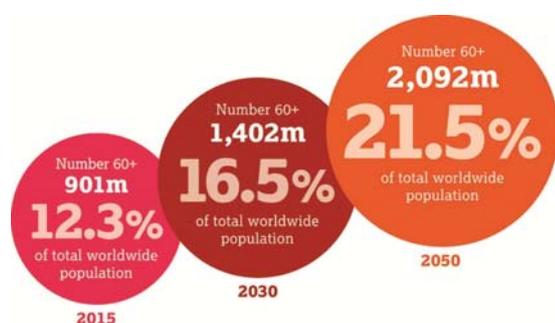

Fig. 1. Projections for the number and proportion of older people globally

Source: UNDESA Population Division, World population prospects: the 2015 revision, DVD Edition, 2015.

The old-age dependency ratio (calculated as the relative size of the older population aged 65 or above compared with the working age population aged 15-64) is projected to more than double from 24% in 2010 to 52% in 2060 [1].

Total EU public spending on pensions, healthcare, long-term care, and education will increase by around 20% between 2010 and 2060. Expenditures for long-term care would double between 2014 and 2060. This implies market opportunities, but uptake of ICT-enabled innovative products and services for ageing well is low, due to many barriers like: user acceptance, professional endorsement and fragmentation of the EU market. [2]

Specific anti-ageing medical information and communication research and technologies, healthier lifestyles have not just increased longevity but have

also decreased the morbid years - when people lose their functional independence and their minds and bodies break down.

Active ageing is the process of optimizing opportunities for health, participation and security in order to enhance quality of life as people age. Active ageing allows people to realize their potential for physical, social, and mental well-being throughout the life course and to participate in society, while providing them with adequate protection, security and care when they need [3].

Healthy ageing is a broad concept including physical as well as mental health and social well-being and support the adoption and maintenance by individuals of attitudes and behaviours known to promote health and well-being. In order to help their patients to have a successful ageing, healthcare specialists should apply up-to-date good practices, strategies and research. An active ageing cannot exist without the health component and for that, new and adapted tools, services and practices must be provided both to individuals and healthcare specialists.

The need for technology that supports age-friendly communities is obvious. Continuously global ageing of population puts higher pressure on social and health systems, so it is compulsory to develop improved services and technologies able to address chronic conditions associated with old age.

The process of shaping the existing communities into age-friendly ones implies to maximize with cost-efficiency the assets of the elderly, allowing them to be valued, respected and actively engaged.

Evolving technology that becomes embedded into everyday lives of older people and a growing number of persons over 55 years using digital technology predict an encouraging support for adapting the communities to the challenges brought by the demographic ageing.

In the same time, the design of new technology should make it accessible, affordable, safe, easy to use and adaptable to specific needs of the elderly.

Silver Surfers are defined as older members of the society that are active Internet users [4] and which often use modern devices as smartphones or tablets.

eHealth has considerable potential to enable and empower the elderly to have an active and independent life, to enhance the quality of life by providing new facilities and opportunities able to support mobility, independent living, and social participation. It facilitates the empowerment of the ageing persons by providing tools for a more

"person-centric" social and healthcare system in which individuals need to take an even more active role in personal care related decisions.

eHealth provides facilities for helping elderly people to continue to live in their own homes for longer, new services that support some treatments or rehabilitation. It also seeking to avoid or delay the need for resource-intensive institutional care and thus it reduces social isolation, and expenditure.

In this context, the paper presents the ProActive Ageing project which aims to build up an integrated platform for online services that highlights the importance of applying new approaches, methods, means and researches for adopting an active, independent and healthy ageing.

The remaining part of the paper is structured as follows: section 2 provides a brief description of the project. Section 3 is focusing on Centre for Active Ageing module of the project: its purpose, structure and functionality, classes of users and access rights. Section 4 presents the implementation of this module using Wordpress platform, its integration with another module of this platform, and the explored solution for identity management using blockchain technology as a Blockstack based decentralised application. Some concluding remarks are formulated in Section 5.

2 Silver Surfers and their specific demands for eHealth

Older people have increasingly started to adopt digital technologies, facing different types of physical, psychological and social challenges. Furthermore, the acceptance of digital technologies for regular use is strongly influenced by age group (50+, 60+, 70+ or 80+) due to the variation of degenerative disorders or technological literacy and background.

In relation to their regular use of the internet, there is a relatively large digital divide between northern and western EU Member States on one hand and southern and eastern EU Member States on the other. Luxembourg (79 %), Denmark (76 %), Sweden (76 %), the Netherlands (70 %), the United Kingdom (66 %), Finland (62 %) and Belgium (52 %) were the only EU Member States where more than half of the elderly population aged 65–74 used the internet in 2014 at least once a week. In Romania and Bulgaria, on the other hand, less than 10 % of all senior citizens aged 65–74 went online at least once a week [5].

The profile of a Silver Surfer comprises at least a minimum IT literacy, an open-mind towards digital technology, the skills and personal involvement in longlife learning and the determination to achieve an independent and active life as long as possible.

As the number of impairments grows with the age, Silver Surfers have wider expectations regarding eHealth services and devices.

In this respect, they demand:

- to have a permanent and secured access to their own health data and information;
- to be directly involved in their health management;
- to be provided with digital tools able to support a better understanding of their health condition and medication;
- to acquire assistive technologies in their personal environment in order to avoid instiualisation and to increase their life quality;
- a more appropriate design of eHealth tools and devices, tailored to their specific needs and disfunctionalities;
- a better interoperability among health services and technology;
- to be helped to avoid possible conservative attitudes towards digitals tools;
- to have timely and affordable access to an infrastructure adapted to bridge disparities in health between different age groups.

The most important degenerative disfunctionalities that have a strong influence for the acceptance and using of eHealth tools by the Senior Surfers can be classified in:

- *sensory impairments*:
  - *vision* – induces a weaker perception of colors, contrast or focus on different displays*;*
  - *hearing* – generates difficulties in perceiving or understanding the sounds, especially on mobile devices*;*
  - *speaking* – produces inconveniences in interfacing with speak recognition devices*;*
  - *touch* – engenders obstacles in a proper use of touchable devices*.*
- *mobility impairments*: the reduced dexterity, the increased difficulty with fine motor control and coordination generate physical problems in using digital devices.
- *cognitive impairments*: short-memory loss, difficulty using language, problems with decision making and increasing isolation from

familiar community make the use of digital technology a real challenge.

Considering all these, the design for eHealth tools and devices should support the demands and needs of Silver Surfers by:

- an older patient-centered approach;
- providing user interfaces adaptable to diverse physical declines;
- a better synergy between the demands of the eHealth tool/device and the demands of the older user of it;
- delivering clear, simple and easy-to-use supporting toolkits aiming to enhance the acceptance of digital technology;
- improving usability and accessibility.

eHealth design must accommodate the needs, skills, cognitive capacities, and/or contexts of use of the intended broader population of health consumers [6]. Placing the Silver Surfer in the center of the eHealth design is one of the most imperative necessity for facilitating the growing ageing population a better access to health care. (see Fig. 2)
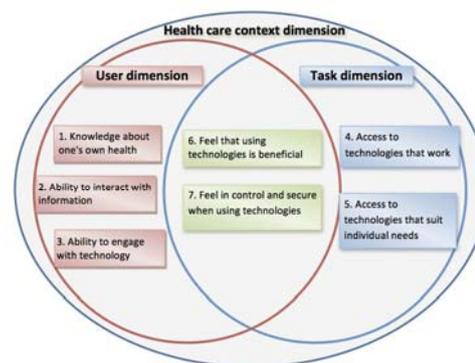

Fig. 2 A framework for designing Silver Surfer-centered eHealth [3*]

3 Overview of ProActive Ageing project

"**PROlonging ACTIVE life for an independent and healthy AGEING" (ProActive Ageing)** project is funded by the Romanian *Partnership* Program, *Joint Applied Research Projects* Subprogram under the *National Plan for Research, Development and Innovation.* The partnership is composed of Clinical Hospital "Dr. Victor Babes", University of Medicine and Pharmacy "Carol Davila", "Ana Aslan" National Institute of Gerontology and Geriatrics, National Institute for R&D in Informatics and Siveco S.A.

3.1 Brief description

ProActive Ageing focuses on developing online tools for:

- a sustainable (re)integration of ageing persons in social and working life,
- enhancing the own health and independence of an ageing person, with a strong emphasis on lifelong learning, knowledge sharing,
- providing comprehensive training courses addressed both to formal carers (specialists) of ageing persons
- achieving more efficient methods of delivering improved outcomes from healthcare research, good practice and a better service to patients.

3.2 Main objectives and outcomes

The main objectives of the project can be synthesized as following:

- to consider and define new ways of promoting an active, independent and healthy life for ageing persons at personal, healthcare, and business level;
- to design a framework for ageing persons for supporting them to improve the skills they need to cope with age-related changes and to remain active in society;
- to encourage and promote new approaches for business managers in order to become more adaptable to the ageing labour market;
- to support the promotion of the specific anti-ageing research and the training and education of formal carers who work with elderly;
- to promote the European innovation reinforcement between innovative IT and anti-ageing actions for deployment and sharing of best practice at social level.

The main output of the project is the *ProActive Ageing* integrated platform for online services.

The platform is structured into three thematic modules providing practical, engaging, accessible, motivating and customized tools that support longlife learning, with an accessible content for a large range of users. Also they are able to support social interaction and adaptability of individuals to the increasing ageing of the population.

The platform module are as follows:

- *"Centre for Active Ageing" module*: it provides online person-centric tools for a better knowledge and understanding of the ageing process, with lifelong learning facilities designed for ageing persons that want to remain active, healthy and independent.
- *"Comprehensive learning courses for (non)specialists taking care of ageing people" module:* it offers innovative and practical training courses for specialist or non - specialists carers, including family, to improve and better understand their attributions in taking care of ageing persons.
- *„A Toolkit to Support Medical Research Addressed to Healthy and Active Ageing" module:* it provides centralized services for a better management of degenerative diseases, by providing instruments for specific innovative strategies/protocols/ algorithms, and knowledge exchange that will enhance the quality of researches and healthcare in the anti-ageing domain.

3.3 Relevant characteristics

The project provides a functional model for a set of innovative, adapted online services that can support the active and independent living of ageing people

ProActive Ageing characteristics: ● it has as targeted beneficiaries the ageing people (i.e.>50 years old), not the elderly, as the great majority of similar products has ● it addresses specialists and non-specialists, using appropriate content and interfaces ● it goes clearly beyond state of the art in terms of increasing efficiency (e.g. easy customization and adaptation to specific needs and preferences, with efficient data and context sharing between different required services), improving reliability and easy end-user acceptance ● because in Romania there is a lack of IT tools addressing the age management, *ProActive Ageing* platform will provide practical and ready-to-use guidance to the business environment on how to improve the management of demographic change and age diversity

3.4 Current Implementation Status

ProActive Ageing project started in 2014 and it will be finished in 2017. It is under the development of the 3rd phase (of 4 phases).

4 Case Study: "Centre for Active Ageing" module

This module represents an exemplification of an eHealth tool that provides a practical support to Romanian Silver Surfers and their families to achieve information and help for an independent and active life.

4.1 Purpose

The module implements innovative methods of personal development, knowledge sharing and learning, adapted to the needs, diversity, and understanding of ageing persons (see Fig. 3).

The purpose of this module is to promote independence of ageing people, offering a holistic approach to maintain an independent life as long as possible, health promotion and lifelong learning. It is designed to assist and facilitate people to know better their own ageing process and provide information on physical, psychological and social aspects of growing older.

Ageing people will have access to online person-centric tools that will simplify the knowledge gaining for achieving a successful, healthy and active ageing.

Fig. 3 Main page of "Centre for Active Ageing" module

4.2 Structure and functionality

This module from ProActive Ageing represents a collection of baseline information targeted to ageing people who need support for a prolonged independence.

It provides a framework able to enhance the social and intellectual knowledge and experience of ageing citizens and expands longlife learning opportunities adapted to the particular needs related to ageing process.

It aims to enhance the ageing persons' development by providing education for health, by developing life skills and by promoting positive mental health and self-confidence, thus leading to a better quality of life.

The module aims:

- to provide an opportunity for ageing persons to continue learning. The module targets all retired and semi-retired persons who share a love of learning and wants to continue their studies regardless of the extent of their formal education.

- to give people the tools they need to take responsibility for their health in order to "keep well" and to improve their quality of life.

- to provide self-evaluation tests for senior or ageing persons able to facilitate a better understanding of their own problems, how to improve their lifestyle and how to enhance their autonomy.

- to centralize resources about the most important issues of a healthy, safe and active ageing like: home fall prevention, steps for mental wellness, depression management, promoting physical activity etc.

The module is hierarchical structured into thematic components:

a. *Home care*
   - Adjustments to the housing needs of the elderly; (see Fig. 4)
   - How to employ a caretaker for an elderly person;
   - Types of home care services.

b. *An active and independent person*
   - Improvement of personal knowledge about healthy aging;
   - Aspects of an active and independent ageing;
   - Means of maintaining an active life;
   - Self-assessment tests

c. *Useful information*
   - Emergency
     (Ambulances, Hospitals Foundations, Palliative Care, Physicians, NGOs)

- Legislation on seniors
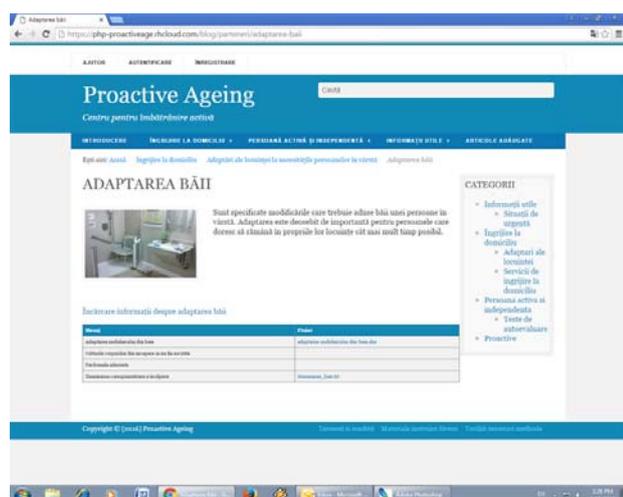
Fig. 4 "Bathroom adaptation to elderly needs" issue
in the Centre for Active Ageing

4.3 Classes of users and access rights

The target beneficiaries of "Centre for Active Ageing Module" are ageing persons wanting to adapt to age-related changes, seniors expecting to remain active and healthy.

The information contained can be seen without any restriction by any user of the ProActive Ageing online platform.

Only authorized health specialists have the right to introduce/modify/delete information into this module's components.

A user is authorized to enter data and information in this module only by following an authorization procedure supervised by the online platform administrator.

5 Experimental testbed

5.1 WordPress platform

The module "Centre for Active Ageing" is focused on providing useful information related to health issues to a broad audience of senior citizens and their families, as well as leveraging a content management system to organise and enable different levels of access and publishing rights for a specialised category of expert users. They could be physicians who provide active support to the target user community, but there could also be editors who are uploading already prepared materials. The content management system should be able to support different editorial workflows, and it must provide several types of accounts and associated

access rights. In addition, there must be enforced a procedure for new members registration and validation.

WordPress, which is the current leading platform for web publishing, has expanded its foundation as a Content Management System to become the solution of choice for web sites creation [7]. Its major advantages include: easy to configure and to personalize through the large number of accessible themes and plug-ins; easy to use due its intuitive, user friendly interface; powerful search engine optimisation (SEO) features; flexibility to fit needs quickly being built on PHP, JavaScript, and MySQL technologies [8]. The WordPress popularity is proved by the large online community, which provides an effective support through the information available on blogs, web pages and social media posts about any problem encountered during the development process.

WordPress is available both in a Software-as-a-Service (SaaS) model at www.wordpress.com, but also as an open-source application which is free to deploy on private resources. In addition, there are specialised providers for WordPress hosting such as Bluehost or DreamHost, and all major Platform-as-a-Service (PaaS) cloud infrastructure providers like Heroku, Openshift, Azure, etc. have templates and tools for automatic deployment of WordPress instances.

There are therefore numerous and various options to create new WordPress sites, which have the benefits of automated management, on demand scaling and resource availability, as the cloud provider is responsible for the operation of underlying computing infrastructure in accordance with a Service Level Agreement (SLA).

By using cloud computing services to build web applications, the user has the advantage of not committing the upfront investment in new hardware resources, but instead he is able to scale the size of the platform according to its actual use. It is very convenient to be able to deploy a new application almost instantaneously, without the effort required to setup and configure the operating system and all the application dependencies. As these operations are automated, the same level of performance is expected by every other client of the cloud provider.

Regarding the commitment to a cloud service provider, one can use first the limited free accounts provided with a minimum amount of resources required for testing and development of new applications in order to evaluate the features the platform and the performance of the cloud services.

Major public cloud infrastructures such as IBM Bluemix, AWS, Heroku and OpenShift have a free tier which can be used to deploy a new application in a development testbed, and then to migrate it in a production environment once the desired functionalities have been implemented.

5.2 Platform integration requirements

The WordPress based application that implements the "Centre for Active Ageing" module needs to be integrated with a specialised training platform – the "Comprehensive learning courses for (non)specialists taking care of ageing people" module, which is developed in Java with the Spring framework.

There are several requirements for the interoperation of these two applications. For example, the user interface should be consistent on both applications, which means that a common colour palette and layout theme needs to be shared by both applications. Another important aspect for the interoperation is related to the user management. Both application have to authenticate and authorise access to their resources to the same users, therefore a single sign-on solution is required.

One of the most common solutions for single sign-on for the web is the Central Authentication Service (CAS) protocol [9]. Both WordPress and Spring framework provide CAS authentication by default or with additional plug-ins which makes the implementation of user credentials sharing between the two applications only a decision where to deploy the CAS server - the other application will implement the CAS client.

However, these standard implementations of the CAS protocol are not well suited to accommodate the complex structure of the user profiles, their roles and relationships, as required by each application. They are based on the underlying platform features, WordPress and Spring respectively, and can be difficult to use in practice, thus limiting the potential of adoption by senior users and non-technical personnel. It is desired to have a flexible and extensible identity management solution which can allow defining several types of user profiles, for example web site editors, medical experts, technical writers, and individual users, each could have detailed profiles with roles and relationships properly defined.

5.3 Identity Management based on Blockchain technology

The solution currently investigated is based on the blockchain technology which was proposed initially by the Bitcoin system [10]. Since its inception, when the blockchain was defined as a distributed ledger which records Bitcoin transactions using cryptographic algorithms, it has evolved as one of the most promising technology with the potential to disrupt the financial sector and several technology related fields, as well as the administrative and logistic operations, due to its innovations in terms of transactions verifications and the decentralised and trustless nature.

A new generation of distributed applications is developed on several new blockchains which have expanded the original Bitcoin protocol with new features (e.g. Ethereum[11], Nxt[12]), as well as new protocols on top of Bitcoin or sidechains (e.g. Omni[13], Counterparty[14], Rootstock[15]) featuring smart contracts as a new model for expressing user transactions and interactions, which can be scripted and executed without any human intervention and tampering.

Blockstack is a platform running on top of Bitcoin protocol which provides support for decentralised identity and authentication [16]. It can be used to create digital profiles, and integrate them with other decentralised applications which run on top of the Bitcoin protocol. The next step is to create a bridge between a decentralised application which is executed on the Bitcoin blockchain and a CAS server which is used for user management by the WordPress and Spring applications. As the CAS protocol allow the delegation of the authentication by the CAS server to an external provider, this can be achieved with a proxy CAS server which can understand the Blockstack profiles.

There is a great amount of flexibility in creation of the Blockstack profiles, with further customisations possible without any adverse effects on the main applications as they are completely decoupled. The roles and relationships associated with Blockstack profiles can be defined in new decentralised applications which run on the Bitcoin protocol..In this way, it is possible to delegate the user registration process from WordPress to a decentralised application on the Bitcoin blockchain. This has the benefit of a more flexible system to sign up new users and to validate new registration requests, which are specific to the application domain, than it is possible with the default WordPress 's user registration module.

The general architecture of this system is presented in Fig.5. The main components are:

- a Blockstack based application for identity management;
- a CAS Server that uses Bockstack digital profiles and the identity management application;
- a Rootstock based smart contract application to reward user engagement and activity on the Wordpress platform;
- an oracle, which is a special type of an application that provides data which is consumed by the smart contracts executed in the blockchain.

For the user authentication process on the Wordpress platform, a CAS client module is required to access the CAS server which is connected with an identity management application implemented on the Blockstack platform.
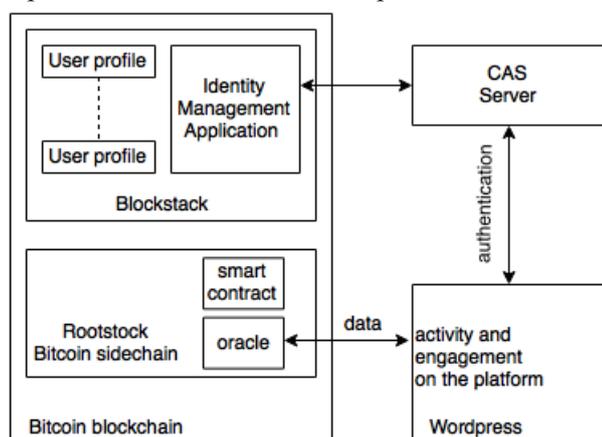

Fig. 5 General architecture of the system

A second major component of the system is a smart contract application which rewards users with digital assets (tokens) according to a predefined agreement that monitors their activity on the Wordpress site. The purpose of this application is to foster the user engagement on Wordpress by rewarding the prolific content creators, curators and commentators that provide feedback.

Currently, the most used platform for smart contract applications is the Ethereum blockchain, however, recent developments on the Bitcoin ecosystem have proposed various solutions to enable smart contracts. One such solution is based on the sidechain technology - a separate blockchain from the Bitcoin mainchain, with specific features, but which still uses the Bitcoin, instead of its own token.

Rootstock is a sidechain that was inspired by the Ethereum project. It was designed to be compatible with the Ethereum Virtual Machine (EVM), so the decentralised applications that runs on the Ethereum blockchain can also run on the Rootstock sidechain.

The smart contracts can be seen as a programs that are executed on the blockchain. As the general rule, the nodes that are part of the blockchain should come to an agreement regarding the state of the program. Therefore, it is not feasible that the smart contract application to pull data from external sources, as it may create inconsistent states on different nodes.

Instead, a trusted party has to be used in order to provide the data that is required by the smart contracts (e.g. financial information, weather, sports or political events) - that is, to push the data into the blockchain where it can be consumed.

This trusted party is called an oracle, and in our case, it must provide several stats related to the user activity (by using Wordpress API): pages created or updated, number of likes and comments received by those pages, comments made by the user to other pages and likes added to other posts.

These are counted and weighted as the aggregate user engagement metric. The oracle provides this information to smart contracts, which implement a payment method based on its value.

Finally, it is worth mentioning, that both the identity management application, smart contract application together with the oracle are based on the Bitcoin blockchain. The former uses the Blockstack platform, and the latter are implemented on the Rootstock sidechain (which is Bitcoin based). This emphasize the potential of this technology, in addition of its main feature as a virtual currency.

6 Conclusions

Social protection systems face the consequences of demographic change and the financial and economic crisis. Ageing population, increasing age-dependency ratio and productive population decline threaten the availability and viability of public budgets for health and social system. For these reasons it is necessary to develop new opportunities to maintain an active, independent and healthy life in the third age population.

The ProActive Ageing project can help to facilitate a decent, healthy and active ageing.

The module "Centre for Active Ageing" is focused on providing useful information related to health issues to a broad audience of senior citizens

and their families, as well as leveraging a content management system to organise and enable different levels of access and publishing rights for a specialised category of expert users.

WordPress, the current leading platform for web publishing and cloud computing services have been proved to be the most appropriate solution to develop this module. To address specific integration requirements at the ProActive Ageing platform level, the solution currently investigated for identity management is based on the blockchain technology due to provided flexibility in defining user profiles and managing their roles and relationships.

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