1. Ageing in the 21st century in Europe: social challenges and innovation opportunities to support elderly independency and wellbeing.

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Abstract This chapter describes the vision of the EMPATHIC project of social challenges and innovation opportunities to support elderly independency and well-being. As an introduction, we first identify the main challenges that result from the current demographic status in Europe. Then, we show the vision and approach proposed by the EMPATHIC project to deal with some of these challenges. Next section develops the main concepts, goals and outcomes of the EMPATHIC project. The following section reports the impact of the project and the final section describes the exploitation of the results as well as the concluding remarks

1.1 Challenges of the 21st century demography as an introductory context.

Population ageing is one of the social challenges of the 21st century that directly concerns Europe as well as other developed communities. The decline of the fertility rates along with the increase in life duration result in a fast raise of the percentage of the population above 65. In Europe, this percentage is expected to growth from 16% in 2010 to 29% in 2060[1]. Moreover, this population segment expected to be predominantly female and includes a growing number of elder persons above 80. In this context, social challenges to be addressed are, among others:

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[1] Ageing Populations in Europe: Challenges and Opportunities for the CEB (Council of Europe development Bank), 2014 https://coebank.org/media/documents/Study_Ageing.pdf

- A high demand of infrastructures and services targeting the elderly needs and wishes. In particular, the extended preference of ageing at home has to be fulfilled while taking into consideration specific cultural facts as well as the diversity of societies.
- A cross-cutting approach covering different sectors such as health, housing, low-income persons and adequate living conditions in cities and rural areas.
- Support healthy older people to remain productive and have an independent life in their community as long as possible. To this end, a wide range products and services need to be conceived to assist a certain standard of living and wellbeing as people age. Furthermore, technology is in the core of most of nowadays innovative products and services.

Currently there is a huge demand for autonomous systems able to assist people on several needs in their aging. Provisions of support have been made either through the monitoring and detection of changes in the physical, and/or cognitive, and/or social daily functional activities, as well as in offering therapeutic interventions (Cordasco et al. 2014). These systems have targeted vulnerable elder people who face complex and stressed interactional exchanges. In this context, strong emotional behaviors arouse, having as consequences discomforts, loss of control, anxiety, stress, depression, misplaced conducts. These behaviors are furtherly affected by several factors including personality, individual traits, social and cultural information (Esposito et al. 2016, Esposito et al. 2015, Troncone et al. 2014). Having an EMPATHIC coach for facing such daily facets would be desired. To do so there is a need to develop "experimental and theoretical models of behaviors for implementing computational paradigms that should produce ICT interfaces equipped with a human level of automaton intelligence" (Esposito et al. 2015, p. 48). Their design has to take into account the user involvement and interests. Users must judge the developed technology acceptable and useful in their context of use. Text, voices, or nonverbal communication must be appropriately exploited to generate feedback messages but also capture user's acceptance and trustworthiness.

1.2 Vision of the EMPATHIC project.

As a consequence of the previous context, there is a need to follow a novel user centered approach focused on making the interaction personalized to the prospective users, accounting of their age, gender, culture, preferences, personality, role, occupation, and responses to the system's strategies. The interactions and feedback messages must be tailored to the knowledge the system has about that specific user at that specific interactional instant, with system's reactions attuned by the knowledge gained during previous interactional turns, and the whole history of users-device interactions.

The EMPATHIC Research and Innovation project researches, innovates and validates new paradigms, laying the foundation for future generations of Personalised

Virtual Coaches to help elderly people to live independently. The wellness coaching advice promotes healthy habits and behaviors, by challenging each user to transform their personal goals and needs into actions. The EMPATHIC Virtual Coach engages the healthy-senior user to take care of potential chronic diseases, maintain a healthy diet, have adequate physical activity as well as encourage social engagement, thus contributing to the older adults' ability to maintain a satisfying and independent lifestyle. The EMPATHIC Agent motivates the user through a friendly virtual coach to reach pre-set benefits, whose achievement are measured through project-defined metrics. Our ambition was to create a personal, friendly and familiar environment for the users, avoiding the threatening effects of unfamiliar new gadgets or an excessive focus on medical supervision. The project looks beyond the basic medical and physical needs of a person, to the link between body and emotional well-being. The EMPATHIC Agent is designed to be capable of perceiving the emotional and social state of a person, in the learned context of the senior users' expectations and requirements, and their personal history, and responds adaptively to his/her needs.

1.3 Main concepts and outcomes of EMPATHIC project.

The EMPATHIC project implements the concept of coaching through a virtual conversation agent. Nevertheless, the aspiration is not to conceive and put into practice a coach who provides personalized nutritional advice or recommendations for physical and social activities adapted to the particular conditions of the user. In contrast, the project proposes coaching strategies aimed to get behavioral changes on the user. Coaching dialogs are logical structures based on question-answer model with the objective to understand needs, restrictions and goals of the user (Montenegro et al. 2019, Justo et al. 2020a). The goals need to be accepted by the user. Therefore, coaching dialogs will promote the user's self-awareness and guide the user through realistic and healthy goals. Each dialog follows a sequential structure based on the GROW (Goal, Reality, Options and will of action plan) which was proposed by professionals of health coaching.

In this framework, EMPATHIC project a) Provides automatic personalised advice guidance (through the coach) having a direct impact in empowering elder users into a wide of advanced ICT keeping improving their quality of life and level their independent independency living status of the people as the age (Tenorio-Laranga et al. 2019); b) Identifies non-intrusive technologies to detect the individual's emotional and health status. of the person through non-intrusive technologies (Esposito at al. 2020); c) Implements health-coach goals and actions through an intelligent computational system, intelligent coach and spoken dialogue system (Torres et al. 2020) adapted to users' intentions (Montenegro et al., 2019), emotions and context d) Provide the virtual coach with a natural, empathic, personalised and expressive communication model (Esposito et al. 2019, Montenegro et al., 2019, Torres et al., 2019).

In addition the main technological goals carried out are: a) the development of a simulated virtual coach allowing to develop coaching conversations between professionals and end-users, which enables the project to acquire a corpus of dialogues as well as engage the end-users on the design decisions as well as evaluate the progress b) the integration a proof-of-concept of the technology running on different devices and c) the validation through field trials performed in three different countries (Spain, Norway and France) with three distinct languages and cultures (plus English for research and development) of the proposed methods, approaches and solutions.

1.4 Expected impact of EMPATHIC project.

Nowadays, at the beginning of the 21st century, most elderly people may experience barriers to access to some philological or coaching-based interventions. Those barriers are related to mobility, accessibility, economical or even lack of awareness. Those type of interventions may be especially relevant for those suffering a decrease of their well-being (e.g. suffering social isolation, sadness, depression or anxiety).

The use of information and communication technologies (ICTs) is becoming a cost-effective way to overcome those barriers mentioned above. Moreover, ICTs enable in an accessible and scalable way the promotion of health, prevention, active aging and even early diagnose. Thus, ICT based therapies can reach thousands or millions of people simultaneously.

Speaking about ICT based therapies and important concept raises. Low intensity interventions refer to brief therapies, group treatments, self-help approaches, such as bibliotherapy and computerized treatments. Low intensity interventions represent a new paradigm in evidence-based practice and the delivery of health and well-being services to promote healthy habits and to increase access (availability, utilization and equity) to them. In that sense, EMPATHIC project, is a clear example of low intensity intervention promising and providing impact as described below:

- New model of psychological/health care that limits specialist time or used this time in a highly cost-effective manner.
- The development of new services which can be more efficient as well as effective.
- Key element in a stepped and collaborative care model. The low intensity intervention represents and initial step before refereeing to a human professional.
- New ways of working and new workforces that provide more rapid and flexible access to early intervention and preventive programs. People can access to short weekly sessions of about 10-20 minutes, depending on persons time availability.

- New ways of training new and skills.
- New ways of assessment, monitoring and evaluation of variables and key elements related with well-being and health.
- New ways of increase adherence and engagement to e-coach through more attractive, relevant and interesting.
- New communication tool with our target population to deliver coaching.
- New ways to disseminate services in a massive scale to sparse populations located in remote communities. E.g. providing recommendations based on personal desires, needs or interest.
- Intervening in a way that the patients' choices are respected (anonimity, time slots….)
- Tailored intervention with best matching between program contents and idiosyncratic patient's needs.

In conclusion, Low intensity can be a great solution to a stepped support service model where the intensity of the coaching can be adjusted depending on the situation. The elderly population is highly heterogeneous and they may need from different types of solutions. E.g. professional support, activities recommendations, awareness of the local offer etc.

1.6 Exploitation of the results and concluding remarks

We are living in a longevity revolution. The numbers are clear, the 20% of the population in western countries is over 65 years and this percentage is growing. However, the old age does not depend on the age but with the dependency. Even though, senior population is highly heterogeneous, there is a main profile of active person, consumer and committed with the community. We are speaking about retired people with a lot of active years to enjoy. People that expects quality of life, contribute to the community and postpone the old age.

Considering this reality, there is a need to accommodate current products and services to this new demography (Fernandez Ruanova et al, 2019). In other words, adapt the current market to the senior qualities (not necessarily create new offer). Therefore, there are a lot of efforts, from different entities, to centralize and "silverize" the current offer. Regarding active aging, especially relevant the offer related to culture, leisure, physical activity and healthy nutrition. This offer, can be (and will be soon) centralized and adapted through different platforms age friendly. Most probably, through public-private collaborations. Those initiatives will open new spaces for virtual advisors and coaches.

This type of solutions are a very suitable environment to integrate and exploit a virtual coach such EMPATHIC. We are speaking about a virtual coach capable to understand (in an automatized way) the needs of each user (as a unique individual).

In that sense, EMPATHIC is trained to understand needs related 4 main areas: Leisure and culture, social relations, physical activity and nutrition. Those areas are key for a suitable active aging. Moreover, EMPATHIC is engaging and motivating the users to take actions.

Therefore, connecting EMPATHIC with the local offer, especially the silver offer, provides a huge potential for both public and private entities. First, it can provide a real sensor of the senior needs and desires from a specific area. Second, connects the local offer with the seniors' interests. The local offer can be public or private, but the strengths relies on the personal suggestions linked with the local offer. Imagine somebody that feels a bit blue and through EMPATHIC ends up buying a ticket for the local theatre.

On that scenario, the exploitation model relies on both the public and the private sector. The public contribution would help the implementation and an initial maintenance. The expected source would be local entities which aim to both provide response to the demographic challenge and stimulate the local economy. After the implementation and the market penetration, the maintenance would come from the private offer, as a percentage of the sales coming from an EMPATHIC recommendation.

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