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Article

The NESTORE e-Coach: Designing a Multi-Domain Pathway to Well-Being in Older Age †

Leonardo Angelini [1,2,*], Mira El Kamali [1], Elena Mugellini [1], Omar Abou Khaled [1], Christina Röcke [3], Simone Porcelli [4], Alfonso Mastropietro [4], Giovanna Rizzo [4], Noemi Boqué [5], Josep Maria del Bas [5], Filippo Palumbo [6], Michele Girolami [6], Antonino Crivello [6], Canan Ziylan [7], Paula Subías-Beltrán [8], Silvia Orte [8], Carlo Emilio Standoli [9], Laura Fernandez Maldonado [10], Maurizio Caon [2], Martin Sykora [11], Suzanne Elayan [11], Sabrina Guye [12] and Giuseppe Andreoni [9]

1 Humantech Institute, University of Applied Sciences and Arts Western Switzerland (HES-SO), 1700 Fribourg, Switzerland; mira.elkamali@hes-so.ch (M.E.K.); elena.mugellini@hes-so.ch (E.M.); omar.aboukhaled@hes-so.ch (O.A.K.)
2 School of Management, University of Applied Sciences and Arts Western Switzerland (HES-SO), 1700 Fribourg, Switzerland; maurizio.caon@hes-so.ch
3 URPP Dynamics of Healthy Aging, University of Zurich, 8050 Zurich, Switzerland; christina.roecke@uzh.ch
4 Istituto di Tecnologie Biomediche (ITB), Consiglio Nazionale delle Ricerche, 20054 Segrate, Milano, Italy; simone.porcelli@itb.cnr.it (S.P.); alfonso.mastropietro@itb.cnr.it (A.M.); giovanna.rizzo@itb.cnr.it (G.R.)
5 Technological Unit of Nutrition and Health, Eurecat, Centre Tecnològic de Catalunya, 43204 Reus, Spain; noemi.boque@eurecat.org (N.B.); josep.delbas@eurecat.org (J.M.d.B.)
6 CNR-Institute of Information Science and Technologies (ISTI-CNR), 56127 Pisa, Italy; filippo.palumbo@isti.cnr.it (F.P.); michele.girolami@isti.cnr.it (M.G.); antonino.crivello@isti.cnr.it (A.C.)
7 Research Center Innovations in Care, Rotterdam University of Applied Sciences, 3015 GG Rotterdam, The Netherlands; c.ziylan@hr.nl
8 Digital Health Unit, Eurecat, Centre Tecnològic de Catalunya, 08005 Barcelona, Spain; paula.subias@eurecat.org (P.S.-B.); silvia.orte@eurecat.org (S.O.)
9 Department of Design, Politecnico di Milano, 20158 Milan, Italy; carloemilio.standoli@polimi.it (C.E.S.); giuseppe.andreoni@polimi.it (G.A.)
10 Fundació Salut i Envelliment UAB, 08041 Barcelona, Spain; laura.fernandezm@uab.cat
11 School of Business and Economics (SBE), Loughborough University, Loughborough LE11 3TU, UK; m.d.sykora@lboro.ac.uk (M.S.); s.elayan2@lboro.ac.uk (S.E.)
12 F. Hoffmann-La Roche Ltd., 4070 Basel, Switzerland; sabrina.guye@roche.com
* Correspondence: leonardo.angelini@hes-so.ch
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Abstract: This article describes the coaching strategies of the NESTORE e-coach, a virtual coach for promoting healthier lifestyles in older age. The novelty of the NESTORE project is the definition of a multi-domain personalized pathway where the e-coach accompanies the user throughout different structured and non-structured coaching activities and recommendations. The article also presents the design process of the coaching strategies, carried out including older adults from four European countries and experts from the different health domains, and the results of the tests carried out with 60 older adults in Italy, Spain and The Netherlands.

Keywords: older adults; virtual coach; healthy lifestyles; pathway; well-being

1. Introduction

Nowadays, designing and deploying effective and reliable systems and services for preventing health decline or for supporting wellbeing in older age is a major target for our silvering society. The European Commission (EC) has invested in this topic with dedicated and funded research actions, such as the SC1-PM15-2017 call entitled "Personalised coaching for well-being and care of people as they age" [1]. "Novel Empowering Solutions and

Technologies for Older people to Retain Everyday life activities" (NESTORE) [2] is one of these initiatives aimed at designing a virtual coach for ageing well. Based on cloud, mobile and IoT embedded solutions, it provides everyday suggestions for staying healthy through distributed and ubiquitous interactions [2]. In particular, the goal of NESTORE is to assist older adults through an innovative, multi-dimensional, personalized coaching system to support healthy ageing in four well-being domains: physical and physiological functioning, nutrition, cognitive functioning, as well as social interactions. The emotional/mental domain is also monitored in NESTORE, but no coaching is provided in such a domain. In this paper, we chose to use the term "well-being" to describe a wide range of functional domains relevant for health and well-being.

The NESTORE system is constituted by different components: a cloud platform, two apps (a coaching app and a serious game), a tangible device acting as a voice assistant, a wearable device and environmental sensors to collect users' data. Data collected through these components are sent to a smart Decision Support System (DSS) [3], hosted in the cloud platform. The DSS measures the status of people in the aforementioned domains, assesses their interests and provides through a mobile app and a tangible interface a personalized coaching strategy based on their status and interests.

The role of the virtual coach is to motivate older adults to take care of their health and to provide personalized and data-driven strategies for healthy ageing. For instance, the NESTORE coach will suggest a personalized healthy diet and/or a customized physical, cognitive and/or social activity as a support to daily behaviours that could improve the performances and preserve well-being or, on the other hand, as a countermeasure to unhealthy behaviours that could lead to a cognitive/physical decline. Two key points in this strategy is users' engagement and motivation: in order to sustain these factors, the NESTORE e-coach was designed as a friendly life-like companion that guides the users to improve their well-being.

The pathways to well-being are a key innovation element in NESTORE. In our project, the pathways have been designed to ensure that overall well-being and health status is maximised, prompting personalized suggestions and well-being services according to the users' interests. As such, NESTORE provides an innovative multi-domain intervention, bridging domain experts' recommendations through interfaces that have been co-designed with users in order to support long-term use and self-reflection.

During the 3.5-year project, first, the project consortium bridged the needs of older adults, elicited through different co-design activities, and the recommendations of experts. This activity led to the definition of the NESTORE multi-domain coaching pathway that was then implemented into the NESTORE system. Finally, the system was tested in three pilot sites to assess the user experience of the NESTORE coach and the adherence to the proposed coaching activities.

In this paper, we reflect on the users' and expert requirements that led to the definition of the multidomain pathway, on the different strategies implemented in the NESTORE system to make such a pathway effective and on the feedback collected during the pilot studies. The insights collected in this project aim at helping future research towards more effective digital health interventions for older adults.

The paper is structured as follows: Section 2 presents previous e-coaching interventions that support healthy lifestyles in older age; Section 3 describes the objectives and the challenges of the NESTORE project, detailing the domains tackled by the NESTORE e-coach; Section 4 describes the co-design process carried out to conceive a pathway to well-being that could at once be beneficial for and appreciated by the end-users; Section 5 details the coaching strategy of the NESTORE system, explaining in particular the underlying behaviour change model, the concept of pathway to well-being (and its differentiation with the concept of a clinical pathway), a subset of the proposed coaching activity plans and other design aspects of the interventions; Section 6 describes the system architecture and the main components of the system; Section 7 presents the pilot studies conducted

with the NESTORE system and the insights collected in these tests; Section 8 discusses the lessons learnt and Section 9 concludes the paper.

2. Related Work

This article is an extended version of the conference paper presented at the PETRA'19 conference [4]. In this article, in addition to the previous paper, we present the co-design process carried out to design the well-being pathway and we present the results of the pilot studies carried out in the NESTORE project, providing further insights and design recommendations for accessible e-coaching systems.

Several interventions have been carried out to improve the well-being of older adults, both for prevention [5] and rehabilitation [6]. In the past, most interventions were carried out by healthcare professionals who delivered appropriate coaching and guided the user towards healthier lifestyles. These interventions required face-to-face meetings or were mediated via phone calls, emails or SMS. Modern technologies offer the potential to automatize most of this process, allowing to reach a larger population with a limited need for personnel formed to deliver the intervention.

Digital coaching, as recently defined by Banos and Nugent [7], implied "frequently, but not continuously, observe, listen to, question, understand, reason with, teach, and/or advise the users in order to change their behaviour and to improve their health". Digital coaches are also known in the literature as virtual coaches or e-coaches. In NESTORE, we used the e-coach term to emphasize our goal of materializing the digital system into a tangible companion that blends unobtrusively in the users' life (see Section 6.3). Since e-coaches aim at acting as substitutes of human coaches, they must exhibit advanced features and intelligent behaviours. Kamphorst [8] summarized the following key features for e-coaching systems:

- Social ability: The coach has the ability to converse with the user.
- Credibility: The system has to be trustworthy and should be perceived as having an expertise of the coached domains.
- Context-awareness: The system needs to be aware of user context to propose ideas and actions that are relevant for the user.
- Learning abilities: The system needs the ability to ask questions, give feedback, and offer advice that is tailored to the individual user, building up and maintaining a personalized user model.
- Data gathering: The system should be able to gather information from different data streams (e.g., direct user input, but potentially also measurements of physical activities, mood self-reports, sleeping patterns) and take advantage of these data to personalize the coaching intervention.
- Proactivity: The system should not only be responsive to user interactions, but it should also initiate interactions with the aim of stimulating action or users' reflection on their behaviours.
- Behaviour Change Model (BCM) integration: The system needs to know what a behaviour change trajectory looks like in order to provide successful coaching.
- Planning support: To support users in setting themselves up for behaviour change success, the system should guide the user through the intention formation with appropriate planning strategies.

As discussed in the following sections, NESTORE integrated all these aspects through the e-coaching strategy (described in Section 5) and system architecture (described in Section 6).

To understand how NESTORE relates to previous e-coaching interventions, we conducted a systematic review of virtual coaches for promoting healthier lifestyles in older age [9]. The systematic review showed that about half of the previous coaching systems adopted a multidomain approach, but only four systems tackled four or more domains. The well-being domains addressed by previous systems are physical activity (with most of the interventions tackling this domain), nutrition, cognitive, social, and emotional/mental well-

being. In this respect, few insights were found on how to conceive a holistic multidomain framework for promoting healthier lifestyles.

NESTORE aims at providing a holistic framework to promote well-being in older age, delivering tailored coaching in physical activity, nutrition, cognitive and social domains. Additionally, it addresses the emotional/mental domain for monitoring and building empathy with the user (see Section 5.5). In particular, the multi-domain approach is designed using a novel integrated coaching strategy that is described in depth in this paper: a multi-domain pathway to well-being (see Section 5.2).

In order to improve or maintain well-being in older age, new behaviours should be introduced in the everyday activities. To this purpose, behaviour change models can help to motivate users in taking such decisions. As discussed in Section 5.1, NESTORE e-Coach is underpinned by the Health Action Process Approach (HAPA) behaviour change model, which is specifically conceived for health interventions. In our systematic review [9], only 18 of the 56 explicitly adopted or discussed a conceptual behaviour change model (BCM) guiding the design of the intervention. Only one study [10] in our systematic review adopted the HAPA model to design the e-coaching intervention strategy, but outside of e-coaching, in the health psychological behaviour change literature, it is a very prominent framework as it is specifically designed to support behaviour change in various health domains and one of the only models specifying the intention-behaviour transition [11]. Therefore, it was chosen in NESTORE as a highly appropriate and established underlying framework for designing the intervention pathways.

Transforming recommendations of BCMs into successful implementations of the e-coaching intervention is particularly challenging. In a scoping review on 27 studies, Lentferink et al. [12] analysed the key components that can significantly affect a variety of health outcomes, the adherence and the usability of an e-coaching intervention. The following Behaviour Change Techniques (BCTs) were found to positively affect both health outcomes and usability in the studies reviewed:

- Setting short-term goals to eventually reach long-term goals;
- Personalization of goals;
- Praise messages;
- Reminders to input self-tracking data into the technology;
- Use of validity-tested devices;
- Integration of self-tracking and persuasive e-Coaching;
- Provision of face-to-face instructions during implementation, as key components for influencing both health outcomes and usability in a positive way.

Moreover, the provision of personalized content was beneficial for both adherence and usability. These 8 key elements were often adopted in previous studies, although, from our analysis [9], no study adopted them all or the authors did not report it. The most frequent BCTs applied in the studies were the personalization of goals and content, followed by using validity-tested devices and combining self-tracking and e-coaching. Praise messages and reminders were present in about a third of the studies, while the reduction in long-term goals to short-term goals and face-to face instructions was present in 9 and 15 studies, respectively. In NESTORE, we paid particular attention to these 8 key elements, as explained in the following sections.

3. NESTORE Challenges and Objectives

With advancing age, structural and functional impairment occurs in most physiological systems, even in the absence of discernible disease. These age-related physiological changes affect a broad range of tissues, organ systems, and functions, which, cumulatively, can affect activities of daily living and the preservation of physical independence in older adults. Counteracting the physiological decline occurring with ageing can be achieved by improving or maintaining the well-being of older adult users through a dedicated coaching system. In NESTORE, the target population are healthy older adults, with a good perception of their quality of life or lifestyle level, with potential subjective feeling

of decline in one or multiple health domains but without severe chronic pathologies. The main challenge of NESTORE is thus to provide a coaching system which is both effective in maintaining the user's health, and, at the same time, affective and non-obtrusive to sustain its use in the long term.

In order to be effective, the coaching system should consider all main coaching domains related to healthy aging, in particular: physical activity, nutrition, cognition and social interaction. Moreover, the proposed coaching activities must be inspired by solid approved guidelines whose efficacy has been already verified. Based on these considerations, the NESTORE e-coach deals with different intervention areas and provides a complete set of coaching plans, built on domain experts' evidence-based recommendations. An additional challenge raised by the domain experts was to address all the well-being domains at the same time, to provide a holistic approach to well-being.

At the same time, health recommendations adopted in NESTORE for tackling all the different well-being domains are various and complex (see Section 3.1). Therefore, the second challenge of the NESTORE project was to shape such recommendations into a user-friendly and user-tailored format to ensure sustained use of the e-coaching system. In this respect, on the one hand, health recommendations had to be tailored to the user to make it more appealing and effective. This required additional data collection and user interactions and further algorithm complexity for the tailoring of recommendations. On the other hand, simplicity of the interaction was the first requirement elicited from the co-design activities.

Conciliating these two challenges was the main difficulty faced in NESTORE.

3.1. NESTORE Domains

The proposed approach is based on a holistic well-being model tailored to healthy older people [13,14]. This model is aimed at providing a structured knowledge, built on expertise of the NESTORE experts (exercise physiologists, nutritionists, psychologists, geriatricians) able to characterize the person in terms of both status and behaviour; the model adopts a multi-domain classification, which includes three main dimensions related to well-being: Physical/Physiological, Nutritional, Cognitive/Mental/Social. Each of these dimensions tackles different aspects of wellbeing, which are detailed in the following subsections. As discussed in Section 5, these aspects (or-subdomains) will allow users to personalize their pathway in each domain, choosing to work on a particular aspect (coaching plan) for each domain. Table 1 presents an overview of the possible activities for each domain. Table 2 shows an overview of the possible pathways to well-being as they were initially designed for the NESTORE e-coach.

Table 1. List of 5 most popular activities that participants already do and would do in NESTORE domain, ranked from the most popular to the least popular.

Already Do	**Would Do in NESTORE**
Physical activity	
Walking	Walking
Climb stairs	Climb stairs
Walk with shopping bags	Doing Stretching
Doing Stretching	Walk with shopping bags
Go hiking	Go hiking

Table 1. *Cont.*

Already Do	Would Do in NESTORE
Cognitive activity	
Write	Write
Engage in digital photography	Engage in commercial brain training application
Attend senior university lessons	Attend senior university lessons
Play video games	Engage in digital photography
Work on my own website	Work on my own website
Nutrition	
Choose seasonal fruits and vegetables	Eat 5 portions of fruit and vegetables every day
Limit the consumption of industrial pastries	Increase vegetable consumption
Try to drink 2 more glasses of water every day	Increase fruit consumption
Eat legumes (chickpeas, lentils, beans) at least 2 times per week	Include legumes regularly in your diet
Remove visible fat from meats and skin from poultry before cooking	Choose lean meat without visible fat like: chicken, turkey, veal, rabbit, beef or pork sirloin
Social activity	
Spend time with friends and neighbours	Volunteer with others in your community
Volunteer with others in your community	Spend time with friends and neighbours
Be part of a special senior citizen activity group	Join a special senior citizen activity group
Be part of a Reading Club	Attend a class to improve conversational skills
Be part of a Cineforum/movie or theatre club	Attend a class about nonverbal communication methods

Table 2. List of the preferred pathway to well-being for each domain, from the most popular to the least popular.

Physical	Cognitive	Nutrition	Social
Improve or maintain body flexibility	Improve or maintain everyday mental skills	Decrease or maintain body weight	Improve or maintain social integration
Improve or maintain aerobic fitness	Improve or maintain memory	Achieve or maintain a healthy diet	Improve or maintain social abilities
Improve or maintain body strength	Improve or maintain broader thinking skills	Increase or maintain muscle mass	
Improve or maintain body balance		Increase body weight	

3.1.1. Physical/Physiological Domain

Since deconditioning, reduced muscle mass, and/or low functional capacity contribute to poor health outcomes and low quality of life, the American College of Sports Medicine's (ACSM) recommends that older adults engage in a combination of aerobic, resistance, flexibility, and balance training to promote and maintain health [15,16]. In this perspective, the NESTORE system aims to modify users' behaviour in the physical activity domain, by proposing personalized coaching plans targeting four subdomains: (1) aerobic training, consisting of structured activities, such as walking, running or cycling to improve cardiorespiratory fitness; (2) strength exercises, such as chair squats or knee push-up to improve

upper and lower limbs strength and power; (3) flexibility training, using stretching exercises for upper and lower limbs to improve the joint range of movement and posture; (4) balance exercises, such as one-leg-stand or toe-to-line to improve the overall body stability.

Furthermore, in extension to the coaching paths, the NESTORE project also introduced a sensor-based approach to assess nocturnal sleep activity via unobtrusive sleep monitoring. In fact, sleep is a fundamental daily activity of human beings. A night of good sleep is strictly correlated to good conditions in both physical and cognitive domains. Furthermore, accurate sleep detection could be enabled to detect early signs of sleep deprivation and insomnia and, as a consequence, to implement mechanisms and systems for preventing these problems. Especially older people exhibit sleep fragmentation or difficulty falling asleep. Assessing sleep quality is a challenging task from a technological point of view [17] and, in this context, the NESTORE system identifies different sleep stages through the deployment of research-grade devices based on ballistocardiography (muRata SCA11H).

3.1.2. Nutritional Domain

Older adults are at higher risk of undernutrition than younger adults due to different factors, including age-associated physiological changes, cognitive impairment or socioeconomic aspects. Simultaneously, the incidence of overweight and obesity typically augments with age, as seen in most of the European countries [18,19]. Both undernutrition and obesity critically affect quality of life and increase mortality risks [20,21]. Ageing is also related to significant changes in body composition that are characterized by: (i) the progressive reduction of muscle mass; (ii) the increase in body fat mass accompanied by slow organs metabolic rates; and (iii) the decrease in metabolic flexibility and in the basal metabolic rate.

Opportune and efficient nutritional interventions for this population are considered as a key strategy for improving health outcomes and, therefore, achieving healthy ageing [22]. Following this line, the coaching plans for the nutrition domain are addressed to: (1) body weight management, focused to increase or decrease body weight, and consisting of tailored dietary activities, as well as energy balance monitoring, (2) body composition management, focused to increase muscle mass or decrease body fat, and consisting as well of tailored dietary activities and energy balance monitoring, and (3) the achievement of a healthy diet, focused to improve their dietary habits by targeting macronutrients and micronutrients intake through both diet monitoring (based on automated food image recognition) and nutrition coaching.

3.1.3. Cognitive/Mental/Social Domain

Cognitive and social well-being tend to show distinct age-related trajectories. Whereas many cognitive domains show reliable decline with age, particularly in the biology-driven fluid intelligence, the number of emotionally close others in people's networks tends to remain stable. Nonetheless, loneliness is one important risk factor for diminished well-being in later life. To address these age-related changes, we designed three different coaching plans in the cognitive domain that are intended to support the improvement and maintenance of fundamental cognitive processes and broader cognitive functioning (see also [23]). In line with traditional standardized cognitive training interventions, the first coaching plan involves a computer-based working memory task (e.g., [24,25], the second coaching plan has a multi-domain focus and involves a serious game adapted from a previously developed training game [26] that requires simultaneous involvement of multiple cognitive domains so that broader thinking skills are trained. The third and final coaching plan includes unstructured daily life activities and thus represents a productive intellectual engagement intervention, in which people are asked to engage in cognitively challenging and stimulating activities that are particularly relevant to daily life cognitive functioning [27].

Coaching plans in the social domain were selected based on the limited evidence on impactful interventions that can be implemented in daily life and address non-clinical groups of older adults. The first coaching plan encourages people to seek out opportunities

for new social contacts, aiming to improve a person's social integration (e.g., [28]). The second coaching plan in this area was a social abilities intervention, targeting a person's ability to adequately function in various social contexts and interactions (e.g., [29]). Furthermore, in extension to the two previous coaching plans, the NESTORE project also introduced a sensor-based approach to monitor social interaction of involved users, helping them to reflect on the quality and quantity of face-to-face interactions with family and/or friends. Indeed, exploiting a commercial and widely diffused sensing technology, namely Bluetooth LE, NESTORE enabled users tracing contacts between the NESTORE users and their family or friends who accepted to bring a NESTORE beacon with them.

4. Co-Design of the NESTORE Pathways

A co-design approach has been adopted to conceive the components and services offered by NESTORE and to adapt them to the desires, needs and expectations of the users [30]. The representatives of users and stakeholders become active participants in all phases of the design process. The design process has been organised according to the Double Diamond, a framework proposed by the British Council of Design [31]. This framework identifies and alternates between research and discovery phases (divergent) and practical phases focused on the concretisation of the project (convergent). A first phase of exploring the boundaries of the project topic (discover) is followed by a step to define the design problem and the users' needs (define). After that, there is a phase of development and exploration of the project possibilities (develop), followed by a phase of making the project idea concrete (deliver). Users and stakeholders from different countries (UK, Italy, Spain, The Netherlands) were actively involved in each phase. In the first two phases (discover and define), workshops were held to understand users' needs and attitudes towards technology products.

In the discover phase, a tool named Exhibition in a Box [32] (Figure 1) was used to facilitate the stage of discussion and exploration, involving 80 participants in the UK. The activity was then replicated in the other countries (Italy, Spain, The Netherlands) with smaller groups to validate the insights collected in the UK or to acknowledge cultural differences. Thanks to the Exhibition in the Box method, through a series of everyday objects, older adults started conversation about their wishes and desires for their everyday life. Relevant insights were collected regarding the different well-being domains, which were particularly useful to design the NESTORE pathways. Concerning physical activity, participants acknowledged the benefits of exercising not only in terms of physical well-being but also in terms of mental and social well-being. Indeed, physical exercise could be an opportunity to go outside, relax and stay with other people. On this aspect, users highlighted the importance of the social dimension of activities for their mental well-being. Spending time with family and friends was also driver for being motivated in doing such activities. Being able to learn something new also perceived as an important driver for motivation, but also as a possible barrier, when such expectations are disappointed. Another barrier for engaging in activities was the lack of time, especially for the "sandwich generation", i.e., older adults having to care for both grand-children and older parents. Barriers for adopting technology were also discussed within this activity frame. The main difficulties were mainly linked to the cognitive demand required (a typical example being the difficulty to remember all the passwords).

Technological factors were further discussed in the define phase. Eight people participated to a digital probe activity, tacking photos of good and bad examples of technology, to inspire requirement with the NESTORE system (Figure 2). Such requirements where further discussed together with technologists in order to ensure the transferability into the final requirements. Among the negative aspects highlighted by the participants, the following remarks are worth noting, such as too high number of inputs required to accomplish an operation, too small interfaces or numbers, poor cable management, intrusive audio notifications. Portability of some technology, their ability to provide easy access to information and voice control were considered as positive aspects of technology.

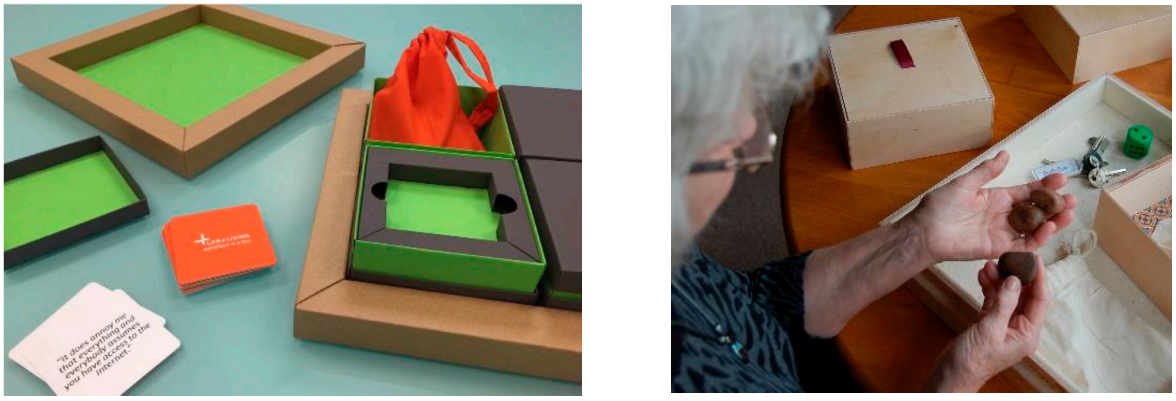

Figure 1. Exhibition in a box co-design tool.

Figure 2. Digital probes co-design tool.

In this phase we also held a workshop with design cards to understand how users would explore the different NESTORE pathways and commit to behaviour change in different well-being domains. Participants were shown a series of cards of use cases, based on the user's profile, needs and requirements, and different activities (Figure 3). The scope of this tool was to co-design different scenarios of use of the NESTORE system and investigate users' attitude toward each scenario. One result example was an e-coach who would want to know first the gender of the user and the status of living (alone or couple). Next, the system would need to understand the users' goals in terms of well-being. For instance, the user can be asked if a decrease in weight or increase in weight is their first goal to achieve for now. Then, the system would ask the users in which activities they would like to engage in order to improve their well-being. The workshop provided an opportunity to envision a methodological approach to mapping and creating different pathways and scenarios for the NESTORE e-coach from a user's perspective.

As a further co-design activity, in the define phase we conducted a survey to understand the type of activities that users usually do to stay fit and those that they would like to carry out in order to improve users' well-being in the different domains. Participants were also asked to rank the goals that they would select in each domain and to rate the activities that they would carry out in each domain to stay fit. The survey was also an opportunity to test the pathway selection process and the explication of each domain provided by the expert. The list of activities was developed taking inspiration from the insights collected during the co-design activities of the first phase and was validated by the domain experts, to ensure that the proposed activities could actually be beneficial for their well-being. The survey was implemented as a responsive web application and was translated in four languages, in order to collect data from UK, Spain, Italy and The Netherlands; 11 participants

from Spain, 7 participants from the United Kingdom, 6 participants from The Netherlands, and 2 participants from Italy completed the survey. Based on the users' feedback, we prioritized the development of the preferred coaching activities and goals. The main result of the survey was that the preferred coaching activities that participants would like to do are those that they were already doing. For example, for the physical activity domain, walking was the most common activity that participants already engaged in to stay fit, but also the one they reported to preferentially do to improve their well-being. Thus, an e-coach should suggest the users to walk-faster to train in the cardiovascular domain or to walk with heavy shopping bags to train their strength. Provided that survey participants could do activities they already engaged in to improve their well-being, they reported they would spend an average of 4.38 h per day doing NESTORE coaching activities. Table 1 presents the 5 most popular activities that participants already reported doing, compared to those that they said they would like to do, ranked by decreasing popularity.

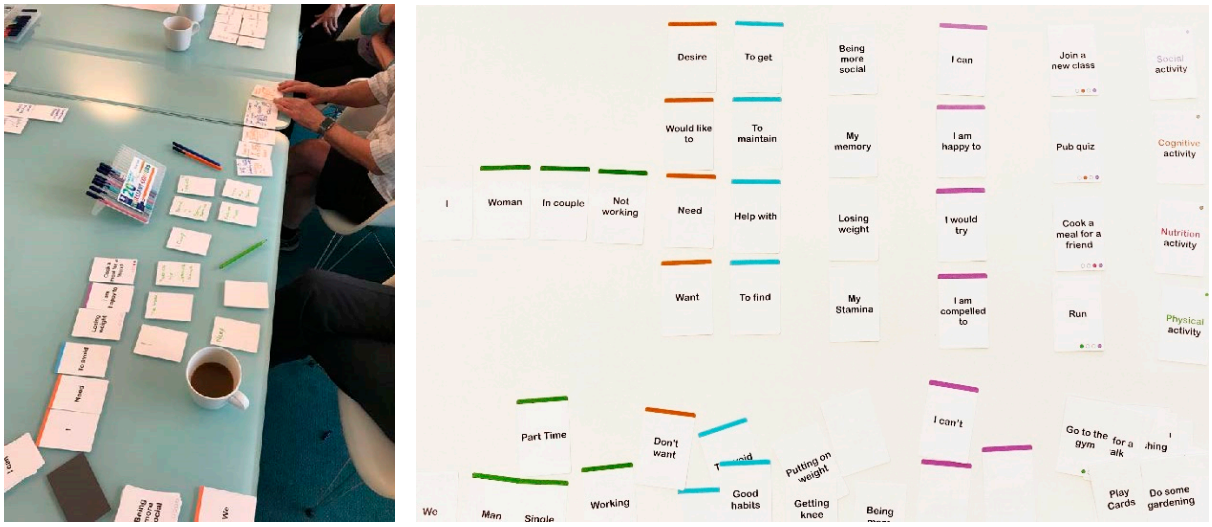

Figure 3. (**left**) Picture from the workshop, using both pre-printed and empty design cards. (**right**) example of a pathway choice process.

Table 2 presents the pathways to well-being preferred by participants in each domain. Participants received a short description of each sub-domain and of the activities that would be carried out in each pathway, as described in Section 3.

In the subsequent phase (develop), users and stakeholders were involved through focus groups and questionnaires to evaluate and choose between the different opportunities offered by the project. In particular, an embodied vocal assistant was co-designed and tested within a focus group in the UK. Through a survey conducted in the four countries, older adults preferred a physical design with a geometric shape, such as Google Home or Amazon Echo, rather than a life-like [33] (animal or plant) device. Through the focus group, we identified the conversations expected by older adults from such embodied e-coach. In particular, older adults would like to ask which are the activities they should do during the day and how they are progressing in the different domains. The final system is described in Section 6.

Then, in the deliver phase, 60 older adults took part in a pilot study, to test the complete system in their home environment. The main results of the pilot study are presented in Section 7.

5. NESTORE Coaching Strategy

Promoting behaviour change requires considering several aspects, such as understanding psychological processes that can foster motivation, recommendations from domain experts for providing an effective intervention and user needs and preferences to obtain an

enjoyable and sustainable experience. To this purpose, Section 5.1 details the Behaviour Change Model (BCM) adopted in NESTORE and the related Behaviour Change Techniques (BCTs) that were implemented. Section 5.2 presents the concept of pathway to well-being, explaining how this was implemented in NESTORE. Section 5.3 discusses examples of coaching activity plans for the different domains presented in Section 3.1. Finally, Sections 5.4 and 5.5 show how NESTORE tries to increase the user experience and eventually the intervention effectiveness through a high level of personalization and a sense of companionship between the e-coach, physicalized in a tangible device, and the user.

5.1. BCM and BCTs

To guide the NESTORE coaching implementation, we used the Health Action Process Approach (HAPA) [11] as the theoretical framework of behaviour change (see also [34]). The advantage of the HAPA framework over alternative models of behaviour change is that it specifically focuses on two distinct phases (i.e., motivational and volitional phase) and consequently on phase-specific factors underlying the success or failure of the formation of an intention and eventually change in behaviour. In contrast to alternative models, it thereby also addresses the often-neglected intention-behaviour gap, meaning that some individuals may develop an intention to change their behaviour, but they might not act upon this intention. There are six key variables, which predict intention formation and change in behaviour. In the motivational phase, three variables predict if someone will form an intention to change their health behaviour: risk awareness, which starts a process of critical reflexion, positive outcome expectancies and self-efficacy, which jointly operate to form the intention to change behaviour [35]. In the volitional phase, another set of three variables predicts how effectively the actual behaviour will be implemented by the individual. First, self-efficacy, as an indicator to overcome the intention-behaviour gap, which is also linked to how easily a person can get back on track after a relapse [36]. Second, action and coping planning, which denotes the when, where and how a target behaviour will be performed and how an individual will deal with potential problems arising when changing their health behaviour. Finally, action control, which subsumes self-monitoring and self-regulatory efforts when pursuing a target behaviour. In orchestration, these six key variables determine whether or not a health behaviour change is successfully initiated by any given person.

The NESTORE e-coach is a multi-domain coaching system, meaning that it offers older adults multiple coaching activities from various health domains (described in Section 3.1). The NESTORE intervention is particularly challenging in terms of pursuing a behaviour change, as it may recommend the user to change more than one behaviour at once by engaging in multiple coaching plans simultaneously. Thus, it is crucial to implement a variety of BCTs to sustain the motivation of the user and promote the overall effectiveness of the intervention (e.g., [37]). Based on a literature search identifying the most effective BCTs in the NESTORE domains, we implemented a variety of BCTs in the NESTORE coaching, including providing general educational information, providing information of health consequences, prompting intention formation, providing instructions, prompting specific goal setting and reviewing these behavioural goals, providing detailed feedback on health behaviours and many more. These messages were personalized based on contextual and other person-specific information so that the BCT messages come at the time and in the form needed by each individual (see also [38]).

5.2. Pathways to Well-Being

The overall goal of NESTORE is to accompany older adults towards a healthier lifestyle. This is not possible without considering all the domains presented in Section 3.1. Identifying the optimal pathway for each individual is not trivial, and the role of the NESTORE e-coach is to guide the user in the choice of the appropriate pathway to well-being based on their status and interests. We note that our concept of a pathway is slightly different from the term "clinical pathway" found in the literature (e.g., [39]). Within NESTORE, a pathway

encompasses the different components a user travels through in the process of finding and pursuing their individually suited behaviour change process. While in its core this resembles the essential steps recommended in clinical care settings to address a specific disease, our focus goes beyond circumscribed individual diseases and involves the person-specific fine-tuning rather than a more normative approach. As informing the user in an intuitive manner on the goals and outcome of the intervention is crucial for adherence and engagement, we chose the metaphor of a pathway to represent the journey that each user should regularly go through, introducing healthy activities and behaviours into their daily routines. As well-being is intrinsically multi-domain, we represented a pathway as in Figure 4, encompassing the 4 domains presented in Section 3.1. Nevertheless, as every domain is also multifaceted and training in all aspects of well-being at once would be overwhelming for the user, we identified for each domain different coaching plans that the user can choose from to build their own pathway and ultimately reach the goal of improving their well-being. These coaching plans mainly correspond to the different sub-domains elicited in Section 3.1 and assessed with users in the co-design phase (Section 2), with the exception of the physical activity domain where flexibility and balance exercises are integrated in both coaching plans for aerobic fitness and muscle strength.

	Pathway			
	Physical	Nutritional	Social	Cognitive
Coaching plans (option 1)	**Improve (or maintain) aerobic fitness**	Decrease (or maintain) body weight	**Improve (or maintain) social integration**	Improve (or maintain) everyday mental skills
Coaching plans (option 2)	Improve (or maintain) body strength	**Achieve (or maintain) a healthy diet**	Improve (or maintain) social abilities	Improve (or maintain) memory
Coaching plans (option 3)		Increase (or maintain) muscle mass		Improve (or maintain) broader thinking skills
Coaching plans (option 4)		(Increase body weight)		**None**

Figure 4. Summary of the possible pathways for a NESTORE user. In parenthesis are noted the alternatives for each coaching plan, which will be personalized according to the user needs in the specific sub-domain. For example, a user with good level of aerobic fitness and poor level of body strength will be able to choose between "Maintaining aerobic fitness" and "improving body strength". The user is asked to choose one coaching plan in each domain, training at the same time all the dimensions of well-being. Only the cognitive domain can be skipped if there is no need for improvement. In bold, highlighted with the dashed line, a possible pathway choice.

After a period of two weeks in which the system monitors the user's habits, objective functioning and subjective feelings, the NESTORE e-coach asks each user to build their own pathway to well-being, selecting for each domain one of the available coaching plans. Coaching plans are presented to the user as high-level long-term goals, to which the user should commit through specific activities. Indeed, the choice of the pathway at the end of the second week influences the type of coaching activities (shorter-term goals) that are proposed to the user in the following 12 weeks. These activities are proposed in specific coaching activity plans (CAPs), described in Section 5.3. Splitting longer-term goals in smaller shorter-term goals should help support behaviour change, as shown by Lentferink

et al. [12]. It is worth noting that the user is informed about the kind of activities they have to engage in for each coaching plan before committing to the chosen pathway. In order to increase their motivation, just after choosing the different subdomains, the user has to confirm the goals they committed to in each domain, signing a sort of behavioural contract.

In building the personalized pathway to well-being the role of the e-coach is crucial, since it guides the choice of the user towards a pathway that will likely most effectively lead to an improvement in well-being. For this purpose, based on the information collected in the first two weeks, the e-coach recommends the coaching plans where the user needs more training to meet the domain recommendations elicited by experts. Therefore, the pathway is customized for each user, including a recommendation whether an improvement is needed or whether maintaining the current level is sufficient. The presentation order of the coaching plans depends on the urgency of training in each of them.

Finally, to limit the user-burden to train concurrently in multiple domains, the system allows the user to skip the domains that do not need particular changes in behaviour to maintain the current level. As users were mainly interacting with the NESTORE e-coach through a mobile app, the representation of the whole pathway to well-being as illustrated in Figure 4 could not fit the vertical, small size of the smartphone screen. Therefore, the pathway choice process was rather split in different tabs, with a final review of the different choices as depicted in Figure 5.

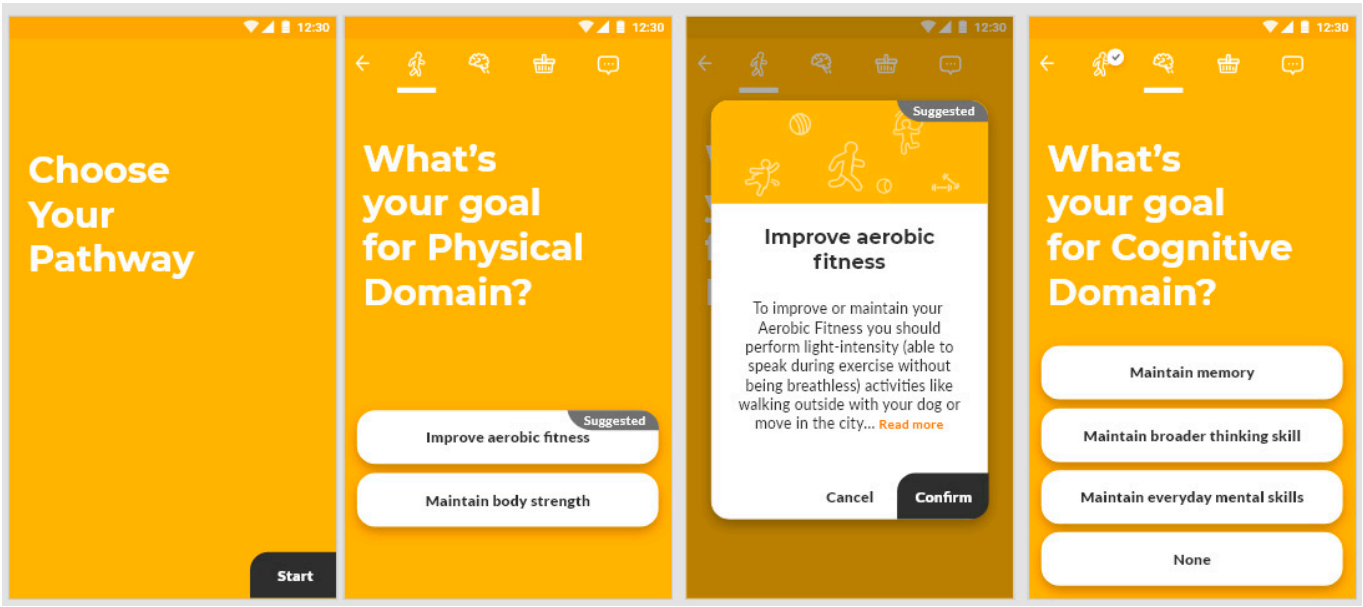

Figure 5. Pathway choice interface in the NESTORE Mobile app.

5.3. Coaching Plans

A three-layer coaching strategy [3] is proposed in NESTORE to better adjust to users' needs and likings. This layered approach allows users to (1) select a pathway to follow (as described in Section 5.2), which is composed by a coaching plan (goal) for each domain; (2) choose how they want to achieve that goal, henceforth referred to as coaching activity plans (CAPs); and (3) accomplish their goal by executing specific coaching activities scheduled by the system, named coaching events (CEs). Here, we can see as the overall goal of improving the well-being is first reduced to specific goals in each domain (the pathways) and then to elementary activities that users should carry out during their daily routines. These three layers are consecutively dependent on each other: a pathway contains many CAPs, and a CAP is formed by many CEs.

5.3.1. Example of a Coaching Activity Plan for Physical Activity

If users decide to improve aerobic fitness they can choose among three different schedules (CAPs): three, five or seven sessions per week; moreover, they can select exercise intensity (light, moderate or vigorous). Based on these choices, the system provides a personalized physical activity training plan (75–300 min per week depending on the selected intensity), asking the user to put the training sessions (CEs) into the weekly calendar and encouraging them to adhere to the plan. Each training session is monitored using a wearable device able to estimate physiological effort and provide prompt feedbacks to the user. In order to reduce the workload from carrying out structured training sessions, the NESTORE system also measures through the wearable device the activities performed by the users during their everyday life and adapts the physical activity training plan (CAP) accordingly, reducing the time to be dedicated to the structured training sessions. In NESTORE, users' physical activities are classified into non-structured and structured activities. Non-structured activities include activities taken during the day such as walking or doing housework. On the other hand, structured activities are defined by the aforementioned specific training plan.

5.3.2. Example of a Coaching Activity Plan for Nutrition

If users decide to increase muscle mass, the system provides them with personalized dietary plans (CAPs) based on personal food preferences and especially designed to favour muscle mass increase by targeting mainly protein and total energy intake. Some CEs' examples are "Add pumpkin seeds to salads" or "Choose nuts as a snack". Moreover, users are asked to monitor their dietary intake during at least 3 days per week (including one weekend day) by taking pictures of all their meals with the mobile phone. The system returns their daily and weekly energy and nutrient intake, and shows them whether they are within, below or above the recommended ranges. Energy expenditure is monitored by using a wearable device and displayed to users in order to help them to obtain a positive energy balance, essential to achieve an increase in muscle mass.

5.3.3. Example of a Coaching Activity Plan for Cognition

If users decide to exercise their broader thinking skills, they will be asked to engage in the serious game activity 5 times per week for approximately 30 min, resulting in 2.5 h of cognitive engagement per week. The CE consists of manually navigating a boat along a memorized path through a natural reservoir, while reacting to certain stimuli and inhibiting their reaction to other stimuli. Thus, three cognitive abilities are incorporated in the serious game task: inhibition, spatial memory, and visuo-spatial coordination (adapted from [26]). The serious game is also adaptive in nature, meaning that the difficulty level increases (or decreases) if the performance of the user increases (or decreases). Adherence is monitored and data is stored in the system.

5.3.4. Example of a Coaching Activity Plan for Social Activity

If users, for example, choose the social integration intervention, they will be asked to engage in this activity approximately once per week for 1–2 h (as most group-based leisure activities take place on a weekly basis). The user may choose from a variety of provided suggestions on how to engage in social opportunities (CEs), such as joining a theatre club, orchestra, choir, group sport, or senior citizen activity. The NESTORE system will provide information on where to find these activities in the area of the user. Some of these activities may also involve cognitive or physical elements and thus can facilitate cross-domain pathways. After four weeks of participating in the same social activity, users will be asked to evaluate their enjoyment and, in case of dissatisfaction, the NESTORE system will suggest new social CEs tailored to their profile.

5.4. Personalization

NESTORE deploys several tools towards fostering the adoption of well-being of older people. However, the success of the mechanisms designed throughout the different modules of the system greatly depends on the users' engagement with the platform and, more specifically, with the degree of personalization of those mechanisms. Thus, it is clear that regardless of having a good design of BCTs, NESTORE will not be able to trigger any effect on users' health and behaviours if they do not feel engaged or feel a sense of real support from the system. In this regard, what should be avoided is user burnout and immunization to the interactions, which could be caused by either non-personalised recommendations or out-of-context interventions. Therefore, what NESTORE aims to achieve is an emotional link between users and the platform, making the users feel supported by the e-coach whenever they need it, in an appropriate format, and in a personalised manner. For such purpose, knowledge processing algorithms and reasoning techniques are included so that, for instance, coaching plans can be personalised in terms of which kind of CEs are proposed, when they are sent—frequency, time of day, etc.—the total amount of recommendations to administer, and their priority. For example, the status of users on the different target domains, their enjoyment and likings, and the weather are items that will have an impact on the coaching plan proposal and its personalization.

Users have multiple possibilities for choice, starting from the choice of the pathway, as described in Section 5.2, which will affect the sub-domains that they will train and the types of coaching activities they can engage on. Depending on the domain, the user will also have the possibility to choose among different coaching activities for achieving the same goal.

In general, the system has also been tailored for older adults of the four different countries that participated in the co-design process, as described in Section 3. This resulted not only in an interface translated in the four respective languages, but also in an attempt to have conversations tailored to the local habits and traditions, in dishes and food recipes typical of each country, as well in social activities that were linked to the local facilities and events.

In particular, the CEs that are implemented in the system reflect the interest of the users, collected in the four countries, first through co-design workshops and then through a survey. Whenever possible and within the terms agreed by domain experts, user feedback is also employed to adapt the amount of training that the e-coach should propose, according to how much time the users think that they can reasonably spend to engage in coaching activities.

5.5. NESTORE e-Coach as a Companion

As anticipated in Section 5.4, a key goal of the NESTORE e-Coach is also to build an empathic relationship with the user in order to increase trust in the system and to foster adherence to the proposed intervention. In order to avoid a distant e-coach that is perceived as a mere virtual entity, the e-coach was embodied in a tangible artefact [40]. The tangible coach allows users to interact with an embodied e-coach, constituting a daily companion that might encourage people to engage in the NESTORE intervention. This tangible artefact also helps building an emotional relationship with the user and, to this purpose, one of its goals is understanding users' emotions. Indeed, in order to build empathy with the user, the system asks the user to report about her day and a semantic analysis [41] of its corresponding response allows the e-coach to detect the emotions experienced by the user and to respond accordingly. Nevertheless, as mentioned already in Section 3, it is worth noting that no specific e-coaching intervention was provided directly for the emotional and mental well-being. Physical interactions were also implemented, such as changing the position and orientation of the tangible coach to activate the possibility to speak with the coach. This should further foster the emotional bonding between the e-coach and the user and also ensure higher trust in the system, as the users could be sure that the system was not listening to them all the time.

As the interface of the tangible coach may be limited in terms of type of content that can be delivered and not adequate for all situations, different interfaces were available to ensure a proper communication between the user and the e-coach, typically available on the user's smartphone. The e-coach then continued interacting with the user in a more virtualized manner through the different interfaces, namely, an app with integrated chatbot, a game and a wearable. These interfaces are detailed in Section 6.

6. e-Coaching System Architecture

Ochoa and Gutierrez [19] identified a typical architecture for e-coaching systems. The key elements of the proposed architecture can be categorized in (1) data gathering, (2) data processing (which includes sensor data analysis and decision making for adapting the intervention to the context) and (3) actuation of the intervention through the delivery of the coaching action to the user. Data analysis includes both the understanding of user variables and characteristics (i.e., monitoring unit) and user actions (i.e., diagnosing unit). In particular, the intelligence of the system (i.e., learning unit) should be able to adapt the intervention according to different contexts: the state of users' characteristics, the user model (including users' preferences), the coaching plan and the progress throughout the coaching plan. Figure 6 depicts the e-coaching architecture of the NESTORE system. In the following subsections, we detail each part of the e-coaching system. A more detailed description of the system can be found in [42].

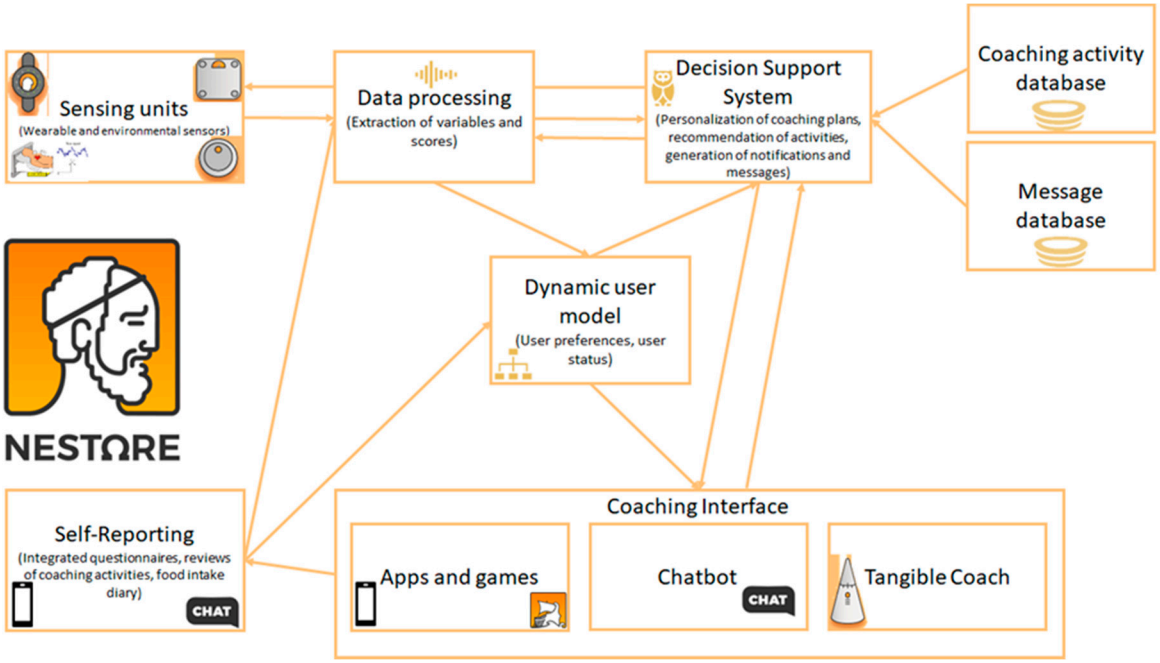

Figure 6. NESTORE e-coaching architecture.

6.1. Data Gathering and Sensing Architecture

The NESTORE architecture comprises a set of wearable/portable sensing units and back-end Cloud for storing and processing the collected data. It is worth noting that most domains also require self-reporting in order to accurately monitor user status, which is important for providing tailored coaching, as described in previous sections. Figure 7 shows the main components of the sensing architecture. Data is collected mainly through the wearable device and the NESTORE app on smartphones. Some sensors, such as the smart scale and the sleep sensors, are able to directly send the data retrieved to the NESTORE cloud infrastructure using dedicated endpoints of the NESTORE API. A wearable device is worn by the user during their daily activities. Environmental sensors, including BLE

Beacons, Smart Scale and a sleep sensor based on Ballistocardiography (BCG), have been deployed in the user's vital space.

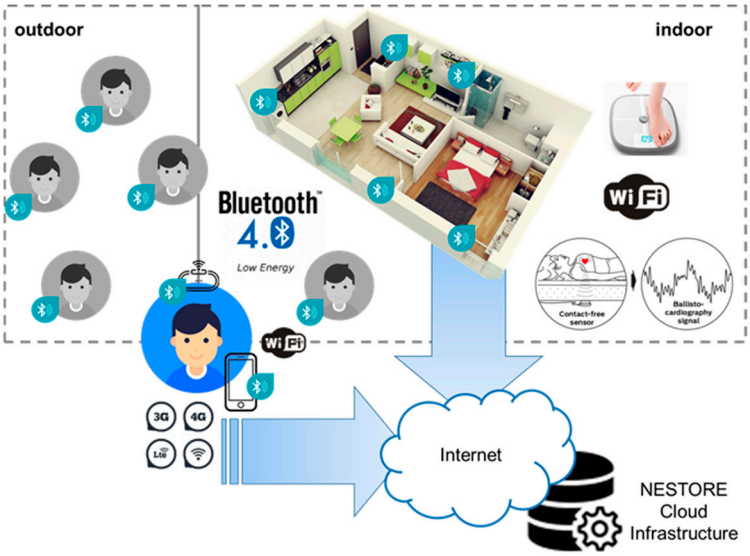

Figure 7. The data gathering and sensing Architecture.

For the purpose of this work, we briefly summarize the strategies adopted for collecting data belonging to the NESTORE domains described in Section 3.1.

6.1.1. Physical/Physiological Domain

The monitoring of the daily physical activity is performed through a wearable device worn by the user. This device is able both to gather data sent from the BLE beacons and to monitor the structured activity during the exercise session. Furthermore, it provides the user feedback through a vibration. When a user ends the exercise, the system evaluates the adherence with the prescribed plan. Finally, to find the appropriate training plan, after each session the system asks the user to provide the Borg Scale and the Total Quality of Recovery scale as indicators of perceived fatigue and recovery. Thanks to these subjective indicators, NESTORE is able to adjust intensity and duration of the next activity session, maintaining an adherence to the weekly prescriptions conducted by the domain experts. The user can also self-report specific daily activities that can be beneficial for the aerobic fitness or body strength coaching plans.

In relation to the physical well-being of the user, physiological parameters have been col sleep indicators have also been gathered. NESTORE uses a ballistocardiography sensor (muRata SCA11H), which reports multiple parameters at 1 Hz frequency. In particular, this sensor is able to collect heart rate, respiratory rate, relative cardiac stroke volume, heart rate variability, signal strength, bed occupancy status and beat-to-beat intervals. Evaluating the raw data collected from the sleep sensor, NESTORE algorithm is able to evaluate perceived calm sleep, awakenings, time in bed, sleep stages, calm sleep, total sleep time, sleep onset, sleep onset latency, sleep offset, wake after sleep onset. Finally, by combining these high level and objective indicators, NESTORE showed to the user a sleep quality index. It is worth noting that some indicators are useful from a long-term perspective. In particular, perceived calm sleep, time in bed, sleep stages, total sleep time, and sleep quality index can guarantee a posteriori trend analysis, identifying significant differences in terms of sleep behaviour.

6.1.2. Nutritional Domain

Food intake can be monitored both through an app and through a conversational agent. The Logmeal food recognition API [43] is used to support the user in food tracking, allowing the user to track food by simply sending a photo (or the name of the dish) to

the e-coach, through the chatbot or through the app. NESTORE calculates the nutritional information of the food entered by the user: besides calories and macronutrients (proteins, fat and carbohydrates), the app keeps track of important nutrients such us Vitamin B12, Calcium, Omega-3, etc. Moreover, physiological parameters are collected through a smart scale (Withings Body+), which allows keeping track of the user weight, fat-free mass, total body water, muscle mass, bone mass and body mass index (BMI). These parameters are particularly useful for the coaching plans for increasing, maintaining, or decreasing weight and for the coaching plan for increasing muscle mass.

6.1.3. Cognitive/Mental/Social Domain

The NESTORE project adopted commercial sensing technologies to demonstrate the possibility of automatically tracing contacts between the NESTORE users. To this purpose, the adopted hardware consists of Bluetooth tags to be carried as keyrings and the NESTORE app paired with the NESTORE wristband. Tags have been designed to periodically broadcast Bluetooth messages, namely beacons [9]. In turn, the NESTORE app and the NESTORE wristband record and store such messages to the Cloud for a periodical analytic process. Such a process identifies the time periods during which two users are in proximity, i.e., co-located for a time period. In particular, the implemented analytics compute for each user the following three metrics:

- The starting and ending time of each contact with a monitored user;
- The number of detected contacts over a time period;
- The cumulative duration of contacts over a time period.

Such metrics are computed on a daily basis and uploaded on the personal user's profile of the NESTORE dashboard. We report in Figure 8 on the right the adopted hardware and on the left a detail of the computed analytics available from the NESTORE mobile app.

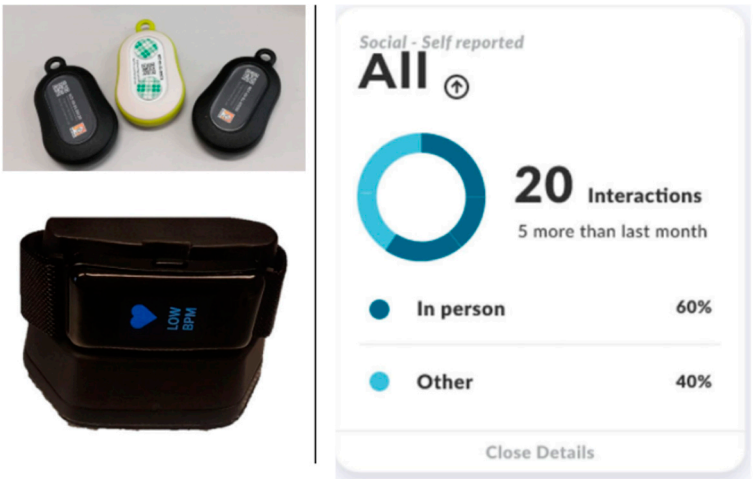

Figure 8. (**right**) The Bluetooth tags and the NESTORE wristband. (**left**) Detail of the computed analytics.

The same technology has also been adopted to possibly detect the indoor locations visited by users and eventually to identify the location of an interaction between two users. More specifically, a limited number of Bluetooth tags have also been deployed by users in their private houses to monitor target environments, e.g., kitchen, living room or main entrance (the exact target locations strictly depend on the house's layout). Such fixed tags periodically emit Bluetooth beacons with a specific message identifier. In turn, the NESTORE wristband can collect them and record on the Cloud. Such information allows us to infer two information: (i) the user's visited locations and (ii) the location of a contact between two users.

Cognitive games and exercises integrated in the app allow monitoring user's memory and broader cognitive functioning. The e-coach also periodically asks questionnaires

about daily social engagement, perceived loneliness and cognitive behaviours in daily routines. These standardized questionnaires are presented through the chatbot or the app in order to speed up the process and improve the user experience and engagement with the coach. Emotions and stress are tracked both through questionnaires and through semantic analysis of user's answers to selected questions with the conversational agent. The analysis is performed through an adapted version of the EMOTIVE ontological model [44].

6.2. Processing

NESTORE personalization techniques are encompassed inside a Decision Support System (DSS), which is the core component that provides intelligence to NESTORE modules and adequate the interactions to users' preferences, status and context.

A DSS can be defined as a "computerized information system used to support decision-making in which the characteristics of an individual are matched to a computerized knowledge base" [45]. A DSS allows to peruse large amounts of data and easily systematise the information to properly tackle complex problems and make tailored decisions. In NESTORE, the data collected through the data gathering stage (Section 6.1) is treated by the DSS in order to provide tailored recommendations to the user.

The NESTORE DSS compiles information about the lifestyle and preferences of older adults with the final goal of identifying their strengths and weaknesses (areas in need for improvement) with respect to the NESTORE domains and, ultimately, select the most appropriate decisions that will help them to improve or maintain a healthy life. To ensure the adequateness of the proposed NESTORE journeys for the users, multiple validation points are set to evaluate the representativeness of the data used for the assessments of the NESTORE domains.

In order to achieve this, data mining algorithms are used for modelling the user behaviour in a short-term timespan and then providing support to the user to decide the most convenient coaching activities based on the implementation of a tagging system and other reasoning techniques. NESTORE data processing is based on various techniques used to model and personalize the recommendations. First, a dynamic user profile is built, including either sensed, inferred or manually inputted data and user context. Then, different reasoning systems are applied to make personalised recommendations on the pathway to well-being and coaching activity plans [3]. In particular, the DSS is responsible to generate the list of tailored coaching plans based on the data collected on the first two week, and to continuously monitor and adapt the coaching activity plans (CAPs) proposed to reach the chosen goal in each domain.

6.3. Intervention Delivery

Following the recommendation of the decision support system, coaching is provided to the user through different interfaces, implementing each different BCTs. The different interfaces can also be used in different interaction contexts.

The intervention is provided mainly through a smartphone app, developed with the Ionic cross-platform framework and implementing the different BCTs described in Section 5.1. The app allows the user to monitor progress in the different domains, providing thresholds for optimal ranges and recommendations in the different domains. The app allows also to schedule the activities proposed by the coach in a calendar view, keeping track of all the activities carried out (including all the photos of the dishes entered in the system) and of the activities to be conducted. In order to support a multidomain intervention, each section of the app (the calendar, the chart, the menu for adding new activities or dishes) has specific sections for each domain. The users can rapidly switch across the different domains through intuitive icons for the physical, nutritional, cognitive, and social domains. Following the HAPA model, the calendar has been designed to help people planning their coaching activities and coping with daily hurdles that can prevent them from doing the suggested activities. Rescheduling the planned coaching activities is therefore also possible. Many charts presenting the data collected by the system, aggregated by day, week and

month, and the users' data positioning in relation to expert recommendations support the users' self-reflection. A specific part of the app is shown after the first two weeks, for guiding the user in the pathway choice (see Figure 5). Through the same app, users can also chat with the e-coach, which provides educational content, instructions for coaching activities, reminders, praise messages and ask questions to the users, for self-monitoring purposes (as discussed in Section 5.2). The chatbot has been developed with RASA NLU, which enables intent recognition and context management [46].

The smartphone can further be used to play games, which target the physical, and cognitive domain. As support for physical activity, the wearable device also provides specific feedback on physical activity intensity level and duration. Moreover, a social platform allows participation at local events (in relation to different domains). Finally, a tangible device embodies the e-coach, allowing users to ask about their scheduled and recommended activities and a summary of their score for each domain. The tangible coach provides them with constructive feedback to keep users motivated. Figure 9 below depicts a scenario of the different way of interaction between the NESTORE coach and the user in order to choose their personalized pathways, coaching activities and then to review them and obtain personalized feedback.

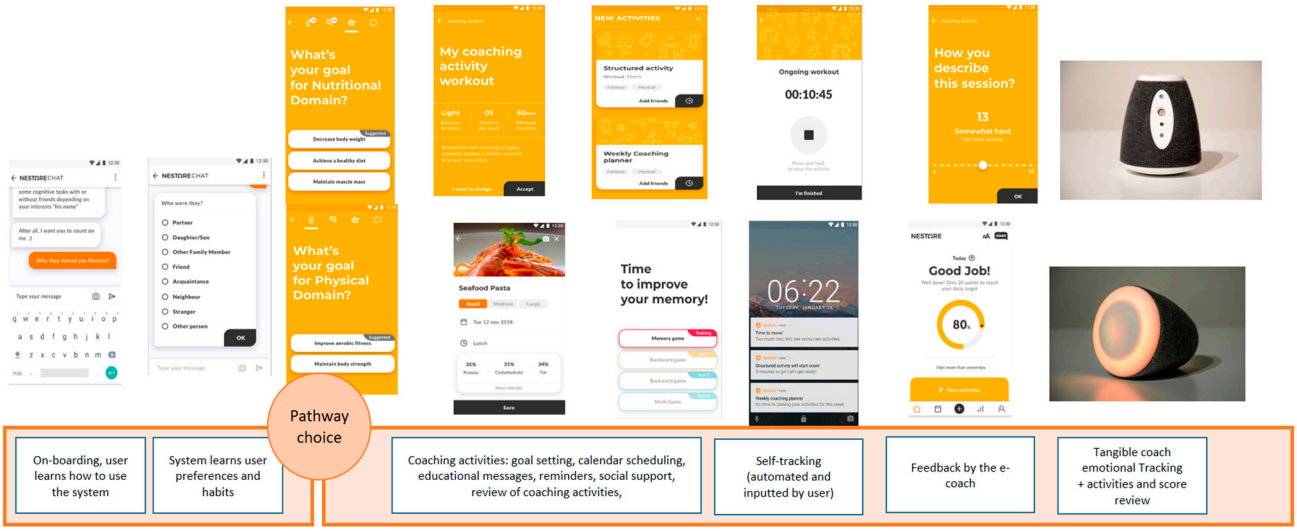

Figure 9. Intervention delivery trough the main coaching interfaces.

7. Pilot Study

At the end of the development, the NESTORE system and its components were tested by final users in a real-life context. The main objective of the testing phase was to study both the use and the impact of the e-coaching system and of its components in the daily life of the target users. Moreover, it was an opportunity to understand possible issues related to functionality, usability, acceptability, and user experience, to improve the system. After the first phase of recruitment and evaluation of the users' characteristics (physical, cognitive, familiarity with electronic devices, etc.), the NESTORE system and its components were presented to the users. The NESTORE system became effective after the installation, learning information (either automatically or by the users) to customise the intervention in different domains and based on their preferences, habits and objectives. Following these first weeks of learning, the intervention period began, in which the system is supposed to suggest activities and goals to be achieved. Unfortunately, the outbreak of the COVID-19 pandemic forcibly modified the testing and evaluation activities of the NESTORE system, starting from the sample size to the duration of the pilot (in some cases, it was not possible to do a 12-week pilot), up to the possibility of doing coaching activities linked to the NESTORE intervention domains (the social domain, and in many cases also the outdoor activities). The COVID-19 outbreak has partially limited the effective action

of the e-coaching system. For the management of the activities, the staff of the pilot sites constantly monitored and supported the users, when possible, in presence or using video call and/or chat systems.

7.1. Participants

Initially, the pilot study was planned with at least 60 participants testing the NESTORE system, equally divided between Italy, Spain, and The Netherlands. All participants required to meet the eligibility criteria (see Figure 10); users affected by severe chronic conditions were excluded. In addition, there was a control group, to check the system impact on people's health and well-being (evaluating the difference between those who used the system and those who did not). Participants were supposed to test the NESTORE system for about 12 weeks independently. Due to COVID-19 pandemic breakout, the pilot scheduling and the users' sample suffered an adjustment according to the context situation and country restrictions. Around 72% of participants were allocated to the intervention group (43 individuals), and the remaining 28% to the control group (17 individuals). The aim of having a gender-balanced sample was achieved. Regarding the socio-demographic composition of the sample, the average age was 70 years old. The educational level was higher than expected in relation to the general population of this age range. A high percentage of participants (81%) lived in a house of his/her partner's property. Around 19% reported living alone. It was decided to take the "time of use of the wearable" as a reference to calculate the approximate duration of the length of the intervention, due to be one of the first devices setup. As mentioned before, it is important to note that few cases have reached the 12 weeks of intervention, initially established as the standard period. 50% of the participants followed up for more than 9 weeks. This period was calculated based on the start-up of the wristband and first use.

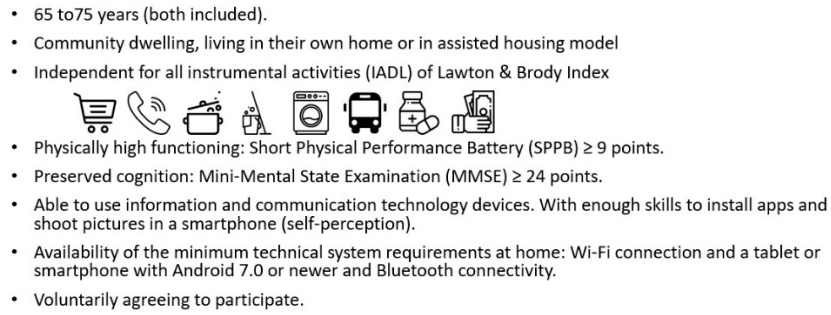

Figure 10. Eligibility criteria.

7.2. Methods

The study was designed as a prospective interventional study aimed to assess the validity of technological procedures developed by the NESTORE partners for this project, evaluate the usability of the platform, including particular experience of the participants with the system and its components. Finally, the goal was also to assess the effect of using the system on user status and behaviour based on standard measures between pre- and post-test changes in the control and intervention groups. Given the exploratory nature of the pilot study, the small sample size analysed, and the magnitude of missing data, the conclusions derived are more explicative in the usability and acceptance part of the study. The methods and tools for evaluating the functionality, usability, acceptability, and user experience were selected among qualitative and quantitative approaches, according to the various phases of the pilot (e.g., installation, mid-term, final-term). Concerning qualitative methods, three focus groups (carried out remotely, due to the COVID-19), and interviews (conducted by phone) were used; these were mainly employed in the final phases to have direct feedback of the user experience with the system. Concerning quantitative methods, standardised questionnaires were used, such as the SUS—System Usability Scale [47,48], the TAM—Technology Acceptance Model [49–51], the UEQ—User Experience Questionnaire [52–54],

the Companionship Scale [55,56], and the Friendship Scale [57]. These questionnaires investigated the different dimensions of use, interaction, and experience of the system and its components. To ease users' answering, the questionnaires were changed into online forms, and sent by email. Users voluntarily answered after the first use of the system and at the end of the pilot. We added open-ended questions to these standardised questionnaires, to gain a more detailed insight into the users' experience.

7.3. Results

During the pilot, the use of the system was affected by several factors, both contextual (COVID-19 outbreak) and related to the state of development of the NESTORE system and its components (the system was a prototype). Nevertheless, the users' response regarding acceptability and usability of the system and its components was moderately neutral to positive. The findings regarding the specific pathways of interest, collected in both qualitative and quantitative form, are presented here. Overall, the intervention explored did not show statistically significant nor clinically relevant differences for any of the measures assessed in the pre-post study. Although few participants were conscious of following a pathway spanning across each domain during the intervention, it is important to emphasize that due to the contributing factors and underlying circumstances of this pilot study, it was extremely difficult to identify all the mediating factors in their experience that could affect their pathway selection awareness.

However, in relation to the selected pathway to well-being (Table 3) in the first stage of the intervention, generally, participants were more likely to prioritize those coaching plans aligned with their personal goals. Thus, in the physical domain they prioritized the improvement and retention of fitness activities (37% and 31%, respectively), in nutrition they prioritized achieving a healthy diet (76%), in the mental and cognitive domain they preferred to improve their memory (41%) and in the social interaction domain they prioritized almost equally in both routes (48% and 52%).

Table 3. Pathway choices (coaching plans in each domain) for the 29 pilot users who started the intervention phase.

Domain	Coaching Plan	Number of Users	Percentage of Users
Physical activity	Aerobic fitness	20	69%
	Body strength	9	31%
Nutrition	Achieve a healthy diet	22	76%
	Increase muscle mass	1	3%
	Decrease body weight	6	21%
	Increase body weight	0	0%
Social	Social integration	14	48%
	Social abilities	15	52%
Cognitive	Broader thinking skills	9	31%
	Everyday mental skills	8	28%
	Memory	12	41%

In relation to their performance perception of each of the coaching plans, one of the most valued coaching plans was in the physical domain (i.e., maintaining or improving aerobic fitness) because they could easily monitor their daily activity, as in the case of the nutritional domain (e.g., decrease body weight), thanks to the use of the scale. From the users' insights it could be inferred that the mediation of a device generated a nexus that helped users to maintain the daily monitoring of their activities. If the device that mediated the activity monitoring failed, users' motivation with respect to the coaching plan was affected. The tangibility of the devices acted as a reminder of the existence of a commitment

to the pathways and the project. However, this affirmation could not be constrained in all devices, as with the social beacons due to the confinement situation or the pandemic social restrictions.

From the results of the surveys and the qualitative approach it become clear that the mechanisms for selecting, scheduling, monitoring and evaluating the coaching activities have a wide range for improvement, since NESTORE system presented usability issues typical of products and systems under development. From the qualitative approach, it can be concluded that the difficulties during the pilot modified users' perception about the system. The participants' effort to confront the technical issues far exceeded what they were getting out of it, and they developed two attitudes: abandoning the system or using it at a low minimum. Any action aimed at reducing the mismatch between the effort required to use the system and the benefit obtained will contribute to improving the final user experience. Some of the recommendations related to the system functioning pointed towards: extend the test period, especially in multi-domain systems, balancing the time required to complete tasks for all domains, making task management more flexible, introducing more engaging activities, reducing complexity and adding more support elements during system use and familiarization period that reinforce users' digital literacy to facilitate the adoption process.

Nevertheless, the integration of participants' views during their performance and creation of mechanisms to evaluate their self-progress have been considered important factors to increase their satisfaction level with the coaching process.

The participants showed a high level of commitment to develop the activities proposed by the system, even though they faced technical and functional barriers in carrying them out that affected the data collection and therefore the proposed coaching strategies. Despite this, they showed a high level of perseverance to do what they were supposedly expected to do. These circumstances were ultimately determinative of their final experience using the system.

As an example, Table 4 presents the results from the quantitative analysis of the use of the NESTORE system and its components. Specifically, it gives the results of the questionnaire carried out based on the SUS and TAM questionnaires, in which the satisfaction (S) and acceptability (A) of the system are evaluated. The first nine questions investigate satisfaction of use, and the last three, acceptability of use; the tenth question covers both domains. The surveys were submitted to the participants in digital form, at the beginning and the end of the pilot; the participants could answer it voluntarily. We present the mean and the mode of the collected answers. The sample of answers demonstrates acceptable values for the satisfaction and acceptability of the system.

Table 4. The results of the SUS/TAM surveys, answered by the users at the beginning and the end of the pilot.

NESTORE System Satisfaction (S) and Acceptance (A) Global Evaluation		**Beginning of the Pilot 23 Answers**		**End of the Pilot 22 Answers**	
		MEAN	**MODE**	**MEAN**	**MODE**
S	I think that I would like to use the system frequently	3.3	4	2.9	3
	I found the system unnecessarily complex	3.4	4	3.4	3
	I thought the system was easy to use.	3.1	3	2.7	3
	I think that I would need the support of a technical person to be able to use the system	3.5	3	3.4	3
	I found the various functions in the system were well-integrated	3.2	2	2.9	4
	I thought there was too much inconsistency in the system	2.9	2	3.5	3
	I would imagine that most people would learn to use the system very quickly	3.2	3	3.1	4
	I find the system very awkward to use	3.1	3	3.1	2
	I feel very confident using the system	3.1	3	2.9	3

Table 4. *Cont.*

NESTORE System Satisfaction (S) and Acceptance (A) Global Evaluation		Beginning of the Pilot 23 Answers		End of the Pilot 22 Answers	
		MEAN	MODE	MEAN	MODE
S&A	I needed to learn a lot of things before I could get going with the system	3.5	3	2.7	2
A	I find the system easy to use	3.1	4	2.8	3
	Using the system to help me maintain and improve my mental well-being is a good idea	3.7	4	3.1	4
	Using the system is beneficial to improve my overall well-being	3.7	4	3.4	4

8. Discussion

8.1. Discussion of Results

The NESTORE project, through an iterative process that involved users and domain experts, allowed to conceive a novel multi-domain intervention aimed at improving well-being in older age. One of the main challenges in the project was to design an e-coach able to recommend effective healthy behaviours in multiple domains of well-being (physical, nutritional, cognitive and social) and, at the same time, to ensure the usability of such a complex system, requiring multiple devices and inputs from the user in order to provide tailored recommendations in each domain.

The iterative co-design and testing process allowed us to discover important insights on users' desires and needs. Although most healthy older adults who are interested in maintaining their well-being have already quite busy days, they are still interested in finding time for training in the four different domains tackled by NESTORE. The participants to the survey estimated that they could spend, on average, around one per day in each domain. From the answer to our survey, we also evidenced that they reported a preference for those activities that were already part of their daily routines. Based on expert recommendations, for example, walking fast enough or walking with heavy shopping bags could contribute to the user's physical well-being, respectively for the aerobic fitness and body strength coaching plans. Still, some time should be dedicated to specific exercises that could not be integrated in daily routines. Monitoring progress in each domain is also technically challenging adding multiple devices and questionnaires to check user's progress. Users are happy to spend time in such reporting activities if there is enough feedback on the monitored activities and on the overall progress. However, the uptake at once of several devices and apps (in our case, mostly prototypes, which were still prone to bugs) brought an important cognitive effort and time burden, which decreased the user experience of the user. Precisely, one of the suggested recommendations by users was to adding more support elements during system use and familiarization period that reinforce users' digital literacy to facilitate the adoption process. This type of actions may initially require a significant resource investment to define, design and implement them. However, the impact of their implementation can be high impact as they can definitely contribute not only to increasing users' awareness of the system's performance and what to expect from it, but also to increasing success in future interactions. So, it can be an opportunity if the system embraces the user and offers contextual aid (always available and visible if user needs it) and welcome 'step by step' help. In the other hand, it is necessary that the system could be adapted to different levels of digital literacy (e.g., basic, moderate and advanced). In addition, it is useful if the system is permeable to the accumulation of usage experiences and has the capacity to adjust messages according to the learning detected, so that it can offer help depending on the user's needs.

Considering the time constraints imposed by the European funding for designing, implementing, and testing the system and the difficulties brought by COVID-19 pandemic the results of the study have limited scope and it is difficult to generalize findings on

the efficacy of the NESTORE multidomain intervention. Nevertheless, the qualitative approach used during the co-design and evaluation of the system allowed to derive design recommendations for building future e-coaching systems and for the improvement of the NESTORE system.

8.2. Design Recommendations

On one hand, participants considered that flexibility and freedom were important ingredients in their life. Therefore, they value having the chance to improvise and decide what activities they want to engage in and when without excessive planning; this recommendation, although not completely aligned to the HAPA model, can be considered in future studies and interventions.

The pathway selection stage is a key moment in the well-being intervention, in which user needs to receive from the e-coach a greater follow-up and support and in a meaningful way, to become more aware of the importance of their choice. This phase should carefully manage the expectations of the users, so that they clearly understand the next steps to be taken. Participants suggested selecting the pathways in a more visible and structured way. Additionally, it will be useful if users can constantly check their progress in each pathway, also as a reminder of their choice and final goal. Such progress was nuanced in the app among various charts monitoring progress in each domain and clearly provided only as oral feedback in the tangible coach, which unfortunately encountered technical problems for some users. On the other hand, they also expressed the need that the pathway selection becomes a meaningful moment that generates an informed and conscious choice (i.e., clear intention formation).

Participants considered that experiencing happiness and fun are important not only to increase the interaction with the system but also to maintain their engagement and to improve the app user experience. Therefore, participants suggested different strategies to enhance the user experience (e.g., improving the vocal interaction—in terms of languages and styles—and introducing a greater variability and diversity in the interaction modes and activities).

Finally, participants in the study agreed that coaching styles could affect their acceptance and receptiveness to the intervention. Because of this, if the communication style is considered as coercive, strict, rigid, or unfriendly that will not encourage them to interact more with the system and to be motivated and engaged.

Considering the multidomain design of the intervention, there is scientific evidence [58,59] that the different domains are strictly intertwined, and a comprehensive e-coach should tackle the different domains at once. At the same time, the burden associated with adopting several devices and apps is not negligible. For a commercial e-coaching system, we would recommend exploiting the modularity of such e-coach, introducing additional domains one at a time, once the user is already acquainted with a part of the system and managed to integrate healthy behaviours in one domain in their daily routines.

9. Conclusions

This paper presented NESTORE, an e-coaching intervention for promoting healthy lifestyles in older age. In the article, we highlighted the novel approach of providing simultaneous coaching activities in different domains, modelled as a personalized pathway to well-being. We showed how the design of the NESTORE e-coach was based on state-of-the-art recommendations for e-coaching systems, as well as on the HAPA model for behaviour change as conceptual underpinning. We highlighted the importance of designing an e-coach which is not only a tool for exercising but also a companion of the user during the process of behaviour change, providing support and knowledge for sustainable and long-term well-being improvement. Finally, we presented the results of the pilot study conducted with 60 older adults in three European countries.

The overall process highlighted the many open challenges to design a multi-domain e-coaching system that is at the same time effective and easy to use. Personalization, simplicity, engagement and integration in daily life are the main aspects that older users highlighted as key features of such e-coaching system.

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References

1. European-Commission. Personalised Coaching for Well-Being and Care of People as They Age. Available online: https://cordis.europa.eu/programme/id/H2020_SC1-PM-15-2017 (accessed on 4 March 2022).
2. NESTORE H2020—SC1-PM15-2017 Grant, N. 769643. Available online: https://nestore-coach.eu/ (accessed on 4 March 2022).
3. Subías-Beltrán, P.; Orte, S.; Vargiu, E.; Palumbo, F.; Angelini, L.; Abou Khaled, O.; Mugellini, E.; Caon, M. A decision support system to propose coaching plans for seniors. In Proceedings of the 2019 IEEE 32nd International Symposium on Computer-Based Medical Systems (CBMS), Cordoba, Spain, 5–7 June 2019; pp. 592–595.
4. Angelini, L.; Mugellini, E.; Khaled, O.A.; Röcke, C.; Guye, S.; Porcelli, S.; Mastropietro, A.; Rizzo, G.; Boqué, N.; del Bas, J.M. The NESTORE e-coach: Accompanying older adults through a personalized pathway to wellbeing. In Proceedings of the 12th ACM International Conference on PErvasive Technologies Related to Assistive Environments, Rhodes, Greece, 5–7 June 2019; pp. 620–628.
5. Chang, J.T.; Morton, S.C.; Rubenstein, L.Z.; Mojica, W.A.; Maglione, M.; Suttorp, M.J.; Roth, E.A.; Shekelle, P.G. Interventions for the prevention of falls in older adults: Systematic review and meta-analysis of randomised clinical trials. *BMJ* **2004**, *328*, 680. [CrossRef] [PubMed]
6. Shahabi, S.; Rezapour, A.; Arabloo, J. Economic evaluations of physical rehabilitation interventions in older adults with hip and/or knee osteoarthritis: A systematic review. *Eur. J. Physiother.* **2021**, *23*, 185–195. [CrossRef]
7. Banos, O.; Nugent, C. E-coaching for health. *Computer* **2018**, *51*, 12–15. [CrossRef]
8. Kamphorst, B.A. E-coaching systems. *Pers. Ubiquitous Comput.* **2017**, *21*, 625–632. [CrossRef]
9. El Kamali, M.; Angelini, L.; Caon, M.; Carrino, F.; Röcke, C.; Guye, S.; Rizzo, G.; Mastropietro, A.; Sykora, M.; Elayan, S. Virtual coaches for older adults' wellbeing: A systematic review. *IEEE Access* **2020**, *8*, 101884–101902. [CrossRef]
10. O'Brien, N.; Heaven, B.; Teal, G.; Evans, E.H.; Cleland, C.; Moffatt, S.; Sniehotta, F.F.; White, M.; Mathers, J.C.; Moynihan, P. Integrating evidence from systematic reviews, qualitative research, and expert knowledge using co-design techniques to develop a web-based intervention for people in the retirement transition. *J. Med. Internet Res.* **2016**, *18*, e5790. [CrossRef]
11. Schwarzer, R. Modeling health behavior change: How to predict and modify the adoption and maintenance of health behaviors. *Appl. Psychol.* **2008**, *57*, 1–29. [CrossRef]
12. Lentferink, A.J.; Oldenhuis, H.K.; de Groot, M.; Polstra, L.; Velthuijsen, H.; van Gemert-Pijnen, J.E. Key components in eHealth interventions combining self-tracking and persuasive eCoaching to promote a healthier lifestyle: A scoping review. *J. Med. Internet Res.* **2017**, *19*, e277. [CrossRef]
13. Mastropietro, A.; Roecke, C.; Porcelli, S.; del Bas, J.; Boquè, N.; Maldonado, L.F.; Rizzo, G. Multi-domain Model of Healthy Ageing: The Experience of the H2020 NESTORE Project. In *Italian Forum of Ambient Assisted Living*; Springer: Cham, Switzerland, 2018; pp. 13–21.

14. Mastropietro, A.; Palumbo, F.; Orte, S.; Girolami, M.; Furfari, F.; Baronti, P.; Candea, C.; Roecke, C.; Tarro, L.; Sykora, M. A multi-domain ontology on healthy ageing for the characterization of older adults status and behaviour. *J. Ambient Intell. Humaniz. Comput.* **2021**, 1–19. [CrossRef]
15. Chodzko-Zajko, W.J.; Proctor, D.N.; Singh, M.A.F.; Minson, C.T.; Nigg, C.R.; Salem, G.J.; Skinner, J.S. Exercise and physical activity for older adults. *Med. Sci. Sports Exerc.* **2009**, *41*, 1510–1530. [CrossRef]
16. Pescatello, L.S.; Riebe, D.; Thompson, P.D. *ACSM's Guidelines for Exercise Testing and Prescription*; Lippincott Williams & Wilkins: Philadelphia, PA, USA, 2014.
17. Crivello, A.; Barsocchi, P.; Girolami, M.; Palumbo, F. The meaning of sleep quality: A survey of available technologies. *IEEE Access* **2019**, *7*, 167374–167390. [CrossRef]
18. Eurostat. "Overweight and Obesity—Bmi Statistics," Eurostat, Statistics Explained. Available online: https://ec.europa.eu/eurostat/statistics-explained/index.php?title=Overweight_and_obesity_-_BMI_statistics (accessed on 14 January 2022).
19. Mathus-Vliegen, E.M.; Basdevant, A.; Finer, N.; Hainer, V.; Hauner, H.; Micic, D.; Maislos, M.; Roman, G.; Schutz, Y.; Tsigos, C. Prevalence, pathophysiology, health consequences and treatment options of obesity in the elderly: A guideline. *Obes. Facts* **2012**, *5*, 460–483. [CrossRef] [PubMed]
20. Osher, E.; Stern, N. Obesity in elderly subjects: In sheep's clothing perhaps, but still a wolf! *Diabetes Care* **2009**, *32*, S398–S402. [CrossRef] [PubMed]
21. Gentile, S.; Lacroix, O.; Durand, A.; Cretel, E.; Alazia, M.; Sambuc, R.; Bonin-Guillaume, S. Malnutrition: A highly predictive risk factor of short-term mortality in elderly presenting to the emergency department. *J. Nutr. Health Aging* **2013**, *17*, 290–294. [CrossRef] [PubMed]
22. World-Health-Organization. *World Report on Ageing and Health*; World Health Organization: Geneva, Switzerland, 2015.
23. NESTORE-Consortium. *NESTORE D2.2: Guidelines for the Virtual Coach in All the Target Domains*; NESTORE Deliverable; 2018. Available online: https://nestore-coach.eu/ (accessed on 4 March 2022).
24. Guye, S.; Röcke, C.; Mérillat, S.; von Bastian, C.C.; Martin, M. Plasticity in different age groups: Adult lifespan. In *Cognitive Training*; Springer: Berlin/Heidelberg, Germany, 2016; pp. 45–58.
25. Guye, S.; Von Bastian, C.C. Working memory training in older adults: Bayesian evidence supporting the absence of transfer. *Psychol. Aging* **2017**, *32*, 732. [CrossRef] [PubMed]
26. Binder, J.C.; Zöllig, J.; Eschen, A.; Mérillat, S.; Röcke, C.; Schoch, S.; Jäncke, L.; Martin, M. Multi-domain training in healthy old age: Hotel Plastisse as an iPad-based serious game to systematically compare multi-domain and single-domain training. *Front. Aging Neurosci.* **2015**, *7*, 137. [CrossRef] [PubMed]
27. Park, D.C.; Gutchess, A.H.; Meade, M.L.; Stine-Morrow, E.A. Improving cognitive function in older adults: Nontraditional approaches. *J. Gerontol. Ser. B Psychol. Sci. Soc. Sci.* **2007**, *62*, 45–52. [CrossRef]
28. Petryshen, P.M.; Hawkins, J.D.; Fronchak, T.A. An evaluation of the social recreation component of a community mental health program. *Psychiatr. Rehabil. J.* **2001**, *24*, 293. [CrossRef]
29. Fokkema, C.; Van Tilburg, T. Loneliness interventions among older adults: Sense or nonsense. *Tijdschr. Gerontol. Geriatr.* **2007**, *38*, 185–203.
30. Chamberlain, P.; Craig, C.; Dulake, N. Found in translation: Innovative methods of co-design in the development of digital systems for promoting healthy aging. In *Digital Health Technology for Better Aging*; Springer: Berlin/Heidelberg, Germany, 2021; pp. 29–52.
31. British Design Council. What is the Framework for Innovation? Design Council's Evolved Double Diamond. Available online: https://www.designcouncil.org.uk/news-opinion/what-framework-innovation-design-councils-evolved-double-diamond (accessed on 14 January 2022).
32. Chamberlain, P.; Craig, C. Engagingdesign–methods for collective creativity. In Proceedings of the International Conference on Human-Computer Interaction, Las Vegas, NV, USA, 21–26 July 2013; pp. 22–31.
33. Schmitz, M. Concepts for life-like interactive objects. In Proceedings of the Fifth International Conference on Tangible, Embedded, and Embodied Interaction, Funchal, Portugal, 22–26 January 2011; pp. 157–164.
34. Christina Röcke, S.G.; Angelini, L.; Caon, M.; El Kamali, M.; Khaled, O.A.; Mugellini, E.; Rizzo, G.; Mastropietro, A.; Porcelli, S.; Kniestedt, I. *NESTORE-D5.1 Definition of Intervention Techniques*; NESTORE Deliverable; 2018. Available online: https://nestore-coach.eu/ (accessed on 4 March 2022).
35. Schwarzer, R.; Lippke, S.; Luszczynska, A. Mechanisms of health behavior change in persons with chronic illness or disability: The Health Action Process Approach (HAPA). *Rehabil. Psychol.* **2011**, *56*, 161. [CrossRef]
36. Scholz, U.; Sniehotta, F.F.; Schwarzer, R. Predicting physical exercise in cardiac rehabilitation: The role of phase-specific self-efficacy beliefs. *J. Sport Exerc. Psychol.* **2005**, *27*, 135–151. [CrossRef]
37. Abraham, C.; Michie, S. A taxonomy of behavior change techniques used in interventions. *Health Psychol.* **2008**, *27*, 379. [CrossRef] [PubMed]
38. Nahum-Shani, I.; Smith, S.N.; Spring, B.J.; Collins, L.M.; Witkiewitz, K.; Tewari, A.; Murphy, S.A. Just-in-time adaptive interventions (JITAIs) in mobile health: Key components and design principles for ongoing health behavior support. *Ann. Behav. Med.* **2017**, *52*, 446–462. [CrossRef] [PubMed]
39. Rotter, T.; Kinsman, L.; James, E.L.; Machotta, A.; Gothe, H.; Willis, J.; Snow, P.; Kugler, J. Clinical pathways: Effects on professional practice, patient outcomes, length of stay and hospital costs. *Cochrane Database Syst. Rev.* **2010**, *3*, CD006632. [CrossRef]

40. El Kamali, M.; Angelini, L.; Caon, M.; Andreoni, G.; Khaled, O.A.; Mugellini, E. Towards the NESTORE e-Coach: A Tangible and Embodied Conversational Agent for Older Adults. In Proceedings of the 2018 ACM International Joint Conference and 2018 International Symposium on Pervasive and Ubiquitous Computing and Wearable Computers, Singapore, 8–12 October 2018; pp. 1656–1663.
41. Sykora, M.; Elayan, S.; Angelini, L.; Röcke, C.; El Kamali, M.; Mugellini, E.; Guye, S. Understanding Older Adults' Affect States in Daily Life for Promoting Self-reflection About Mental Wellbeing. In *Digital Health Technology for Better Aging*; Springer International Publishing: Cham, Switzerland, 2021; pp. 179–193.
42. Palumbo, F.; Crivello, A.; Furfari, F.; Girolami, M.; Mastropietro, A.; Manferdelli, G.; Röcke, C.; Guye, S.; Salvá Casanovas, A.; Caon, M.; et al. "Hi This Is NESTORE, Your Personal Assistant": Design of an Integrated IoT System for a Personalized Coach for Healthy Aging. *Front. Digit. Health* **2020**, *2*, 545949. [CrossRef]
43. Nagarajan, B.; Khatun, R.; Bolaños, M.; Aguilar, E.; Angelini, L.; El Kamali, M.; Mugellini, E.; Khaled, O.A.; Boqué, N.; Tarro, L.; et al. Nutritional Monitoring in Older People Prevention Services. In *Digital Health Technology for Better Aging: A Multidisciplinary Approach*; Andreoni, G., Mambretti, C., Eds.; Springer International Publishing: Cham, Switzerland, 2021; pp. 77–102.
44. Sykora, M.D.; Jackson, T.; O'Brien, A.; Elayan, S. Emotive ontology: Extracting fine-grained emotions from terse, informal messages. *IADIS Int. J. Comput. Sci. Inf. Syst.* **2013**, *8*, 106–118.
45. Holsapple, C.W.; Whinston, A.B.; Benamati, J.H.; Kearns, G.S. Instructor's Manual with Test Bank to Accompany Decision Support Systems: A Knowledge-Based Approach. In *Digital Health Technology for Better Aging*; Springer International Publishing: Cham, Switzerland, 1996.
46. El Kamali, M.; Angelini, L.; Caon, M.; Khaled, O.A.; Mugellini, E.; Dulack, N.; Chamberlin, P.; Craig, C.; Andreoni, G. NESTORE: Mobile Chatbot and Tangible Vocal Assistant to Support Older Adults' Wellbeing. In Proceedings of the 2nd Conference on Conversational User Interfaces, Bilbao, Spain, 22–24 July 2020; pp. 1–3.
47. Brooke, J. SUS-A quick and dirty usability scale. *Usability Eval. Ind.* **1996**, *189*, 4–7.
48. Brooke, J. SUS: A retrospective. *J. Usability Stud.* **2013**, *8*, 29–40.
49. Davis, F.D. Perceived usefulness, perceived ease of use, and user acceptance of information technology. *MIS Q.* **1989**, *13*, 319–340. [CrossRef]
50. Davis, F.D.; Bagozzi, R.P.; Warshaw, P.R. User acceptance of computer technology: A comparison of two theoretical models. *Manag. Sci.* **1989**, *35*, 982–1003. [CrossRef]
51. Venkatesh, V.; Davis, F.D. A theoretical extension of the technology acceptance model: Four longitudinal field studies. *Manag. Sci.* **2000**, *46*, 186–204. [CrossRef]
52. Laugwitz, B.; Held, T.; Schrepp, M. Construction and evaluation of a user experience questionnaire. In Proceedings of the Symposium of the Austrian HCI and Usability Engineering Group, Graz, Austria, 20–21 November 2008; pp. 63–76.
53. Schrepp, M.; Hinderks, A.; Thomaschewski, J. Design and evaluation of a short version of the user experience questionnaire (UEQ-S). *Int. J. Interact. Multimed. Artif. Intell.* **2017**, *4*, 103–108. [CrossRef]
54. Schrepp, M.; Hinderks, A.; Thomaschewski, J. Construction of a Benchmark for the User Experience Questionnaire (UEQ). *Int. J. Interact. Multim. Artif. Intell.* **2017**, *4*, 40–44. [CrossRef]
55. Lawson, S.; Chesney, T. The impact of owner age on companionship with virtual pets. In Proceedings of the European Conference on Information Systems (ECIS), St. Gallen, Switzerland, 7–9 June 2007.
56. Luh, D.-B.; Li, E.C.; Gao, Y.-R. The study on companionship scale of electronic pet. In Proceedings of the 2010 IEEE 11th International Conference on Computer-Aided Industrial Design & Conceptual Design 1, Yiwu, China, 17–19 November 2010; pp. 533–538.
57. Hawthorne, G. Measuring social isolation in older adults: Development and initial validation of the friendship scale. *Soc. Indic. Res.* **2006**, *77*, 521–548. [CrossRef]
58. Ryff, C.D. Psychological well-being in adult life. *Curr. Dir. Psychol. Sci.* **1995**, *4*, 99–104. [CrossRef]
59. Cesari, M.; Araujo de Carvalho, I.; Amuthavalli Thiyagarajan, J.; Cooper, C.; Martin, F.C.; Reginster, J.-Y.; Vellas, B.; Beard, J.R. Evidence for the domains supporting the construct of intrinsic capacity. *J. Gerontol. Ser. A* **2018**, *73*, 1653–1660. [CrossRef]

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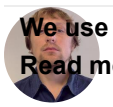

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Website (http://www.ifkp.tu-berlin.de/menue/arbeitsgruppen/ag_reitzenstein/)

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Institut für Festkörperphysik, Technische Universität Berlin, Hardenbergstr. 36, D-10623 Berlin, Germany

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Department of Engineering, University of Ferrara, 44121 Ferrara, Italy

Interests: solid and structural mechanics; contact problems; shape memory alloys; elasticity

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Website (http://tareksobh.org/) **SciProfiles (https://sciprofiles.com/profile/596141)**

Editorial Board Member

Electrical and Computer Engineering, Lawrence Technological University, Southfield, MI, USA

Interests: robotics; automation; sensing; computer vision; mobile robotic manipulation; AI; evolutionary robotics; advanced manufacturing and control theory

Dr. Dongran Song

Website (https://www.researchgate.net/profile/Song_Dongran3) **SciProfiles (https://sciprofiles.com/profile/253746)**

Editorial Board Member

The School of Automation, Central South University, Changsha 410083, China

Interests: renewable energy power-generation technologies; microgrid system modeling, optimization and control; economic analysis and optimization of energy/electrical systems

Special Issues, Collections and Topics in MDPI journals

Dr. Fabrizio Stasolla

Website (https://scholar.google.com.hk/citations?user=PezuVMAAAAAJ&hl=en&oi=sra)
SciProfiles (https://sciprofiles.com/profile/2290855)

Editorial Board Member

Developmental Psychology, "Giustino Fortunato" University of Benevento, 82100 Benevento, Italy

Interests: autism spectrum disorders; Cerebral Palsy; Rare genetic syndromes (e.g. Angelman, Rett, Cornelia de Lange, fragile X); cognitive-behavioral interventions; Post-coma; Alzeimer; Parkinson; sclerosis neurodegenerative diseases; single-subject experimental designs

Dr. Ulas Sunar

Website (http://www.wright.edu/academics/bmgt) **SciProfiles (https://sciprofiles.com/profile/195407)**

Editorial Board Member

Department of Biomedical Engineering, Wright State University, 207 Russ Engineering Center, 3640 Colonel Glenn Hwy., Dayton, OH 45435, USA

Interests: diffuse optical imaging; biomedical optics; fluorescence imaging; photoacoustic imaging; imaging-guided

intervention; optical imaging biomarkers; light therapy; photodynamic therapy; therapy response monitoring; optical blood flow and oxygenation

Special Issues, Collections and Topics in MDPI journals

Dr. Francesco Tornabene

★ **(https://recognition.webofscience.com/awards/highly-cited/2020/)** **Website (https://www.unisalento.it/scheda-utente/-/people/francesco.tornabene)** **SciProfiles (https://sciprofiles.com/profile/593361)**

Editorial Board Member

Department of Innovation Engineering, University of Salento, 73100 Lecce, Italy

Interests: theory of shells, plates, arches, and beams; generalized differential quadrature; FEM; SFEM; WFEM; IGA; SFIGA; WFIGA; advanced composite materials; functionally graded materials; nanomaterials and nanotechnology

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Dr. Alexander Tsouknidas

Website (https://mech.uowm.gr/en/alexander-tsouknidas/) **SciProfiles (https://sciprofiles.com/profile/1506770)**

Editorial Board Member

Laboratory for Biomaterials and Computational Mechanics, Department of Mechanical Engineering, University of Western Macedonia, 50100 Kozani, Greece

Interests: materials; finite element modeling

Special Issues, Collections and Topics in MDPI journals

Prof. Dr. Paolo Veronesi

Website (http://www.ing.unimore.it) **SciProfiles (https://sciprofiles.com/profile/328425)**

Editorial Board Member

DIMANT (Design of Innovative Materials for New Technologies), Department of Engineering "Enzo Ferrari", Via Vivarelli 10, 41125 Modena, Italy

Interests: microwave processing of materials; microwave applicator design; powder metallurgy; numerical simulation of electroheat processes; high entropy alloys; nonferrous alloys; heat treatment of metals

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Prof. Dr. Lipo Wang

Website (https://personal.ntu.edu.sg/elpwang/) **SciProfiles (https://sciprofiles.com/profile/506796)**

Editorial Board Member

School of Electrical and Electronic Engineering Nanyang Technological University Block S1, Nanyang Avenue, Singapore 639798, Singapore

Interests: machine learning; data mining; optimization; computational intelligence

Special Issues, Collections and Topics in MDPI journals

Dr. Gustavo Fimbres Weihs

Website (https://www.sydney.edu.au/engineering/about/our-people/academic-staff/gustavo-fimbresweihs.html)

SciProfiles (https://sciprofiles.com/profile/97279)

Editorial Board Member

School of Chemical and Biomolecular Engineering, The University of Sydney, Sydney, NSW 2006, Australia

Interests: desalination; membrane technology; CFD

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Prof. Dr. Pietro Zanuttigh

Website (http://lttm.dei.unipd.it/nuovo/staff/zanuttigh.htm) SciProfiles (https://sciprofiles.com/profile/1391117)

Editorial Board Member

Multimedia Technology and Telecommunications Lab, University of Padova, 35131 Padova PD, Italy

Interests: computer vision; image processing; hand gesture recognition; segmentation and semantic labeling of images and 3D data; 3D data acquisition with multiple sensors; coding of depth maps and multi-view representations

Special Issues, Collections and Topics in MDPI journals

Prof. Dr. Yinghui Zhang

Website (http://gr.xupt.edu.cn/info/1101/3874.htm) SciProfiles (https://sciprofiles.com/profile/451665)

Editorial Board Member

School of Cyberspace Security, Xi'an University of Posts and Telecommunications, Xi'an 710121, China

Interests: public key cryptography; cloud security and wireless network security

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Prof. Dr. Luis Fernando Alarcón

Website (https://www.ing.uc.cl/academicos-e-investigadores/luis-fernando-alarcon-cardenas/)

SciProfiles (https://sciprofiles.com/profile/1079147)

Section Board Member

Escuela de Ingeniería, Universidad Católica de Chile, Casilla 306, Correo 22, Santiago, Chile

Interests: ingeniería civil; construction management

Dr. Carmelo J. A. Bastos-Filho

Website (https://scholar.google.com.br/citations?hl=en&user=t3A96agAAAAJ&view_op=list_works&sortby=pubdate)

SciProfiles (https://sciprofiles.com/profile/1973980)

Section Board Member

Polytechnic School of Engineering, University of Pernambuco, Recife, PE, Brazil

Interests: telecommunications; computational intelligence; Industry 4.0; robotics; applications of artificial intelligence

Dr. Abdellah Chehri

Website (http://www.uqac.ca/portfolio/abdellahchehri/) SciProfiles (https://sciprofiles.com/profile/802126)

Section Board Member

Département des Sciences Appliquées, Université de Québec à Chicoutimi, 555, boul. de l'Université, Chicoutimi, QC G7H 2B1, Canada

Interests: big data; smart and sustainable cities; urban innovation system; urban knowledge and innovation spaces;

knowledge-based development

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Prof. Dr. Ronald A. Coutu, Jr.

Website (https://www.marquette.edu/electrical-computer-engineering/directory/ronald-coutu.php)

SciProfiles (https://sciprofiles.com/profile/80554)

Section Board Member

Department of Electrical and Computer Engineering, Marquette University, Milwaukee, WI 53233, USA

Interests: microelectromechanical systems (MEMS); smart sensors; device fabrication; micro-electrical contacts; phase change materials; energy harvesting; renewable energy; micro-grids; energy storage

Special Issues, Collections and Topics in MDPI journals

Dr. Luc de Witte

Website (http://www.catch.org.uk/team-member/prof-luc-de-witte/)

SciProfiles (https://sciprofiles.com/profile/2250465)

Section Board Member

Hague University of Applied Sciences, 2501 The Hague, The Netherlands

Interests: assistive technology service delivery; care robotics; digital healthcare solutions, technologies applied to global health challenges

Prof. Dr. George F. Fragulis

Website (https://ece.uowm.gr/personnel.php?teachers_info=82) **SciProfiles (https://sciprofiles.com/profile/1847479)**

Section Board Member

Laboratory of Robotics, Embedded and Integrated Systems, Department of Electrical and Computer Engineering, University of Western Macedonia, 50100 Kozani, Greece

Interests: machine learning; control systems; robotics; fuzzy systems

Dr. Haijun Gong

Website (https://cec.georgiasouthern.edu/manufacturing-engineering/faculty/faculty-staff-directory/haijun-gong/)

Section Board Member

Department of Manufacturing Engineering, Georgia Southern University, Statesboro, GA 30458, USA

Interests: additive manufacturing; 3D printing

Prof. Dr. Zhixing Guo

Website (https://msec.scu.edu.cn/info/1028/2710.htm) **SciProfiles (https://sciprofiles.com/profile/2810648)**

Section Board Member

School of Mechanical Engineering, Sichuan University, Chengdu 610065, China

Interests: ceramics-metal materials; refractory metals and hard materials; WC-Co cemented carbide; Ti(C,N)-based cermet; ceramics; FGM; cutting tool; powder metallurgy; coating

Dr. Mauro Iacono

Website (http://www.mauroiacono.com/) **SciProfiles (https://sciprofiles.com/profile/581210)**

Section Board Member

Dipartimento di Elettronica, Informazione e Bioingegneria, Politecnico di Milano, 20133 Milano, Italy

Interests: computer systems modeling

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Dr. Navid Kashaninejad

Website1 (https://www.researchgate.net/profile/Navid_Kashaninejad) **Website2 (http://www.kashaninejad.com)**
SciProfiles (https://sciprofiles.com/profile/282959)

Section Board Member

Queensland Micro- and Nanotechnology Centre, Griffith University, 4111 Brisbane, Australia

Interests: microfluidics; biomicrofluidics; lab-on-a-chip; tumour-on-a-chip

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Prof. Dr. Valeri Mladenov

Website (http://dept-te.tu-sofia.bg/vmladenov_eng.htm) **SciProfiles (https://sciprofiles.com/profile/13419)**

Section Board Member

Department Fundamentals of Electrical Engineering, Technical University of Sofia, Kliment Ohridski St. 8, 1000 Sofia, Bulgaria

Interests: electrical engineering, electronics; artificial intelligence; neural networks; power systems; applied mathematics; signal processing

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Dr. Sharon Nai

Website (https://www.a-star.edu.sg/simtech/Research/Researcher-Portfolio/tid/133/Nai-Mui-Ling-Sharon)
SciProfiles (https://sciprofiles.com/profile/1690542)

Section Board Member

Singapore Institute of Manufacturing Technology (SIMTech), 73 Nanyang Drive, Singapore 637662, Singapore

Interests: metallic powder development; identification; powder metallurgy; sintering; composites

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Dr. James Navalta

Website (https://www.unlv.edu/people/james-navalta) **SciProfiles (https://sciprofiles.com/profile/495664)**

Section Board Member

Department of Kinesiology and Nutrition Sciences, University of Nevada, Las Vegas, NV, USA

Interests: wearable technology/fitness tracker validation; exercise in an outdoor environment; exercise immunology

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Dr. Petra Paiè

Website (https://www.fisicamedica.it/dr-ssa-petra-paie/) **SciProfiles (https://sciprofiles.com/profile/506705)**

Section Board Member

Istituto di Fotonica e Nanotecnologie (IFN)-CNR, Piazza Leonardo da Vinci 32, 20133 Milano, Italy

Interests: femtosecond laser micromachining; photonics; microfluidics; biophotonics; lab on a chip

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Prof. Dr. Rodrigo Picos

Website (https://www.uib.eu/personal/ABTE3MTk1/) **SciProfiles (https://sciprofiles.com/profile/1214096)**

Section Board Member

1. Industrial Engineering and Construction Department, University of Balearic Islands, 07122 Palma, Majorca, Spain
2. Balearic Islands Health Institute (Idisba), 07021 Palma, Majorca, Spain

Interests: device modelling; memristors; nonlinear electron device

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Dr. Jacquie Ripat

Website (http://umanitoba.ca/rehabsciences/ripat.html) **SciProfiles (https://sciprofiles.com/profile/2316806)**

Section Board Member

Department of Occupational Therapy, Associate Dean Research, College of Rehabilitation Sciences, University of Manitoba, R215-771 McDermot Avenue, Winnipeg, Manitoba R3E 0T6, Canada

Interests: assistive technology; environmental adaptation; community participation; disability; rehabilitation; qualitative research methods; person-centred practice

Prof. Dr. Nelson P. Rocha

Website (https://www.ua.pt/en/p/10308248) **SciProfiles (https://sciprofiles.com/profile/283544)**

Section Board Member

Institute of Electronics and Informatics Engineering (IEETA), Department of Medical Sciences of the University of Aveiro, Aveiro, 3810-193, Portugal

Interests: active aging; functioning; cognitive training; usability; ambient assisted living; eHealth

Prof. Dr. R. Simon Sherratt

Website (http://www.reading.ac.uk/biologicalsciences/sherratt) **SciProfiles (https://sciprofiles.com/profile/414683)**

Section Board Member

Department of Biomedical Engineering, University of Reading, Reading RG6 6AY, UK

Interests: wearable healthcare sensors; biosensors; fall detection; Parkinson's disease

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Dr. Yury A. Skorik

Website1 (http://macro.ru/laboratorii/lab5/) **Website2 (http://www.almazovcentre.ru/?page_id=38122)**
SciProfiles (https://sciprofiles.com/profile/332307)

Section Board Member

1. Head of the Laboratory of Natural Polymers, Institute of Macromolecular Compounds of the Russian Academy of Sciences, St. Petersburg, Russia;
2. Head of the Analytical Chemistry Department, Almazov National Medical Research Centre, St. Petersburg, Russia

Interests: polysaccharides; biomaterials; tissue engineering; drug delivery; gene delivery; nanomedicine; nanocomposites; electrospinning

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Dr. Alexey Tarasov
Website (http://nmse-lab.ru/index.php/en/) SciProfiles (https://sciprofiles.com/profile/1027429)
Section Board Member
Laboratory of New Materials for Solar Energetics, Faculty of Materials Science, Lomonosov Moscow State University, 119992 Moscow, Russia
Interests: solar energetics; perovskite solar cells; nanomaterials; PVD; solid state chemistry; thin films

Prof. Dr. Vijayakumar Varadarajan
Website (http://www.cse.unsw.edu.au/~vijayakumar/) SciProfiles (https://sciprofiles.com/profile/1228136)
Section Board Member
School of Computer Science and Engineering, The University of New South Wales, Sydney, NSW 2052, Australia
Interests: detection system; network security; intrusion detection system; machine learning
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Dr. Mikhail Vasiliev
Website (https://scholar.google.com/citations?user=BjSAfi4AAAAJ&hl=en)
SciProfiles (https://sciprofiles.com/profile/112541)
Section Board Member
Electron Science Research Institute, School of Science, Edith Cowan University, 270 Joondalup Drive, Joondalup, WA 6027, Australia
Interests: materials engineering; optical physics; solar energy; thin-film coatings; luminescent materials; building integrated photovoltaics; glazing system design; energy efficiency in buildings
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Prof. Dr. Bang Wang
Website (http://ei.hust.edu.cn/teacher/wangbang/index.htm) SciProfiles (https://sciprofiles.com/profile/102804)
Section Board Member
School of Electronic Information and Communications, Huazhong University of Science and Technology (HUST), Wuhan 430074, China
Interests: indoor localization and tracking; Wi-Fi fingerprinting; machine learning; Internet of Things
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Prof. Dr. Jung-heum Yeon
Website (https://sites.google.com/site/jungheumyeon83/people/professor)
SciProfiles (https://sciprofiles.com/profile/2062482)
Section Board Member
Ingram School of Engineering, Texas State University, San Marcos, TX 78666, USA
Interests: structural engineering; multifunctional infrastructure materials; structural health monitoring; automated construction technologies; low environmental impact cement-based materials; pavement engineering

Prof. Dr. Shinobu Yusa
Website (http://www.eng.u-hyogo.ac.jp/msc/yusa/index.html) SciProfiles (https://sciprofiles.com/profile/6791)
Section Board Member

Department of Materials Science and Chemistry, University of Hyogo, Shosha 2167, Himeji, Hyogo, Japan
Interests: controlled/living radical polymerization; RAFT; TERP; water-soluble polymer; self-organization; polymer micelle; bioconjugate polymer

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