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Chapter

Smart Healthy Age-Friendly Environments (SHAFE) Bridging Innovation to Health Promotion and Health Service Provision

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Abstract

A number of experiences have demonstrated how digital solutions are effective in improving quality of life (QoL) and health outcomes for older adults. Smart Health Age-Friendly Environments (SHAFE) is a new concept introduced in Europe since 2017 that combines the concept of Age-Friendly Environments with Information Technologies, supported by health and community care to improve the health and disease management of older adults and during the life-course. This chapter aims to provide an initial overview of the experiences available not only in Europe, based on the research work of the participants of the International Interdisciplinary Network on Health and Well-being in an Age-Friendly Digital World (NET4Age-Friendly), which could be of interest to preventive, health and social authorities. The chapter reports good practices, pain points, and bottlenecks that may require a collaborative, interdisciplinary research approach to facilitate the transformations towards smart, sustainable, health and age-friendly cities and communities.

Keywords: age-friendly cities and communities, digital integrated care, integrated health services, people-centred health services, smart built environments

1. Introduction

A growing body of discourse and narrative surrounds the age-friendly cities and communities (AFCC) domain. Before 2019, discourse was primarily situated

around the World Health Organization's (WHO) age-friendly city model [1], with little acknowledgement from organisations and scholars alike pertaining to technology. Marston and van Hoof [2] proposed an extended version of the current WHO framework [1] in conjunction with coining the term *"Smart Age-friendly Ecosystem"* (SAfE) (**Figure 1**). The purpose of the SAfE framework is to show the interconnected relationships within the existing WHO framework and the role that technology and the physical space interplay.

Conversely, the *"Concept of Age-friendly Smart Ecologies"* (CASE) (**Figure 2**) framework takes an ecology standpoint while considering various contemporary scenarios across the life course (e.g., intergenerational living, a young family with a disabled child, an older adult who is ageing without children, etc.) and the larger ecosystem of the physical space [3]. Several recommendations are proposed to move this discourse forward, including the use and implementation of the *"Age-friendly Cities and Communities Questionnaire"* (AFCCQ) [4], across different sittings (e.g., urban, city, or rural) and countries, aiming to assess the impact of AFCC on the older adults.

More recently, a succinct overview of various AFCC frameworks has been presented by van Hoof and colleagues [5], suggesting addressing the need for co-creation programmes, initiatives targeting different groups of people to facilitate transparency and explore retrofitting of homes and affordable technologies to be installed into homes, while activities to facilitate intergenerational living are discussed, especially taking a life-course perspective. Moreover, the final recommendation purports to

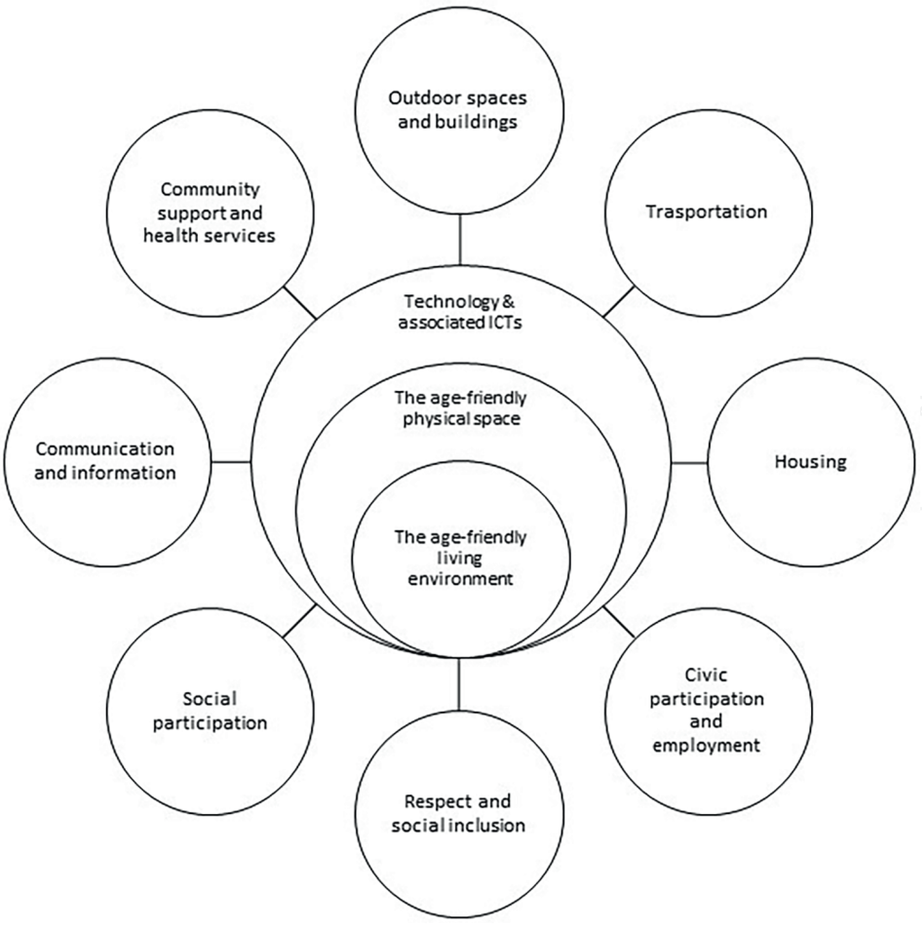

Figure 1.
Smart Age-friendly Ecosystem (SAfE) Framework. Source: own elaboration based on Marston and van Hoof [2].

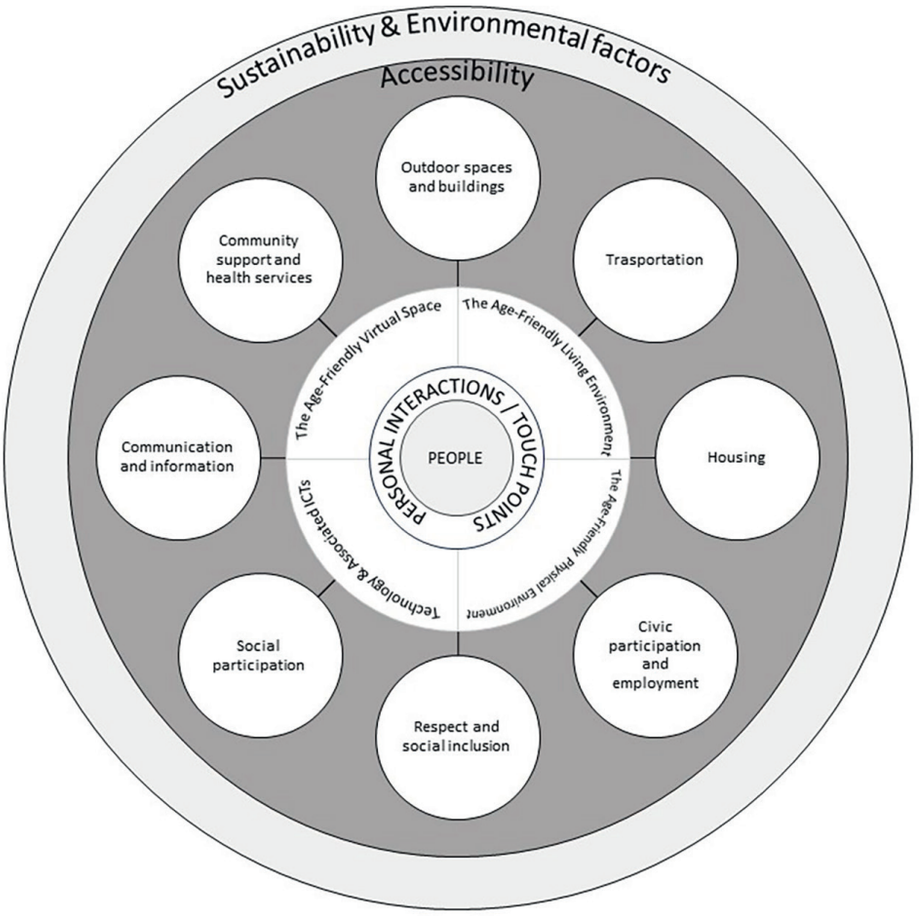

Figure 2.
Concept of Age-friendly Smart Ecologies (CASE) Framework. Source: own elaboration based on Marston et al. [3].

renew standards and classifications of AFCCs to meet twenty-first-century expectations and challenges, ensuring agile approaches can be applied in conjunction with applied needs and considerations [5]. More recently, Marston et al. [6] explored and discussed the current situation of AFCC, culminating in existing evidence and the recent publication of the Dementia Framework by the WHO [7], questioning why it still does not acknowledge technology even though there is a wealth of research surrounding technology use in this domain.

Furthermore, Marston and colleagues [6] coin several new terms, one being "Transgenerational Living Communities and Cities" (TLCC), positing how all generations situated within a community experience and feel part of the inclusive and autonomous ecosystem(s). Such a new term takes forward a viewpoint for the future of our societal ecosystems and builds on the past and present to enhance and move forward in the next 20–50 years.

Smart Health Age-Friendly Environments (SHAFE) is a concept introduced in Europe in 2017, by Dantas and van Staalduinen, through one of the Thematic Networks of the European Union (EU) Health Policy Platform, approved by the European Commission [8]. SHAFE was inspired and bred out of one of the six groups of the European Innovation Partnership on Active and Healthy Ageing (EIP on AHA), group D4 "Age-friendly buildings, cities, and environments" [9]. SHAFE combines the concept of Age-Friendly Environments with innovative technologies, highlighting the importance of connecting them to People and Places to improve health and well-being.

The SHAFE thematic network brought together multidisciplinary stakeholders with the aim of drawing the attention of policymakers, organisations, and citizens to the need for better alignment between health, social care, built environments, and Information Technologies (IT), both in terms of policy and funding [10]. In 2018, the SHAFE network launched a Framing Paper [11] and a Joint Statement [12] in which special emphasis is given to prevention, smart homes for people suffering from chronic diseases and disabilities, and support tools, including robotics, smart living environments, and smart communication, to improve formal and informal care, and increase the well-being and active participation of older people [13]. In 2020, an international multidisciplinary network of scientists, researchers, and entrepreneurs was established under the European Commission's Cooperation in Science and Technology (COST) programme to promote knowledge, improve holistic strategies, and support the development of user-based solutions (users, caregivers, and authorities) for the realisation of SHAFE [14]. Since 2022, the SHAFE Foundation [15] has been launched to sustain the future of the SHAFE network and further explore the results achieved so far.

Another result of the EIP on AHA and in close cooperation with the WHO, the "Covenant on Demographic Change: towards an Age-Friendly Europe" was launched in 2015 [10]. At the end of the two-year EU-funded project AFEINNOVNET in 2016, the Covenant was officially established as an international not-for-profit association under Belgian law. The European Covenant on Demographic Change (Covenant) aims at gathering local, regional, and national authorities and other stakeholders, which commit to cooperate and implement evidence-based solutions to support active and healthy ageing, aligned with existing initiatives such as the WHO Global Network for Age-Friendly Cities and Communities (GNAFCC), the WHO-European Healthy Cities Network, and the Dublin Declaration on Age-Friendly Cities and Communities. Starting with 68 Founding members, the Covenant reached 159 members, including 46 Full members, 88 Ordinary members, and 25 Associate members, with 24 countries represented in the network (21 from the European Union Member States, plus the United Kingdom, Serbia, and Israel).

The EIP on AHA Reference Site Collaborative Network (RSCN) [16] and another one of the six groups of the European Innovation Partnership on Active and Healthy Ageing (EIP on AHA), group A3, on Lifespan Health Promotion & Prevention of age-related frailty and disease, drove forward the evolution of a life-course approach to active and healthy ageing, strengthen the SHAFE approach. The RSCN, Programma Mattone Internazionale Salute (ProMIS) [17] and SHAFE networks, and the VIGOUR project [18] have been collaborating to identify pain points and bottlenecks that may require a collaborative, interdisciplinary research approach to facilitate the transformations towards smart, sustainable, health and age-friendly cities and communities. Their efforts are in line with the four interrelated themes recently set out by the WHO Council [19], to reorient economies to deliver health for all across:

- Value—valuing and measuring what matters through new economic metrics;
- Finance—how to finance health for all as a long-term investment, not a short-term cost;
- Innovation—how to advance health innovation for the common good;
- Capacity—how to strengthen dynamic public sector capacity to achieve health for all.

The present report provides several examples of experiences of innovative approaches for care and cure services that may facilitate the implementation of integrated care, at the same time highlighting challenges and enablers that worked on the ground and may be helpful to others.

2. Experiences with innovative approaches to health

2.1 Environmental determinants of longevity

The multiplicity and interdependencies of the hallmarks of ageing [20, 21] reflect the variety of their contribution underpinning the disparity between biological and chronological age. Indeed, ageing is a complex process to be considered as a whole, where regulatory patterns only in minor part rely upon genetic factors and can be largely influenced during the entire life-course by the adoption of healthy lifestyles, especially in terms of nutrition [22] and physical activity [23]. This concept has been stimulating the development of integrated and innovative approaches where "precision ageing" is enabled by an individual signature elaborated through the convergence of the different risk factors towards a scorecard, driving subsequent multidomain interventions [24].

Demographic research has identified the regions of the world with the highest concentration of centenarian people to understand the environmental factors and lifestyles that make the population live longer [25]. Ongoing research into the lifestyle and environment of the longest-lived people in the world has led to the identification of nine specific lifestyle habits that determine longevity [26]. In Europe, the blue zones are not surprisingly located on two islands in the Mediterranean Sea, where climatic conditions, nutrition, and lifestyles far from city life have favoured longevity in local populations [25]. This innovative, systematic, and environmental approach to well-being seeks to optimise politics, urban design, and social networks. The common denominators of long-lived communities have been experimentally transferred to communities across the United States by working with policymakers, local businesses, schools, and individuals to shape Blue Zone community environments.

2.2 The development of "age-appropriate" living environments

In recent years, there has been an evident increase in the number of older people, particularly in urban areas, alongside changing lifestyles. This emphasises the growing importance for older people to be able to continue living in their community. In particular, the population aged 60 and older is growing faster than all younger age groups [27, 28]. "Ageing in place" is defined as "the ability to live in one's own home and community safely, independently, and comfortably, regardless of age, income, or ability level" [29]. This *ageing in place* leads to both concern and a need for current and future older people to be involved in the planning and development processes of their living environments [30, 31]. This is because it has been shown that there is a clear link between the place and environment of older people and their quality of life and well-being [32]. On the other hand, studies show that age-related planning of neighbourhoods, living environments or spaces, in general, is often shaped by stereotypes. In this context, Peterson and Warburton already argued in 2012 [33] that "business interests sustain stereotypes of older people as either ageless or dependent" and that "spaces designed for older people reinforce historical legacies of separation

from the community". As a result, the needs of present and future older people are not, or at least not sufficiently, considered. Fabian et al.'s study [34], based on Lefebvre's "The Production of Space" theory [35], explored how age-friendly living environments are conceived, practised, and lived in and to what extent age-related stereotypes influence these processes. With two case studies (development of a public park for the promotion of intergenerational physical activity/development of a new city square) in different neighbourhoods in Basel (Switzerland), the investigation aimed to explore whether such stereotypes are present and if so, among which stakeholders and what impact they have on the planning processes and outcomes. For both cases, interviews and walk-throughs were conducted with experts from different planning disciplines and with current and future older people. The results show that the ideas of age and older people often remain diffuse in planning practice. At the same time, older people are often seen as a homogeneous and fragile group. The results show that the importance attached to neighbourhoods in old age can vary greatly. For spatial, but also for all other planning projects that are made for older people, it should be the case that the affected older people are made participants to better meet their needs.

2.3 Examples of socio-technological solutions in central and Eastern Europe for smart, age-friendly cities and communities

In 2016, Klimczuk and Tomczyk [36] conducted a study that focused on integrating the concept of smart cities with the idea of age-friendly cities and communities. The study proved that these concepts are intertwined in both theory and practice regarding the promotion of healthy and active ageing, universal design, usability, and accessibility of age-friendly environments, diminishing the digital divide and robotic divide, as well as lowering older adults' social isolation. The study investigated relations between the selected smart and age-friendly cities and communities, the Active Ageing Index of 2012 and 2014 [37, 38], and a well-known typology of European welfare systems by Esping-Andersen [39], expanded by Kazepov [40]. The study findings demonstrated that integrating practical smart city concepts and age-friendly solutions is necessary to address demographic changes and overcome infrastructure gaps and institutional barriers in Central and Eastern Europe (CEE). The comparative analysis was based on the data of the ranking of medium-sized smart cities in the European Union (EU) created in 2007, 2013, and 2014, developed by the Vienna University of Technology [41, 42]. Among the 77 European medium-sized cities with a population between 100,000 and 500,000 inhabitants, none of the cities included in the top 10 positions were based in the CEE countries. Moreover, the findings proved that the ranking of medium-sized smart cities is well correlated with the Active Ageing Index (AAI). Nearly all the smart cities with the highest scores are located in the Nordic countries. The positive correlation between AAI and gross domestic product per capita suggests that countries with relatively higher living standards have a better ability to create environments for active ageing. Finally, the comparison between the ranking of medium-sized smart cities, AAI, and welfare regimes by Esping-Andersen [39] and Kazepov [40] shows that welfare systems in transition countries, such as the CEE countries, need in-depth reforms to create integrated public services, and at the same time, such changes are taken in the context of financial constraints and with ambivalent consequences. Some of the CEE countries focus on privatisation, while others invest in coordinated market and social policies. In addition, in recent years, these countries have faced significant reforms of

their territorial organisation oriented towards moving away from central regulation towards more decentralised levels. In addition, Klimczuk and Tomczyk [36] have been searching for good practices of technological solutions already implemented at the local level in the CEE countries, such as gerontechnologies and social innovations. The good practices of outdoor spaces, buildings, and housing covered examples of the development of spaces that allow the promotion of physical activity and the adaptation of buildings and housing to meet the needs of older adults, such as the removal of existing obstacles. Some examples of multifunctional buildings have also been noticed, combining spaces for professional rehabilitation, public places for feasts, and kindergartens. Also, examples of the development of smart transportation systems, smart heating networks, remote lighting management systems, and smart traffic control were documented. In the fields of social participation, good practices related to smart solutions to selecting projects for older adults under separate municipal budgets dedicated to non-governmental organisations and the establishment of "senior councils," which are designed to act as consultants and advisory bodies. In the field of public transport, good practices focus on improving communication with older users and making changes in public spaces to favour accessibility to services. One of the most popular solutions in the CEE countries is city cards, which offer older adults discounts for public cultural, sports, and recreation institutions and for private companies that have joined the programme. Such cards are also integrated into the public transportation cards, enabling a surcharge and can act as authorisation for special ticket for multiple trips across all bus lines in the city. In the field of communication and information, the good practices identified e-government systems that enable older adults to receive notifications on their mobile phones about important events, including cultural and sporting events about obstacles on the road, or the status of the resolution of administrative cases. Another example of good practice is an open platform that improves the accessibility of municipal services, with information on public transport, traffic, waste collection, properties available for non-profit organisations, tourist accommodation facilities, cultural events and the system of fault reporting. Innovations for social inclusion concern the activation of older adults in clubs specifically for older people and Universities of the Third Age (U3A). There are also time banks for older adults, which create a group of people who want to provide and exchange services with each other.

2.4 Virtual coaches for older adults' well-being

Lifestyles represent the first level of intervention to allow older people to live healthier for longer. Personalised virtual coaching solutions can enable patients to prevent and avoid a sedentary lifestyle and receive useful and comprehensive long-term coaching. Virtual coaching allows patients to receive advice on nutrition and other lifestyle habits (such as smoking, drinking, drug abuse and others), in line with personal preferences [43]. Virtual coaches are promising tools to deploy automated or semi-automated large-scale interventions to promote healthy lifestyles and support rehabilitation and training in older age, requiring less trained personnel, thus potentially decreasing the cost [44]. Thanks to the continuous monitoring of users' behaviour and well-being status, virtual coaches are able to provide personalised advice through user-friendly interfaces.

Healthy nutritional virtual coaching monitors the user's adherence to nutritional prescriptions and the goals to be achieved. By monitoring the user's meal intake, body weight and weight changes, as well as any concomitant pathologies that the user may

have, these systems allow the creation of personalised nutritional plans, which take into account the user's preferences [45].

Virtual coaching for physical activity is connected to validated devices through which the user records their data (SmartWatch, FitBit, etc.) and receives alerts in case of poor daily activity or excessive sedentary lifestyle [46].

Virtual coaching also helps users manage mental health problems by suggesting behavioural changes and strategies to improve sleep. Virtual coaching is used to improve stress management through meditation, breathing exercises, relaxation and conscious movement [47–50].

The Novel Empowering Solutions and Technologies for Older People to Retain Everyday life activities (NESTORE) is a project funded under the European Union Horizon 2020 Programme (Grant agreement ID: 769643) aimed to design and develop a coaching system to promote well-being among older adults, supported by Internet of Things (IoT) technologies to deal simultaneously with different lifestyles domains, such as physical activity, nutrition, social activity, and cognitive function [51, 52].

NESTORE experts designed a multidomain pathway towards well-being where the e-coach accompanies users in the four domains [53]. This approach implies important behavioural challenges since the user should be engaged in several different activities suggested by the coach and technological challenges. The Health Action Process Approach behaviour change model has been implemented to keep the user motivated, even in cases of difficulties that may hinder the completion of suggested activities [53].

The virtual coach provides personalised tasks that could be carried out to maintain or improve the well-being in the different domains. The NESTORE platform has been co-designed with older adults from four European countries [54]. Also, this process allowed the research team to identify the need to integrate the suggested coaching activities into the existing daily routines. To this purpose, in the NESTORE project, domain experts acknowledged, for example, the possibility of training in the physical activity domain by simply walking faster or walking with shopping bags or training in the cognitive domain by learning something new. From a technical challenge perspective, tracking several domains simultaneously would imply increasing the complexity of the system and the amount of information provided (or requested by the user) through the system interfaces. Conversational agents, possibly embodied in physical devices, may increase the easiness and trust of the system [55]. A lesson learned from the NESTORE project was to introduce part of the system one domain at a time, avoiding overwhelming the user with a plethora of sensors and interfaces and introducing new features and new domains only once the user is acquainted with the rest of the system [55].

3. Emerging obstacles to the adoption of new services

3.1 Customisation tailored to local specificities: the example of mHealth hub

The adoption of innovative approaches to health and care varies across countries [56]. In particular, there is a need for effective business models for the implementation of digital solutions at scale [57]. A single implementation strategy or generic business model for scaling up innovation on a pan-European level will most likely not be successful without adapting technology and services or differentiating business models according to different health and social care systems [58].

The European Innovation and Knowledge mobile Health Hub (mHealth Hub) is a project created by the International Telecommunication Union (ITU), in collaboration with the WHO and the Regional Ministry of Health of Andalusia (Spain), supported by a consortium of 17 public and private partners from 12 European countries, to support the integration of mobile Health (mHealth) programmes and services in the national health systems of European countries [59]. Among the project activities, mHealth Hub produced a knowledge tool (KT2) to identify, collect and organise available knowledge for the iterative development of national or large-scale programmes for the patient empowerment and self-management of type 2 diabetes mellitus (T2DM), supported by mHealth solutions, using a person-centred approach.

An interview with policymakers was conducted to capture the countries' objectives in relation to their mHealth agenda and implementation framework focused on T2DM. Four dimensions were followed: Epidemiology; Risk profile and health promotion; Diagnostic-therapeutic pathways; and Technology readiness. To identify key digital solutions and user scenarios, the Personas approach [60, 61] was adopted to represent the unmet needs of an individual with a T2DM profile in collaboration with country stakeholders. The needs of the identified Persona were declined according to the WHO's framework for self-care interventions [62], noting these functions according to disease codes (ICF codes) for unambiguous identification according to the hierarchical structure of the ICF. An algorithm will provide a relational correspondence between identified needs and available solutions. The proposed approach is iterative and supports a model in which the logical structure leads to a gradual/progressive refinement of possible connections, linking actions, prevention, interventions, and solution models with the particular needs of the personas.

3.2 Knowledge representation in the SHAFE domain

Representing knowledge is one of the most important tasks in the information age. The exponential growth of informative content in several contexts (e.g., Internet, enterprise intranet, mobile devices, and so on) requires intelligent information systems that are able to use data to create information [63]. In complex domains, the use of an ontology learning process [64] is a mandatory task also for lack of formalisation. The definition of such a model would be a valid contribution to solving some issues related to the identification of different dimensions of topic knowledge mosaics and to defining their meanings in a common and shared way. The glossary is used as a starting point for the representation of knowledge with a general ontology model based on linguistic features [65]. The development of an ontology-based model for knowledge representation, one that features universal terminology and basic criteria for information exchange, will allow the comparison of experiences in both cultural and operational contexts.

The NET4Age-Friendly COST Action developed the SHAFE core ontology starting from a conceptual map defined by the previous tasks of the COST Action project. Different domain terms/concepts have been extracted using this conceptual map, and they will be the core concepts of the proposed ontology. The analysed conceptual map is composed of different general concepts, and some of them are specialised and/or related to other concepts. The conceptual map covers all classes related to the main domains of the NET4Age-Friendly COST action. Following the requirements of the COST Action researchers, a first acquisition has been made by the conceptual

map, and a first list of core terms has been extracted from it. These terms have been arranged in a glossary, giving a formal definition to each of them. These definitions have been extracted from WordNet [66], a well-known information source in the knowledge engineering research community. The process of decoding SHAFE knowledge objects demonstrates the need for a new methodology for reading the SHAFE/NET4Age-Friendly domain that takes into account its conceptual evolution and the multi-disciplinarity of this subject. The importance of representing SHAFE with new languages related to this novel cultural approach is thus evident. These languages should allow the user to transmit the complexity of involved concepts and their meanings in the SHAFE context. The ontological conceptual representation [67] has been implemented as a logical knowledge graph [68] using a physical multimodel NoSQL DBMS [69]. The obtained knowledge graph has been exported to OWL following the proposed model. Moreover, the knowledge graph has been drawn using a 3D graph visualisation tool [70] (i.e., Graphia) presented in **Figure 3**.

The iCarer project, which was developed to assist informal carers with the activities of daily care for older adults, proposed a new way of developing an ontology to reflect older adults' care aspects, including agencies and professionals involved, within a real-time home monitoring system so that it captures real-life circumstances and interactions. The methodology incorporates iterative and evaluative stages to ensure the ontology captures implementable interactions and concepts [71]. Ambient Assisted Living (AAL) systems provide IT solutions to enable older people to continue living independently. The European Commission's AAL programme offers a taxonomy within which such systems can be classified in a top-down manner. A categorisation of the systems as a whole has not yet taken place, but this has made it possible to assess their technical parts [72].

OPTImAL is a reusable formal model of factors affecting cardiovascular disease (CVD) patient adherence to physical activity and exercise, developed following the Ontology Development 101 methodology [73] and refined based on the NeOn framework [74]. Its basis relies on the analysis of published evidence and enables the identification of adherence based on the patient profile. OPTImAL describes relations of 320 factors originating from 60 multidimensional aspects affecting CVD patient adherence to physical activity and exercise. The formal model is evidence-based and can support cardiac rehabilitation experts in improving patient adherence [75].

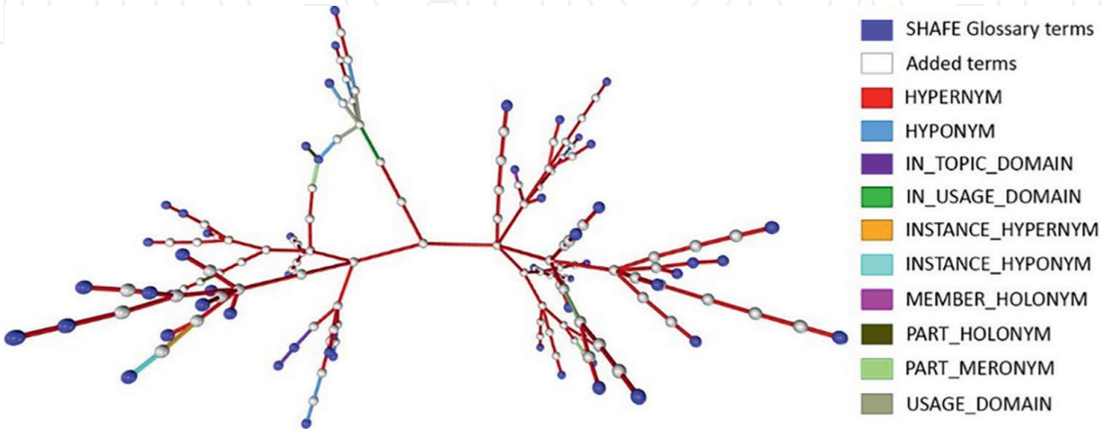

Figure 3.
The Knowledge Graph of the Smart Health Age-Friendly Environments (SHAFE) domain. Source: own elaboration.

3.3 Semantic interoperability of IoT platforms for AHA

Information technologies offer the opportunity to enrich the enormous amount of information available, which can further contribute to supporting the management of older age health, research, and innovation in a multi-sectoral manner. Despite these opportunities, data resources have limited access and interoperability, limiting the full exploitation of potential results, integrative efforts, and long-term reusability. ACTIVAGE is a European project to build an ecosystem for reusing and scaling up underlying open and proprietary IoT platforms, technologies and standards and integrate new interfaces needed to provide interoperability across these heterogeneous platforms. ACTIVAGE provides a set of techniques, tools, and methodologies for interoperability at different levels between existing heterogeneous IoT platforms and an open framework to provide semantic interoperability of IoT platforms for the AHA, addressing reliability, privacy, data protection and security [76].

3.4 Professional training for new skills and new jobs

It is crucial that healthcare professionals develop new skills in evidence-based practice, namely in the field of evidence implementation. Evidence implementation training empowers health professionals to improve health outcomes by providing approaches and tools that facilitate the implementation of the best evidence into clinical practice. Specifically, that training allows the development of skills to lead change, to guide and conduct clinical audits, and to develop continuous quality improvement projects. Thus, evidence implementation training contributes to increasing the levels of compliance of clinical practices with the best available evidence in the different contexts of health care delivery and to train professionals capable of becoming driving forces for the promotion of changes in clinical practice in line with the best evidence available. The International Federation on Ageing (IFA), in partnership with the World Health Organization (WHO), hosts every year a series of webinars on trends and themes relating to age-friendly environments to drive the agenda of the world's ageing populations. The webinar series is aimed at connecting experts and expertise to influence and shape age-related policy [77].

The Joanna Briggs Institute is an international institution that promotes evidence-based practice globally through collaborations with more than 70 institutions across the world. The collaborations inside the Joanna Briggs Institute network help to promote and support the use of the best available evidence to inform decisions made at the point of care, which contributes to closing the gap between research and clinical practice [78]. One of the highlights of this network collaboration is working on funding projects, such as the SPIDER (Strategic Partnership in Innovation and Development of Evidence-Based Healthcare) Project, which brings together 5 European countries with the main goal of fostering the implementation of clinical practices informed by the best evidence to promote effective healthcare that can benefit their users and contributes to alleviating the health economic burden for society.

3.5 Citizen's empowerment for person-centred ICT

Person-centred care is imperative for contemporary healthcare services to assure the sustainability of a future society underpinned by integrated- and citizen-relevant health promotion pathways [79, 80]. According to person-centredness principles, each citizen is a unique being with unique needs who will have as many vulnerabilities

as resources [80]. Within this perspective, the citizen is then an expert in his/her own life experience, which is the reason that warrants the involvement of individuals, families, and communities as co-developers of services, as well as users, according to their expectations, preferences, and values [79].

Translating person-centred principles to the domain of ICT and digital technologies leads to two domains of knowledge: co-design and person-centred care at a distance. Despite the great potential of ICTs to bridge communication and support gaps in healthcare, with a positive impact on both personal, clinical, and organisational outcomes [81], many challenges are still identified in relation to their non-adoption, abandonment, scale-up, spread and sustainability [82].

To overcome such challenges, user involvement has indeed become mandatory for many technological innovations in different sectors, yet very little attention has been given to its epistemic process [83]. Seeing the citizen as a partner demands challenging one's own accommodative perspective, through which science and technology are mere solutions, to consider the importance of designing, developing, testing, and implementing digital technologies that are usable, used, and useful for citizens [84, 85]. Empowering citizens to foster their involvement as partners is therefore crucial to providing sensitive guidance on design features of digital technology that are likely to be most relevant in a particular context for a given population, thereby enhancing its potential for successful and well-accepted implementation [85–87].

Regarding older adults, research carried out internationally in the domain of *Ageing in place* has shown an increase in the supply of digital resources [88, 89]. Specifically, ICT-based platforms that follow a person-centred approach have the potential to improve health and social care services in community settings. Such person-centred ICTs may empower citizens to actively participate in their healthcare and decision-making processes while enabling them to interact directly with healthcare and service providers about their personal health concerns, thereby promoting active ageing [86–88]. Thanks to the use of home automation and the Internet of Things, "Smart Homes" improve the quality of life of older adults and people with disabilities, allowing them to live healthier and more independently and supporting healthcare workers in their care [90]. Home monitoring systems are based on the combination of IT components that collect information from the domestic environment in which the older adult live and the clinical parameters, analysing the data generated by the motion sensors installed in different rooms of the house and the medical devices. Such a system builds, in a certain period of time, a pattern of normal behaviour for each older adult living alone. Sudden and substantial changes from the normal pattern are detected and reported to the caregiver, to verify the actual occurrence of the incident before the emergency procedure is initiated [91].

3.6 Infrastructural interventions: a lifetime home project

Urban spaces, buildings, and housing have long been identified as among the areas of everyday life that most influence the quality of ageing because they may promote the autonomy of older adults, who can remain active and independent even at a very advanced age. Therefore, housing and infrastructural contexts must be characterised by technical, environmental, functional, and spatial qualities, able to support, dynamically, the changing needs and requirements of an ageing population [5].

With reference to living spaces, the concept of the Lifetime Home emerged. The concept was proposed in 1991 in the United Kingdom by the Joseph Rowntree Foundation [92] and then merged in the Lifetime Home Standards [93]. The Lifetime

homes are sustainable housing, where home automation for well-being, autonomy, and safety is now implemented with a multigenerational dimension, conceived to foster independence and quality of life for individuals of all ages and abilities without compromising aesthetic value or cost-effectiveness of accessible, flexible, and affordable architectural and infrastructural solutions [94]. Built examples of Lifetime Home may be seen in London, such as Darwin Court, in Southwark; Lingham Court in Lambeth; Prices Yard in Islington [95].

The design programme aimed at converting the brutalist building Centro Polifunzionale Piscinola-Marianella, located in the north area of Naples (Italy), into a multigenerational lifetime house, is an example of this model of dwelling, proposed by a multidisciplinary team of University of Naples Federico II. Here, new functions of social care and multi-ageing living are integrated within the regional health chain, primarily referring to the older population and to the vulnerable users from a life course perspective [96]. Moreover, the project is consistent with the need to be climate and pandemic-proof to fit in the urban context as an infrastructure for environmental protection, in the knowledge that this qualification is a primary factor for the health of the older population [96].

4. Enabling innovative approaches by improving stakeholders' engagement

4.1 Digital literacy

Although digital literacy has been handled in various ways by different academics since it was introduced, one of the descriptive definitions of this concept has been put forward by the European Information Society [97]. They defined digital literacy as the awareness, attitude, and capacity of individuals to utilise digital tools and facilities correctly to find, access, manage, integrate, evaluate, analyse, and synthesise digital resources, construct new knowledge, produce media expressions, and connect with others in the context of specific life situations, in order to allow constructive social action; and to reflect on this process.

With the increasing dominance of digitalisation in society and academia, it has begun to be thought that technology creates new possibilities. For example, enabling individuals to have access to and use the Internet and related digital technologies, referred to as "digital inclusion," has far-reaching advantages for individuals, the economy, and society. It has even led to opinions that this situation will result in the participation of disadvantaged groups, such as older adults, in society. If older adults become digitally included, this inclusivity can help them maintain their independence, social connectedness, and sense of worth in the face of declining health or limited capabilities and offer new opportunities to improve their quality of life.

However, access to technology and benefits is not now dispersed equally within or within nations, and older people tend to be on the "wrong" side of the opportunities [98]. Urbancikova et al. [99] revealed that as the age of the individuals increased, their digital literacy skills decreased. Tsai et al. [100] emphasised that the barriers experienced by older adults are due to physiological (e.g., the speed of learning and memory) and intersecting socioeconomic (e.g., education status and income) characteristics and despite these difficulties, the motivation of older adults does not disappear and that existing barriers can be overcome with guidance, especially with support for technology use and practical daily practices.

4.2 Identifying and communicating added value

Technological development and digitisation provide an opportunity to increase the effectiveness and efficiency of health and social care systems in several ways. New tools provide the opportunity to foster innovation in existing organised systems and processes through various forms of automation. Digitalisation is facilitated by the clear definition of activities and work. Identifying the parts of the processes allows for the implementation of digital solutions that are truly consistent with the needs and achieve a high impact in terms of speed, quality, or cost [101, 102].

In economic and operational terms, the choice of what to implement and where can be facilitated by the possibility of using existing digital tools that can be adapted to particular and local conditions [103]. In particular, routines and data-based activities can be more easily improved and made more efficient, especially if significant volumes of activity are involved due to economies of scale. All of this is possible, however, if effectively designed within a framework of integrated organisational change. So, identifying the added value of the digital transition lies primarily in analysing the potential benefits but, more importantly, the avoided costs that enable a reallocation of financial resources more consistent with the expressed needs of communities. The ability to communicate added value depends on the careful analysis of the impact of organisational changes and digital transition and the building of collaborative ecosystems for innovation involving key stakeholders that, in addition to building effective internal communication models, have the necessary "political" strength to be able to make innovation implementable on a large scale [104].

The WHO's Age-friendly World (AFW) is a public portal providing a one-stop-shop for age-friendly action at the local level. Age-friendly World creates a place for citizens, policymakers, and organisations to share what they know and learn from others. AFW is an initiative of the Global Network for Age-friendly Cities and Communities [105]. The Ageing and Health Technology Watch (AHTW) provides market research, analysis and guidance about health and ageing-related technologies and services to enable older adults to sustain and improve their quality of life. AHTW advises technology vendors, service providers, businesses, and non-profits about trends and opportunities in the age-related technology market [106].

4.3 Broader communication towards communities

Older people consider participation in society as one of the most important features of life. Those older people who have fewer digital skills or are digitally illiterate feel increasingly excluded from society with the ongoing and unstoppable digitalisation of every single part of society. Digital participation is seen as of the utmost importance. Learning new skills in older age, however, is difficult unless the training meets the needs and interests of older people themselves.

To improve policymaking for the Age-friendly City The Hague in The Netherlands [107], The Hague University of Applied Sciences and AFEdemy, in combination with several organisations of the Knowledge Platform [108], developed the Age-friendly Cities and Communities Questionnaire (AFCCQ) [4]. This questionnaire consists of 23 questions that measure the perceived age-friendliness of a city or community by older people (65+) themselves. The questionnaire is being translated, culturally validated, and applied in countries like Poland, Romania, Turkey, and Portugal. With the results of the AFCCQ, focus group meetings are organised to qualify the outcomes of the questionnaire and to present the needs expressed by older people to local policymakers.

Governments increasingly turn to offer their products and services digitally. To avoid (older) people not being able to make use of these products and services themselves, training and support are essential. One example of successful training of older people is the Erasmus+ project Bridge the Gap! [109]. In this project, 60 older adults of 64–85 years were trained in a sequence of six workshops. The training successfully combined the SHAFE concept with learning and practising digital skills on smartphones and tablets. In training, older people learned what SHAFE is, discussed its importance for them, and which barriers they experience. For example, access to personal health records and health insurance is only feasible if people have a so-called digital identification code (DigiD) [110]. Trainees learned to instal and use DigiD on their smartphones. Learning to participate further digitally includes access to social networks, communication with e-Governments and applying eHealth approaches to support active and healthy living. One year after the training, trainees still consider it successful because of its pragmatic approach.

5. Discussion

Smart healthy age-friendly environments (SHAFE) enable innovations to boost health and well-being. Many efforts are being undertaken at locoregional, national and international levels to develop, adapt, transfer and implement SHAFE: sharing knowledge is a key accelerator for deployment. Successful examples of co-creation, living environments initiatives and digital skills training are being described to support innovation in the lives of citizens and the health and well-being domain.

On the other hand, it is still a challenge to realise SHAFE. Its holistic approach demands much dialogue and consultation between different stakeholders. It is not always obvious what the return on investments is and who benefits. Policymakers play an important role as facilitators in the realisation of SHAFE; however, they must be convinced of the benefits of investments in the longer term, where policymaking often reflects the delusion of everyday life [111]. Towards this purpose, efforts should be carried out to increase the use of research in decision and policymaking. WHO has been recognising for a long time the relevance of evidence-informed approaches to policymaking to improve its effectiveness, efficiency, and equity, but we are still far from integrating such approaches in our innovation ecosystems. WHO's conceptual structure for a more comprehensive and integrated approach provides outstanding guidance to create and apply evidence for a measurable improvement in public health. This is especially important considering the need for coherent and coordinated intersectoral and multilevel planning to impact population health. Indeed, construction and housing organisations should accelerate their efforts to evolve the built environments according to the emerging individual and collective needs of citizens. Health and well-being sectors should improve their digital skills and strengthen a comprehensive and person-centred approach. Citizen empowerment should be developed on the ground of digital skills and capacity in terms of accessibility. Robust evidences are required to scientists, focused deriving from the implementation of innovative methods and solutions for disease prevention, health promotion and integrated health to support the impact measure of SHAFE approach.

Available evidences described in this chapter show that only a strong interplay of actors makes SHAFE a success story.

In Central and Eastern Europe (CEE) countries, it was observed [36] that activities undertaken in relation to implementing smart and age-friendly cities

and communities are mostly targeted at strengthening intergenerational solidarity, enabling citizens to mutually invest in each other, and sharing achievements in accordance with the principles of reciprocity and equality. The study by Klimczuk and Tomczyk [36] also underlined the need to create more integrated theoretical approaches to social and technological innovation associated with ageing in cities and communities. Moreover, the scholars [36] suggest more in-depth studies of organisations of older people that focus on the dissemination and implementation of innovations and identifying their barriers in relation to the development and impact on the ageing policy. Also, there is a need [36] to continue comparative studies of various implementations of the concept of smart and age-friendly cities and communities in relation to well-known typologies of the welfare state and diverse models of the development of the silver economy.

6. Conclusions

A growing body of discourse and narrative surrounds the Age-friendly Cities and Communities domain, with various frameworks and concepts being proposed to enhance the understanding and development of inclusive and technologically advanced environments. These include the Smart Age-friendly Ecosystem (SAfE) framework and the Concept of Age-friendly Smart Ecologies (CASE) framework, which emphasise the role of technology and the interconnectedness of physical spaces.

Furthermore, the importance of co-creation, intergenerational living, and the integration of affordable technologies is highlighted to address the evolving needs and challenges of older adults. The introduction of terms like Transgenerational Living Communities and Cities (TLCC) and Smart Health Age-Friendly Environments (SHAFE) further expands the vision for future societal ecosystems that promote health, well-being, and connectivity. Initiatives such as the SHAFE thematic network and the Covenant on Demographic Change aim to foster collaboration.

Therefore, innovative approaches to health, including the exploration of environmental determinants of healthy ageing, the development of age-appropriate living environments, socio-technological solutions for smart, age-friendly cities and communities, and the use of virtual coaches for older adults' well-being, offer promising strategies to optimise well-being and improve the quality of life for older populations.

In conclusion, this chapter describes SHAFE experiences and highlights several emerging obstacles to the adoption of new services in the healthcare domain. These obstacles include the need for customised solutions tailored to local specificities, effective business models for the implementation of digital solutions, knowledge representation in complex domains, semantic interoperability of IoT platforms, professional training for new skills, citizen empowerment for person-centred ICT, and infrastructural interventions for ageing populations.

Additionally, this chapter emphasises the importance of digital literacy and the need to identify and communicate the added value of technological innovations in healthcare. By addressing these obstacles and engaging stakeholders effectively, the successful adoption of innovative approaches in healthcare can be achieved, leading to improved outcomes and a higher quality of life for individuals.

SHAFE communities have been driving the evolution towards a different approach to health service provision, that is proactive and anticipatory, and brings together the variety of elements and drivers that impact on the complex and interconnected mechanisms determining ageing trajectories.

Several challenges ahead of us lie in data sharing and secondary use of data across domains and repositories, in ethical, responsible, valuable and trusted use of AI, in citizen empowerment, and in organisational flexibility, among others.

Collaborative approaches are pivotal to ensure that knowledge and tools exchange are developed coherently and consistently. NET4Age-Friendly is an extraordinary example of successful collaborations across disciplines and organisations. Following through with new business models is our next challenge.

Acknowledgements

This chapter is based upon work from the Action 19136 "International Interdisciplinary Network on Smart Healthy Age-friendly Environments (NET4Age-Friendly)", financed by the European Cooperation in Science and Technology (COST) program.

Conflict of interest

The authors declare no conflict of interest.

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