

D14 Reference Framework



International Interdisciplinary Network on
Smart Healthy Age-Friendly Environments | NET4Age-Friendly

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AUTHORS

Ivan Chorbev, *Ss. Cyril and Methodius University*

✉ ivan.chorbev@finki.ukim.mk

Aleksandar Stojmenski, *Ss. Cyril and Methodius University*

✉ aleksandar.stojmenski@finki.ukim.mk

Pedro Roseiro (WP5 Leader), *Associação para o Pólo das Tecnologias de Informação, Comunicação e Eletrónica TICE.PT*

✉ pedro.roseiro@tice.pt

Willeke van Staalduinen (Vice-Chair, Grant Holder) *AFEdemy, Academy on age-friendly environments*

✉ willeke@afedemy.eu

Carina Dantas (Chair) *SHINE 2Europe*

✉ carinadantas@shine2.eu

VISUALS AND DESIGN

SHINE 2Europe

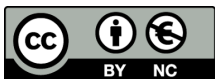
Joana Vieira

✉ joanavieira@shine2.eu

José Henrique Câmara

✉ jhcamara@gmail.com

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EXECUTIVE SUMMARY

The International Interdisciplinary Network on Smart Healthy Age-Friendly Environments ([NET4Age-Friendly](#)) is focused on creating inclusive and supportive environments through smart and inclusive design, digital innovations, and integrated healthcare pathways. This Reference Framework outlines the key resources, structures, practices, guidelines, and standards essential for achieving these objectives. It serves as a comprehensive guide for researchers, policymakers, and practitioners working to improve the quality of life of people throughout the life course, ensuring that innovations in social, digital, and healthcare sectors are inclusive, sustainable, and accessible.

Ontology and Glossary

The reference framework includes a reference to the comprehensive ontology and glossary to define key terms and concepts related to age-friendly environments. It includes visualisations and links to relevant resources, ensuring consistency and clarity across disciplines. The ontology covers concepts such as "inclusive design", "digital literacy", "wellbeing pathways", and "social innovation", providing a shared language for stakeholders.

Key Areas and High-Level Results



Social Innovation

This section highlights how innovative social practices can improve lives, emphasising the role of community-driven initiatives in creating sustainable and inclusive environments.



Policy Uptake and Implementation

Focused on the importance of translating policy into practice, this section outlines strategies for ensuring the effective uptake and implementation of policies that support age-friendly environments, including cross-sector collaboration and funding mechanisms.



Exploitation and Business Models

Provide insights into sustainable business models that support the exploitation of smart age-friendly solutions. This section discusses opportunities for scaling innovations and creating profitable, yet socially responsible, models.



Integrated Health and Wellbeing Pathways

This area emphasises the integration of health services, from prevention to treatment, with social and community care, highlighting the importance of coordinated care, digital health tools, and wellbeing strategies.



User-Centred Design and Community Engagement

Explore the significance of user-centred design in creating environments that are not only functional but also empowering for people of all ages. This section provides best practices for engaging communities in participatory processes.



Digital Transition

Focus on the digital transition, covering topics such as digital literacy, rights, data security, and the deployment of smart technologies. These issues provide guidelines for ensuring that those that are most vulnerable are not left behind in the digital age.

Connecting Key Areas

The six key areas of the framework synergise to create a holistic approach to building Smart Healthy Age-Friendly Environments. Social innovation drives community engagement, which in turn supports user-centred design. Policy implementation ensures that these innovations are sustainable, while business models offer a pathway for scalability. Integrated health pathways and the digital transition further strengthen the foundation for age-friendly environments.

Modules and Links

The framework provides modules that link to further resources, including handbooks, case studies, and guidelines, accessible online and ensuring that practitioners can easily implement the strategies outlined in the reference framework.

Standards and Guidelines

This section details existing standards and guidelines that support the implementation of Smart Healthy Age-Friendly Environments (SHAFE), covering topics such as ageing, disease, education, healthcare, among others.

Next Steps: SHAFE Foundation

Moving forward, the SHAFE Foundation will lead the effort to implement this reference framework across regions and countries. Each member will monitor the progress of SHAFE in their region, identifying good practices, barriers, and success stories. The ongoing collection and evaluation of these findings will be used to update the framework and ensure that it continues to provide actionable insights.

SOURCE MATERIALS

The Reference Framework stems from the work developed during the 4 years of NET4Age-Friendly activities, specifically, results of several Virtual Mobility Grants and the deliverables listed below:

- D2 Dissemination and Exploitation plan
- D3 Handbook for quality assurance
- D4 Report on SHAFE policies, strategies and funding
- D5 Report on effective business and evaluation models
- D6 Final report on user-centred design of Age-Friendly Environments
- D7 Final report on integrated health and wellbeing pathways
- D8 Final report on digital innovation and implementation
- VM SHAFE ontology
- VM SHAFE successful business models
- VM SHAFE mapping social innovation ecosystems
- VM Standards and guidelines on SHAFE

1. INTRODUCTION

1.1 SHAFE origin and objectives

The journey of SHAFE (Smart Healthy Age-Friendly Environments) started with the naivest enthusiasm, as all small things start. Thanks to so many committed organisations and individuals in Europe, a very small conviction and dream has grown into a solid movement. And even into a new word: SHAFE. This only happens when ideas make sense and come at the right historic time. The meaning and notion of SHAFE as a holistic approach that promotes the alignment of policies and strategies is a unique roadmap for the implementation in and across Europe.

To introduce the NET4Age-Friendly mapping of policies and models, an introduction that refers to the concept and evolution of the SHAFE concept, as well as its implementation in specific projects, is needed.

Smart, adaptable and inclusive solutions can help improve and support independent life throughout the course of life, regardless of age, gender, disabilities, cultural differences and personal choices.

A comprehensive approach that optimises social and physical environments, supported by digital tools and services, allows to provide better health and social care, promoting not only independent living, but also equity and active participation in society. This approach follows the United Nations' line-up, with the Sustainable Development Goals (in particular Objectives 3 and 11), stating that sustainable environments for all ages represent the basis for ensuring a better future for the entire population and addressing most of the growing issues of the ageing population.

SHAFE fosters actions that promote partnerships between technological and digital innovation, architecture, urban planning, social studies and health sciences to design and simulate communities of belonging that leverage the potential of each sector to promote the existential dignity of all persons, regardless of their characteristics and conditions, as well as the levels of development of the region where they live.

This is SHAFE. This new concept was created since 2017, based on the desire to implement Smart Healthy Age-Friendly Environments (SHAFE) across Europe, fostering happier and healthier people in all communities. This idea took shape and became a solid movement. SHAFE began as a Thematic Network, approved by the European Commission, to draw policy makers, organisations and citizens' attention to the need of better alignment between health, social care, built environments and ICT, both in policy and funding and delivered a Joint Statement and a Framing Paper in December 2018 to the European Commission and Member States.

After this, SHAFE evolved into a European Stakeholders Network, with over 170 partner organisations, coordinated by Carina Dantas and Willeke van Staalduinen, that is now transitioned to the SHAFE Foundation.

As a multidisciplinary concept, it needs the good knowledge of several concepts and areas, that will be further presented in the following sections.

2. SOCIAL INNOVATION

“Social innovation relates to new responses to pressing social demands by means which affect the process of social interactions. It is primarily aimed at improving wellbeing. It covers wide fields, which range from new models of childcare to web-based social networks, from the provision of domestic healthcare to new ways of encouraging people to exchange cars for bicycles in cities and the development of global fair-trade chains. In its recent usage, the social innovation approach is understood to mean not only a new governance mode working across traditional fields of responsibilities with an active involvement of citizens, which is effective in addressing the challenges of climate mitigation, social justice, ageing, etc., but also the culture of trust and risk-taking which is needed to promote scientific and technological innovations.” (Hubert, 2010)

The concept of Social Innovation is drawn on multiple layers and encompasses multiple elements, such as the transformation of governance arrangements, tools and participation forms; new relationships within society and its different actors; and systemic adaptation at the social level. One key aspect is grounded on the role of citizens and their participatory role, as they are the ones in the position to evolve “initiatives from a localised level to a macro-level”. (van Niekerk, 2021)

In a domain such as SHAFE, social innovation is useful to provide practical insights into how implementation of new technologies and services can be enhanced in societal systems pathways and practice. Social Innovation processes can be rather useful to understand the role of citizens (or specific target groups) in societal transformation. Empowered citizens will be able to be part of the implementation pathways not as service recipients but as “the leaders and ultimately the owners of (for example) health interventions and programmes. (Asha S. George, 2015)

In summary, social innovation can best be understood as innovation in social relations, in power dynamics and in governance transformations, and may include institutional and systems transformations. It has been applied in health research within multiple topics, mainly from an instrumental and technocratic point of view, to foster greater patient and beneficiary participation in health programmes.

However, to achieve this degree of participation, a critical view on the structures of power needs to be undertaken and public authorities are essential to be on board of such initiatives. If the quadruple helix^[4] of stakeholders in one community is aligned and willing to open their minds and hearts to new experiments and participatory initiatives, there is room for “shifting the power dynamics” thus creating “new avenues for involvement and participation”.

Social Innovation provides a framework for understanding systems innovation but goes well beyond the existing premises of functional efficiency or incremental improvement. It launched the basis for the creation of communities that are thought from the person's perspective, their needs and reality – which is also the basic approach of SHAFE - actively voicing their ideas and solutions, especially those emerging at the grassroots level, thus enhancing equity and empowerment.

Social innovation is inherently interdisciplinary and intersectoral, bringing added value for policy making as it emphasises the context in the implementation. It usually discards any solutions of 'one-size fits all', accounting for uniqueness and the specific conditions of each implementation site. This is why a mapping of existing initiatives is helpful to understand current practices and potentially benchmark them, adding value to new communities wishing to embrace such challenge.

NET4Age-Friendly promoted a wide mapping of initiatives in different countries and networks, from which it was possible to create synergies and promote a group of early adopters that are able to progress SHAFE's implementation and upscale. This mapping and connection can contribute to increase awareness of innovation actors on social innovation concepts and, if well disseminated, may also leverage the creation of alliances and synergies between different stakeholders within ecosystems and between ecosystems. Understanding what relevant practices exist, how they are funded and how they involve citizens and organisations is also key to ensure that business actors have access to social innovation and entrepreneurial knowledge, which is key for future sustainable societal change.



Available at: <https://www.net4age.eu/vm-grant-shafe-mapping-social-innovation-ecosystems>.

3. THE SHAFE ONTOLOGY

Clearly defining SHAFE was challenging due to the substantial pre-existing information. Various contexts provided different interpretations, making a shared understanding of its scope crucial. NET4Age-Friendly developed a conceptual map to facilitate understanding of the concepts and topics at stake, as well as the needed participant engagement. However, to classify information across domains and effectively visualise key assets, the map was formalised into an Ontology using a formal ontology-based model to represent the conceptual map of SHAFE through a knowledge graph implemented and visualized with an open access NoSQL DBMS. (Rinaldi, 2022).

3.1 Methodology

The representation of SHAFE knowledge with a general ontology model based on linguistic features is a valid contribution to solving issues related to the identification of different dimension of SHAFE knowledge mosaics and to defining their meanings in a common and shared way.

The process of decoding SHAFE knowledge objects demonstrates the need for a new methodology for reading the SHAFE domains 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 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

3.2 Main Outcomes

The obtained knowledge graph has been exported as OWL file following the proposed model and a part of this instance is in Appendix 1. Moreover, the knowledge graph has been drawn using a 3d graph visualization tool (i.e. Graphia1) showed in Figure 1. Knowledge graph has been drawn using a 3D graph.

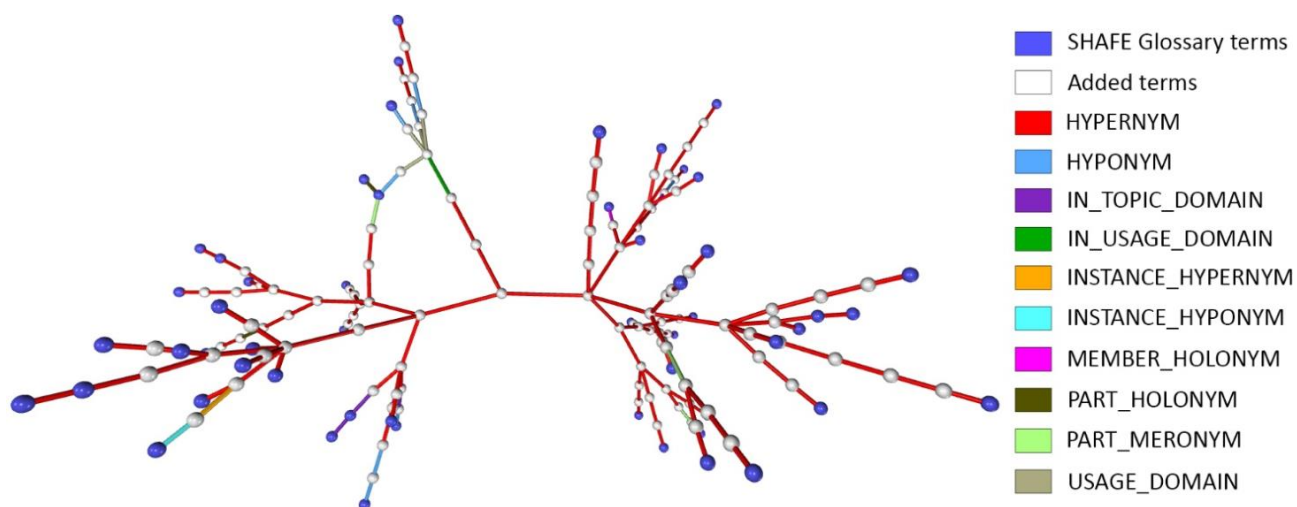


Figure 1. Knowledge graph has been drawn using a 3D graph



Available at: <https://www.net4age.eu/shafe-ontology>

4. USER-CENTRED DESIGN AND COMMUNITY ENGAGEMENT

User-centred design represents a process in which the potential users are involved in the design of a product, tool, software, etc. from the beginning through to the final result (IxDF, 2016). The involvement can have various formats; however, the basic steps and requirements are the same.

Four areas/properties are closely related to these processes, namely inclusion, accessibility, usability and engagement. There are various definitions and descriptions for these processes, however, in the next subsections we focus on those related to the topic of age-friendly environments.

INCLUSION – definition and significance: ensuring inclusion for all ages

Inclusion is a universal human right which is based on the idea that every individual has the right to be fully incorporated into society (Staff, 2021). It formulates the right of equal access and opportunities and the removal of discrimination and intolerance (removal of barriers). The understanding of inclusion may also be connected to some type of disability, covering a broad spectrum from cognitive impairments to learning, motor and age-conditioned disabilities.

Inclusion means to transform communities based on social justice principles in which all community members are presumed competent; are welcome as valued members of their community; are able to fully participate with their peers; and experience reciprocal social relationships (Gentilini, 2021).

There are different levels of participation. Two basic examples are physical access and programmatic access. Physical access is related to the physical environment that is accessible to all people, in other words no supports for participation are necessary. The simplest example is an entrance door to a building that was designed to be accessible to all people (i.e., it is wide enough, without steps or with a ramp for people who use mobility aids): there is no need for a special door for people with disabilities because the common door is accessible to anyone.

Programmatic access requires potential support realized by people (e.g. volunteers) and/or technology to ensure that individuals with disabilities can participate. Eliminating programmatic barriers, such as communication and sensory barriers, creates programmatic accessibility. For example, a communication barrier may be using technical jargon rather than plain language or having a website that is inaccessible to screen reading software. Developing accessible spaces by using universal design principles usually should tackle these types of barriers and enable full participation. (Accessibility: Physical and Programmatic. , 2022)

Inclusion is frequently grouped together with diversity and equity. They are interconnected and only their combination leads to true impact. Diversity (GlobalDiversityPractice, 2024) refers mostly to the

representation of various groups in the community, workplace, sports teams, etc. Examples of diversity include gender, race, ethnicity, physical ability, sexual orientation, neurodiversity, age. The list is not exhaustive. Depending on the context, the range of diversity can be wider.

Nobel Prize winner Richard Thaler (Javetski, 2018) explains his view on diversity in an interview with McKinsey on debiasing the corporation: *“There’s lots of talk about diversity these days. We tend to think about that in terms of things like racial diversity and gender diversity and ethnic diversity. Those things are all important. But it’s also important to have diversity in how people think.”*

Inclusive design reflects the properties of inclusion. Inclusive design aims at making places, products, tools, software, etc. in such a way that everyone can use them. The way environments and products are designed affects the ability to move, see, hear, understand and communicate effectively. It also aims to remove barriers that might lead to undue effort or separation.

Universal design (universaldesign, 2024) is a broader concept that can be characterised as the design of products and environments to be usable by all people, to the greatest extent possible, without the need for adaptation or specialised design. Sidewalks with curb cuts and doors that automatically open when a person moves near them are examples of universally designed products. They benefit people with disabilities, parents with baby strollers, delivery workers, and others. Human characteristics considered in universal designs may include age, gender, stature, race/ethnicity, culture, native language and learning preference.

In the case of information technology, products that are universally designed are accessible to and usable by people with a wide variety of characteristics, including different types of disabilities. These products are often designed to eliminate or minimise the need for assistive technologies. At the same time, they are compatible with common assistive hardware and software devices.

Universal design has been the focus of research for more than two decades, in particular in the context of the concept of ageing successfully (Carr, 2013). The authors formulate the concept of ageing successfully in relation to design and propose basic principles of universal design, accompanied with examples of different product areas (buildings, furniture, software, etc.).

During this period, standards for construction (worlddisabilityunion, 2024), web pages and other areas were developed (or modified from previous norms that did not consider the requirement of inclusion). Additional sources are mentioned in the next subsections, in which the terms accessible design and usable design are explained.

ACCESSIBILITY - definition and significance – ensuring accessibility for all ages

Accessibility is the design of products, devices, services, vehicles, or environments so as to be usable by people with disabilities (Accessibility, 2016). The concept of accessible design and practice of accessible development ensures both "direct access" (i.e. unassisted) and "indirect access" meaning compatibility with a person's assistive technology.

Accessibility can be viewed as the "ability to access" and benefit from some system or entity. While the concept focuses on enabling access for people with disabilities or enabling access through the use of assistive technology, research and development in accessibility brings benefits to everyone, irrespective of ability. Therefore, an accessible society should eliminate any digital divide or knowledge divide. In this context, accessibility also means the possibility to access various services that require the use of a necessary tool. For example, a web application is designed as accessible. However, the user needs a smartphone, laptop or computer to be able to use the application. This is another facet of accessibility.

Accessibility is not to be confused with usability (Georgakas, 2023), which is the extent to which a product (such as a device, service, or environment) can be used by specified users to achieve specified goals with effectiveness, efficiency, and satisfaction in a specified context of use. Accessibility is strongly related to universal design (Universal design. , 2021), the process of creating products that are usable by the widest possible range of people, operating within the widest possible range of situations. Universal design typically provides a single general solution that can accommodate people with disabilities as well as the rest of the population. By contrast, accessible design is focused on ensuring that there are no barriers to accessibility for all people, including those with disabilities.

Accessible design is a design process in which the needs of people with disabilities are specifically considered. Accessibility sometimes refers to the characteristic that products, services, and facilities can be independently used by people with a range of disabilities.

Several countries have already adopted legislation that specifies requirements and standards for the construction of public facilities and services and develops accessibility standards for software, hardware, websites, videos, and other information technology. The European Union adopted the European Accessibility Act (EAA) in 2019 (Directive (EU) 2019/882 of the European Parliament and of the Council of 17 April 2019 on the accessibility requirements for products and services, , 2019). The Directive (EU) 2019/882 aims to improve the accessibility of a wide range of digital products and services to foster the participation and inclusion of individuals with disabilities in society. By establishing accessibility requirements and standards for products and services that are most relevant to people with disabilities, the EEA intends to reduce barriers created by divergent rules in Member States.

Legislation on accessibility has also been adopted outside the EU. Examples include the Americans with Disabilities Act (ADA), which mandated that public facilities and services be fully accessible to people with disabilities; an amendment to Section 508 of the Rehabilitation Act of 1973 (General Services Administration). The amendment mandated that the Access Board (USAccessBoard, 2024) develop accessibility standards for software, hardware, websites, videos, and other information technology. Although these standards apply directly to the development, procurement, modification, and use of information technology of U.S. federal agencies, many states, educational institutions, and other entities have adopted them as one way to meet their ADA obligations.

There are also international initiatives and standardization organizations that develop standards and guidelines with the most important being ISO, IEC, IEEE and W3C.

ISO (International Organization for Standardization) is an independent, non-governmental international organization. Its members are 165 national standards bodies. The standardization work is performed in more than 250 technical committees in which experts delegated by the national standards bodies develop consensus-based and market relevant International Standards. These standards are aimed at supporting innovation and providing solutions to global challenges.

IEC (The International Electrotechnical Commission) is an international standards organization that is constituted by national electrotechnical committees. Its activities build on international cooperation in the area of standardization in electrical and electronic technologies. Based on that, IEC publishes various documentation, prepared by IEC technical committees, such as, International Standards, Technical Specifications, Technical Reports and Publicly Available Specifications and Guides.

IEEE (The Institute of Electrical and Electronic Engineers) is a professional association for electronic engineering and electrical engineering (and associated disciplines). IEEE has many societies, committees and working groups. They are also active in developing standards, in particular, industry standards in a broad range of technologies. In January 2024, there were nearly 1,300 standards and projects under development.

The World Wide Web Consortium (W3C) is the main international standards organisation for the Internet. The Web Content Accessibility Guidelines (WCAG) is the best guidance for making technology useful to all users, including people with disabilities and the ageing demographic. The WCAG guidelines were published in December 2008 by the Web Accessibility Initiative (WAI) of W3C. WCAG 2.0 is an internationally recognised and adopted standard and is approved as an ISO standard.

The W3C WAI offers an extensive literature review on how WCAG 2.0 addresses the accessibility needs of older web users in: *Developing Websites for Older People: How Web Content Accessibility Guidelines (WCAG) 2.0 Applies* (Initiative, 2024).

Design of new technologies and software has demonstrated that it is nearly impossible to group and generalize older people for design as it is done with children and adults. For each individual, ageing is unique, gradual and personal. Everyone has their own level of ability as they age, and the techniques they use to adapt to ageing are as unique as the creases in their palms. Design heuristics and accessibility guidelines may not cover older people so simply. Several aspects must be considered: design must be approached from multiple perspectives; many older people are less comfortable with technology, and some are risk averse; many older people are uncomfortable trying new things or hesitant to explore.

Ultimately, each generation is at risk of facing similar barriers until technology can truly be personalized. We must move past the mass produced, one-size-fits-all user experiences. Personalization will enable designers to tailor the user experiences to accommodate specific individuals and align with their needs.

USABILITY - definition and significance: ensuring usability for all ages

Similar to the preceding terms, usability has several definitions depending on the type of product. ISO defines usability as "The extent to which a product can be used by specified users to achieve specified goals with effectiveness, efficiency, and satisfaction in a specified context of use." (International Organization for Standardization (ISO)., 2018) Usability can be described as the capacity of a system to provide a condition for its users to perform tasks safely, effectively, and efficiently. Usability can also include the concept of prototypicality, which is how much a particular thing conforms to the expected shared norm, for instance, in website design, users prefer sites that conform to recognised design norms. Usability is often associated with the functionalities of the product.

Usability can be tested on a wide spectrum of products, from software applications, websites, tools, machines, and vehicles to processes; simply anything a human interacts with. Usability studies can be performed by different professions, such as usability analysts, designers, engineers, marketing personnel, and/or potential users.

Usability includes methods of measuring usability that is part of the whole process of design, development and evaluation of the future product. Any system or device designed for use by people should be easy to use, easy to learn, easy to remember (the instructions), easy to control, and helpful to users. These requirements are not new as John Gould and Clayton Lewis formulated the following three design principles in 1985:

- Early focus on end users and the tasks they need the system/device to do;
- Empirical measurement using quantitative or qualitative measures;
- Iterative design, in which the designers work in a series of stages, improving the design each time.

Each principle can be realised in several ways depending on the product, its functionalities and complexity, and potential users. An inevitable part of the process is evaluation, for which various methods are available.

The design team should be user-driven and should be in direct contact with potential users. Several evaluation methods, including personas, cognitive modelling, inspection, inquiry, prototyping, and testing methods, may contribute to understanding potential users and their perceptions of how well the product or process works. The designers must know who the users will be, whether they have experience with similar systems, or whether the developed system is completely novel. Analyses must be carried out regarding what tasks the users will perform, which are most important, and what decisions the users will make while using the system. Designers must understand how the cognitive and emotional characteristics of their users will engage with a proposed system.

The developed system must be tested throughout the whole design and development process. It should include tests with real users using behavioural measurements. This includes testing the system for both learnability and usability. It is important at this stage to use quantitative usability specifications, such as time and errors to complete tasks and number of users to test, as well as examine the performance and attitudes of the users testing the system. There are many evaluation methods available.

Iterative design is a design methodology based on a cyclical process of prototyping, testing, analysing, and refining a product or process. Based on the results of testing the most recent iteration of a design, changes and refinements are made. This process is intended to ultimately improve the quality and functionality of a design. In iterative design, interaction with the designed system is used as a form of research for informing and evolving a project as successive versions or iterations of a design are implemented. The key requirements for iterative design are, the identification of required changes, an ability to make changes, and a willingness to make changes. When a problem is encountered, there is no set method to determine the correct solution. Rather, there are empirical methods that can be used during system development or after the system is delivered, usually at a more opportune time. Ultimately, iterative design works towards meeting goals such as making the system user friendly, easy to use, easy to operate, simple, etc.

The importance of usability methods is also confirmed by the existence of standards. Here we present the most significant ones:

- ISO/TR 16982:2002 ("Ergonomics of human-system interaction—Usability methods supporting human-centred design") is an International Standards Organization (ISO) standard that provides information on human-centred usability methods that can be used for design and evaluation. It details the advantages, disadvantages, and other factors relevant to using each usability method. It

explains the implications of the stage of the life cycle and the individual project characteristics for the selection of usability methods and provides examples of usability methods in context.

- ISO 9241 is a multi-part standard that covers a number of aspects of people working with computers. Although originally titled Ergonomic Requirements for Office Work with Visual Display Terminals (VDTs), it has been retitled to the more generic Ergonomics of Human System Interaction. As part of this change, ISO is renumbering some parts of the standard so that it can cover more topics, e.g. tactile and haptic interaction. The first part to be renumbered was part 10 in 2006, now part 110.
- IEC 62366-1:2015 + COR1:2016 & IEC/TR 62366-2 provide guidance on usability engineering specific to a medical device.

ENGAGEMENT - definition and significance: ensuring engagement for all ages

For SHAFE's context, the closest dictionary definition of engagement is 'being involved with or taking an interest in something'. However, this does not fully capture and reflect what engagement really means to us. One of the interesting things about engagement is that we tend to feel or know when it is happening, even if we cannot exactly define it. Whether in an exhibition, a lecture hall, or any other space, we instinctively know that something positive is happening when people are alert, excited, talking about their experience and wanting to do or find out more.

A comprehensive definition of engagement and a measurement scale that can be used across domains and contexts (De Vreede, 2019) was derived by iteratively refining the items in this scale through a series of five data samples to arrive at the final scale. The authors propose that engagement is a three-part phenomenon, which manifests in one or more of the following three forms:

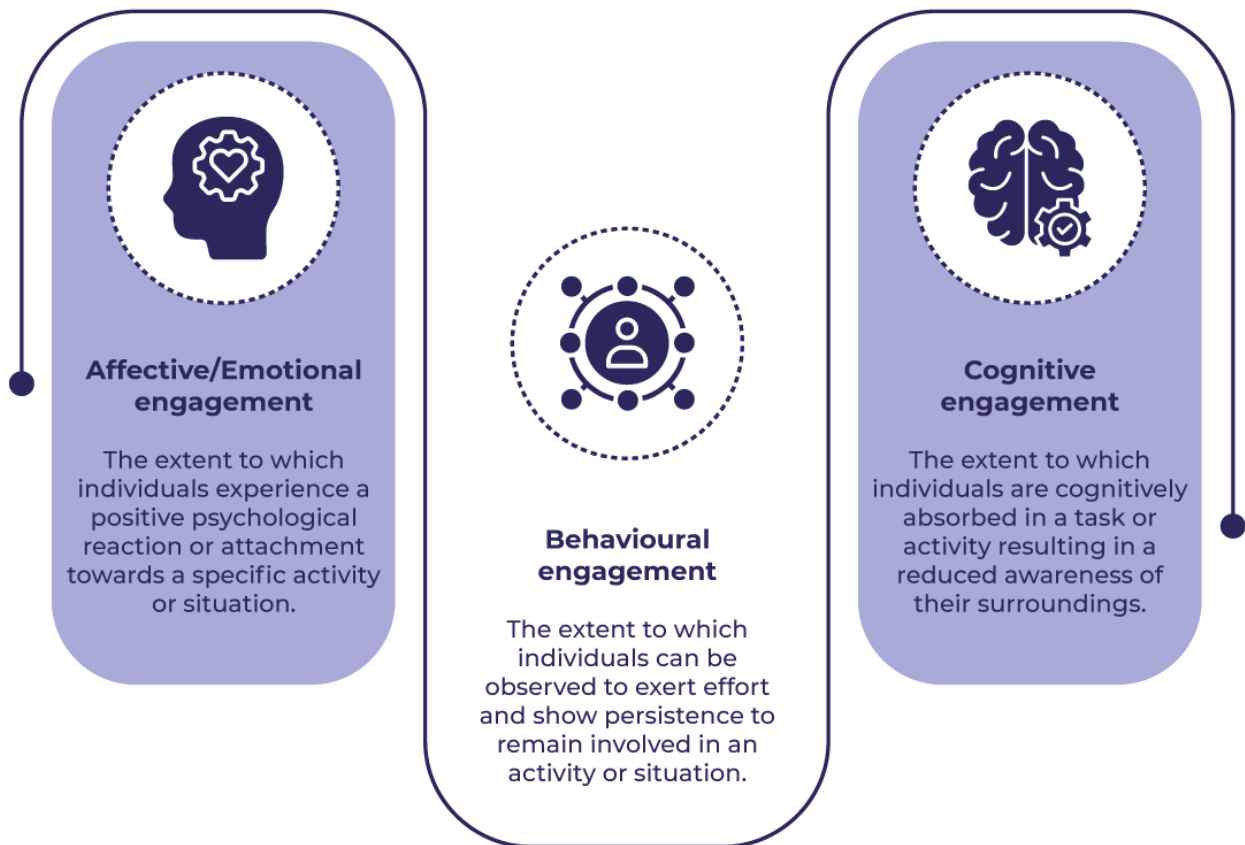


Figure 2. Three forms of the engagement phenomenon

There is a specific understanding of engagement in the area of information technologies, where the term “engagement” refers to user interactions over an interface. It is commonly applied to social media, but engagement can be measured on any platform or website. Typical indicators of engagement include number of page views, bounce times, time spent on a site, user tracking and other metrics.

Key points on user-centred and inclusive design



Holistic integration

Digital inclusion: ensure that digital elements within SHAFE are designed with inclusivity in mind. Consider factors such as user-friendly interfaces, large font sizes, and simple navigation to accommodate varying levels of digital literacy among different individuals.

Social connectivity: integrate features that promote social interaction, such as virtual communities, social networking, or communication tools, to address potential isolation issues. Design interfaces that facilitate easy and intuitive social engagement.



Individual dimension exploration:

User-centric co-design: actively involve users in the co-design process, allowing them to contribute with insights into the specific needs and preferences related to each dimension of the SHAFE. Conduct participatory workshops, focus groups, and usability testing involving the target groups to ensure inclusivity.

Diverse representation: ensure diversity within the group engaged in co-design, representing a wide range of ages, abilities, and cultural backgrounds. This ensures that the insights gathered are reflective of the diverse experiences within the population.



Data-driven design:

Ethical data practices: prioritise ethical considerations in data collection, ensuring privacy and consent. Implement transparent communication about the purpose of data collection and how it will be used to build trust among older users.

User behaviour insights: use data analytics to gain a deeper understanding of the daily routines, preferences, and challenges faced by older individuals. This insight can inform design decisions to create more personalised and adaptive SHAFE solutions.



Affordability:

Cost-effective technology: focus on developing SHAFE solutions that are not only technologically advanced but also cost-effective. This could involve leveraging open-source technologies, promoting the use of existing affordable devices, and exploring scalable solutions that minimise economic barriers.

Cultural adaptability: consider cultural nuances in the design process, ensuring that SHAFE solutions are adaptable to diverse societal contexts. This involves understanding cultural preferences and norms related to technology use and incorporating them into the design to enhance user acceptance.

By incorporating these suggestions, experts can create more inclusive and effective SHAFE environments that address the multifaceted needs of people of all ages, fostering a sense of belonging, connectivity, and improved quality of life.



FOR MORE INFORMATION

Available at: <https://www.net4age.eu/d6-final-report-user-centred-design-shafe>

5. INTEGRATED HEALTH AND WELLBEING PATHWAYS

5.1 Success factors

Standards and Best Practices

As the European Union strives to enhance care for people of all ages, a set of standards and best practices has been established to guide member states in the development of integrated care pathways. These standards are anchored in EU directives, cross-national policies, and evidence from studies and pilot programs. The following segment delves into these elements and incorporates stakeholder feedback to provide a multi-dimensional perspective on older adult care in the EU.

Table 1: Core components of integrated care for older or frail populations (Threapltton)

ELEMENTS OF EFFECTIVE INTEGRATED HEALTHCARE	DESCRIPTION
Care continuity and transitions	Connected service networks, and effective referral systems can ensure patients receive quality care and continuity when they transit between locations or providers.
Policy and governance	Enabling policy is needed to align stakeholder goals/outcomes and provide financing structures to facilitate integration. Cooperation across care provider organizations and the integration of health and social care at the clinical level is important.
Shared values and goals	Shared values and goals are facilitated through formal policies and changes in culture at clinical and managerial levels.
Person centred care	Holistic care should be delivered with a focus on the individual and on enabling autonomy by empowering individuals to be involved in their own care.
Multi-/inter-disciplinary teams	Providers from all services must work together in a flexible way to provide coordinated care and so that patients can benefit from expertise from multiple specialties.
Effective communication	Communication is a vital component for all involved in care and extends to the communication between healthcare professionals by providing integrated electronic record management.
Case management	A named individual is identified as care coordinator/case manager, who has direct responsibility for supporting service users by coordinating care, engaging patients in their own care and providing care directly.

Facilitators for integrated health play a crucial role in fostering a holistic approach to healthcare, promoting collaboration among various healthcare components for improved patient outcomes.

Multi-disciplinary teams, which participate in frequent communication and share common values, was frequently identified as a necessary feature for successful integration of services. Integration can be realized by through planning and financing, shared vision, and a focus on providing patient-centred care. All changes that are large will inevitably be slower to take effect, requiring greater investment in preliminary work. Relevant facilitators and support tools are functional and well-structured information systems and appropriate methodology for evaluation of the implemented integrated care programs.

5.2 Policy Recommendations

Performance of health systems

The following KPIs are recommended:

Data Infrastructure Development: Invest in the necessary infrastructure to ensure that the data required for the KPIs are collected consistently and accurately.

Performance Monitoring Systems: Implement robust systems to monitor these KPIs regularly, providing visibility into the performance of ICPS.

Benchmarking Best Practices: Utilise the KPIs for periodic benchmarking exercises to share best practices and foster improvement across the EU.

Policy Harmonisation: Align national care policies with the standardised KPIs to ensure that all member states work towards the same objectives.

Stakeholder Engagement: Engage with patients, healthcare providers, and policymakers in the KPI development and review process to ensure that the indicators remain relevant and actionable.

Our research reveals a landscape of contrast and diversity where clear disparities are noted, with some regions providing cutting-edge, comprehensive care while others grapple with basic service delivery. Innovation in is emerging as a beacon of progress, with several member states deploying integrated models that marry health and social care, fostering improved outcomes and patient satisfaction. However, these advancements are not widespread, and a lack of consistent data application hinders potential service

improvements. The use of data analytics, crucial for shaping efficient care pathways, remains an underdeveloped resource in numerous regions. Furthermore, while the spirit of collaboration and shared learning is rooted in EU philosophy, practical implementation of such cooperation is patchy, suggesting that more concerted efforts are needed to bridge the gap between policy and practice.

Recommended Actions

To address the varied challenges, a series of targeted actions are recommended. Foremost is the development and enforcement of EU-wide standards for ICPs to ensure all Europeans benefit from a consistent baseline of quality and accessible care. Addressing the stark inequities in care requires a dual approach: localised interventions for under-resourced areas and broader policy reforms to reduce socioeconomic disparities. A central EU platform should be established to facilitate the exchange and scaling up of innovative care practices, enabling member states to benefit from shared expertise and experiences. Such an initiative must be underpinned by a commitment to strengthen health data systems, ensuring data-driven decision-making becomes the cornerstone of care pathway development. Finally, invigorating cooperation across EU borders is crucial for a harmonised approach to older adult care, calling for a renewed focus on partnerships and resource-sharing to fortify the collective capacity to care for Europe's ageing population.



Strengthen inter-sectoral collaboration

Foster collaboration between health and non-health sectors such as education, employment, housing, and transportation. Develop policies that encourage cross-sectoral partnerships to address the various determinants of health and promote holistic well-being.



Community engagement and empowerment

Implement policies that prioritise community involvement in decision-making processes related to health services and programs. Empower communities to actively participate in the planning, development, and evaluation of integrated health initiatives.



Incentivize integrated care models

Create incentives for healthcare providers to adopt integrated care models that focus on coordinating services across different healthcare settings. Support the implementation of accountable care organizations and integrated delivery networks to enhance continuity of care.



Health information exchange and technology integration

Develop and implement policies that facilitate seamless sharing of health information among different healthcare providers and systems. Encourage the integration of technology to improve communication and coordination, ensuring a more comprehensive approach to patient care.



Workforce training and development

Invest in training programs for healthcare professionals to enhance their skills in collaborative care and interdisciplinary communication. Foster a culture of teamwork and shared responsibility among healthcare providers from various disciplines.



Address socioeconomic disparities

Develop policies that specifically target socioeconomic determinants of health, such as income, education, and employment. Addressing these disparities is crucial for achieving true integration and improving health outcomes for all segments of the population.



Preventive and promotional initiatives

Prioritise preventive and health promotion strategies through policies that encourage regular screenings, vaccinations, and lifestyle interventions. Emphasize the importance of addressing root causes and promoting wellness to reduce the burden on the healthcare system.



Patient-centred care

Implement policies that prioritise patient-centred care, ensuring that individuals have an active role in their healthcare decisions. Foster a culture of shared decision-making and support the integration of patient feedback in the continuous improvement of health services.



Evaluation and continuous improvement

Establish mechanisms for regular evaluation of integrated health initiatives. Use data and feedback to identify areas for improvement and refine policies to better meet the evolving needs of the population.



Legislation supporting integration

Enact legislation that explicitly supports and mandates the integration of health services. Provide a legal framework that encourages collaboration among different sectors, ensuring the sustainability and longevity of integrated health approaches.

Main findings

The lives of human beings are a continuum of genetic, biological, social, cultural and economic processes. Each stage in life influences the next and determines the health effects or risks. A life course perspective of an integrated conceptual approach is needed to enable long-term health gain. For younger people, the integrated care approach should mainly focus on mental health, lifestyle, income and health inequalities. When people reach the situation of co-morbidities, such as physical decline, reduction of cognitive

functioning or chronic diseases, the necessity of integrated care becomes even more urgent. According to the WHO, integrated care should focus on the following recommendations listed in Figure 3. Integrated care focus according to the WHO.

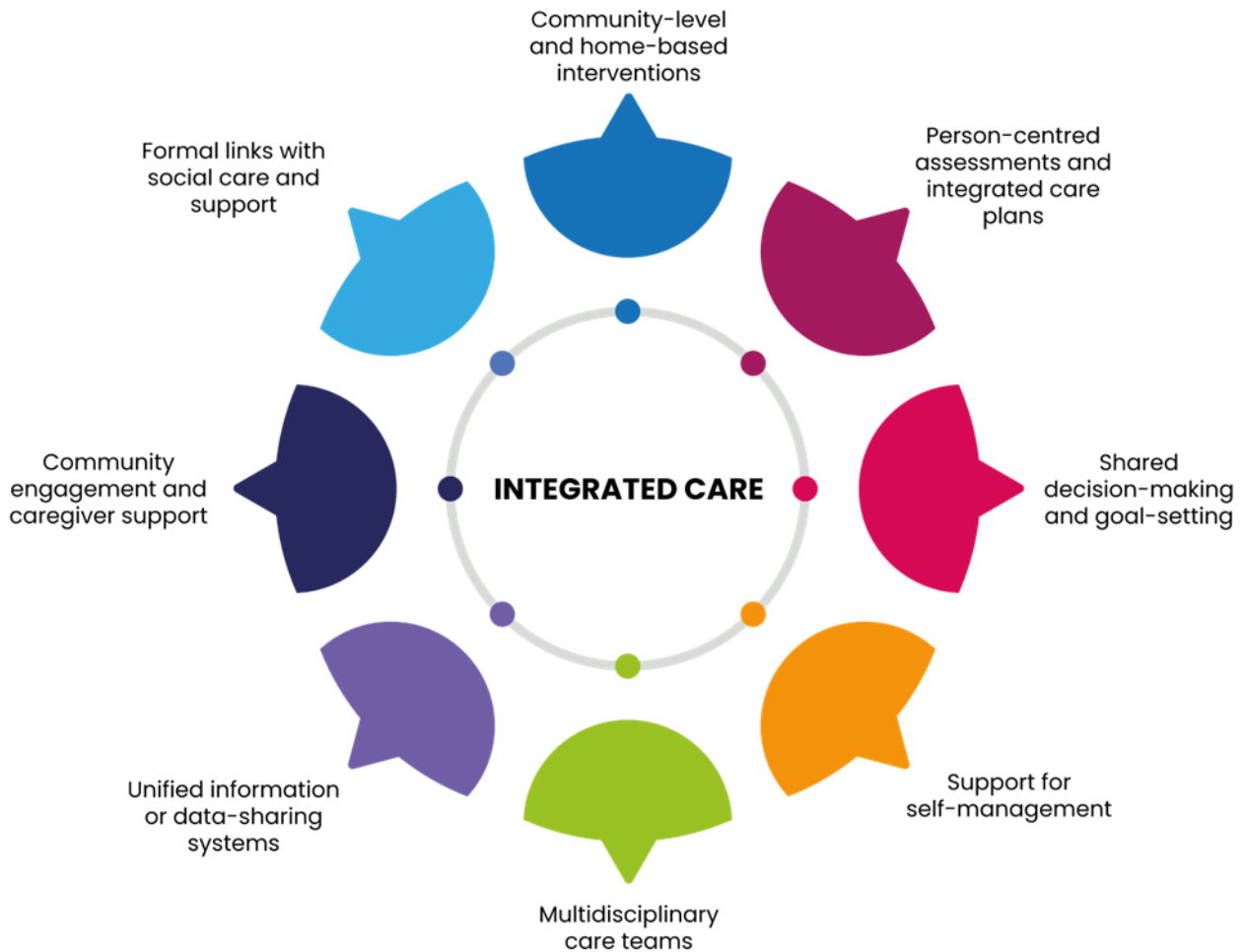


Figure 3. Integrated care focus according to the WHO



Available at: <https://www.net4age.eu/d7-integrated-health-and-wellbeing-pathways>

6. DIGITAL TRANSITION

The primary objective of this section is to present the acquired synthesis of the existing knowledge in digital innovation and implementation of Smart Healthy Age-Friendly Environments (SHAFE) solutions, a critical assessment of practices, and recommendations for the future.

Challenges associated with wellbeing

In the dynamic interplay between the advancing age demographics and the evolving digital landscape, the potential for enhancing the well-being of people of all ages stands out. Digital innovation offers improved connectivity, healthcare access, and overall higher quality of life. However, within this promising landscape, many challenges unfold that are addressed below separately as:

Digital literacy barriers



Vulnerable individuals may face challenges in adapting to and using new digital technologies due to a lack of familiarity and digital literacy skills. This can result in feelings of frustration, isolation, and reduced access to essential services and information.

Social isolation and loneliness



Digital tools hold the promise of connectivity, yet the paradox of social isolation persists. The challenge lies in ensuring that technology not only connects but also mitigates feelings of loneliness, particularly among those with limited social networks. While digital platforms can connect people, there is a risk that more vulnerable people, especially those less familiar with technology, may feel excluded or lonely in the increasingly digital world.

Health monitoring and privacy concerns



Digital health innovations may raise concerns about privacy and data security. People may worry about the collection and use of their health data, impacting their willingness to adopt technologies that monitor health or support telehealth services.



Mental health implications

The digital era brings both opportunities and challenges to mental well-being. While cognitive health apps and online resources can support mental fitness, the constant influx of information and the potential for digital overwhelm may pose risks to mental health.



Quality of digital interactions

The nature of digital interactions, though convenient, may lack the depth and richness of face-to-face communication. Ensuring that digital tools enhance, rather than replace, meaningful human connections is important for overall well-being.



Digital dependence and addiction

The increasing integration of technology into daily life raises concerns about dependency and addiction, particularly among people who may find themselves spending excessive time online. Striking a balance between digital engagement and other aspects of life is essential for well-being.



Information overload and health literacy

The abundance of health information online can lead to information overload, challenging individuals to recognise reliable sources. Improving health literacy and providing curated, accessible health information becomes essential for informed decision-making.



Physical health impact

Prolonged use of digital devices and sedentary behaviour associated with technology use can impact health. Balancing screen time with physical activity is crucial for maintaining overall health and well-being.



Digital discrimination and ageism

Digital platforms and applications may not be designed with the specific needs and preferences of older users in mind. Ageist assumptions about technology use can result in user interfaces that are not intuitive or accessible, impacting the overall user experience. Older individuals may face age-related biases and discrimination in digital spaces, leading to feelings of exclusion.



Technostress

The rapid pace of technological change and the need for continuous adaptation to new digital tools may contribute to technostress. Anxiety, frustration, and feelings of overwhelm can adversely affect mental wellbeing.



Limited tailored content

The challenge lies in the lack of personalised and tailored content that addresses the specific needs and interests of different groups. Digital platforms need to offer content that enhances cognitive, emotional, and social well-being. Personalization is crucial in ensuring that digital tools align with the diverse well-being requirements.



Access disparities

Economic disparities can limit access to the latest digital technologies. Those with lower incomes may struggle to afford devices, high-speed internet, or necessary software, exacerbating existing inequalities and hindering access to digital wellbeing resources. Addressing barriers to entry, such as digital literacy, device affordability and connectivity, is crucial for well-being.



Economic inclusion

The digital economy may inadvertently exclude people who are not actively participating in online marketplaces. Ensuring economic inclusion through digital platforms is vital for financial wellbeing.



Ethical considerations

The use of emerging technologies, such as artificial intelligence in caregiving or companion robots, raises ethical questions. Striking a balance between technological assistance and maintaining the dignity and autonomy, namely of older individuals, is a complex challenge. Navigating these challenges requires a holistic approach that prioritises well-being in the design and implementation of digital solutions. Collaborative efforts from technology developers, healthcare professionals, policymakers, and community organisations are essential to create a digital landscape that genuinely supports the holistic well-being of the ageing population.

We are all currently experiencing a growing dependence on ICTs. Governments, enterprises, academia and entrepreneurs are all in the midst of implementing digital transformation processes in order to better serve their citizens and better adapt to new consumer trends where low physical contact prevails.

Nevertheless, not all are taking into consideration the characteristics and needs of vulnerable people, considering their age, gender and skills. The main scope of the digital innovations and implementation of the SHAFE approach is focusing on the integration of digital technologies to enhance the wellbeing and quality of life of people at all ages. The scope encompasses various areas and industries, strategically addressing real-world challenges faced by ageing populations. In navigating these challenges and targeted areas, a holistic approach is essential, involving collaborative efforts from main groups of stakeholders (policymakers, technology developers, healthcare professionals, community organizations).

The SHAFE approach underscores the creation of environments that are not only technologically advanced but also prioritize health, inclusivity, and age-friendliness. This involves:

- Designing and implementing smart technologies that support active and healthy living.
- Ensuring accessibility and usability of digital solutions by people at all ages.
- Promoting social connectivity and active engagement through digital means.
- Addressing challenges related to digital literacy and ensuring that educational components are aligned with the SHAFE principles.

ICTs and digital solutions can significantly increase the commercial prospects that arise from the ageing revolution. The best equalizer of development opportunities for all people, including those who may have lost some abilities, is technology. Without a doubt, encouraging older adults to use and have access to ICT is crucial to fostering a culture of healthy living. (Union I. T., 2021).

From various angles, the ageing population presents a business opportunity. It symbolizes a potential long-term customer. However, it also possesses invaluable experience that it could use to help entrepreneurs and younger generations, fostering intergenerational communication.(Union I. T., 2021).

By understanding and addressing the unique needs of people at all ages, digital innovations can evolve to become more inclusive, user-friendly and supportive. The goal is to transform the challenges posed by the intersection of ageing and digital innovation into opportunities for improved wellbeing and connectivity. ICTs possess significant capacity to diminish social and economic disparities that impact many people. However, they can also intensify existing inequalities and even generate new ones. It is crucial for all parties involved, particularly governments, to ensure that public policies actively support the beneficial impact of emerging technologies (Union W. H., 2018). Such tools have the potential to generate opportunities for the integration of people in various scenarios (Union I. T., 2021) (Nations, 2012).

In this case, digital inclusion is the key to getting more people to take part in the information society's social and economic life. The term "digital inclusion" (Figure 4. Digital inclusion explained **Erro! A origem da referência não foi encontrada.**) means that everyone, no matter their gender, age, or location, can access and use information and communication technologies. To make this happen, digital inclusion needs three basic things: a digital infrastructure, easy access to ICT, and people using technology (Union I. T., 2021) (S. Taipale, 2019).



Figure 4. Digital inclusion explained (Union I. T., 2021)

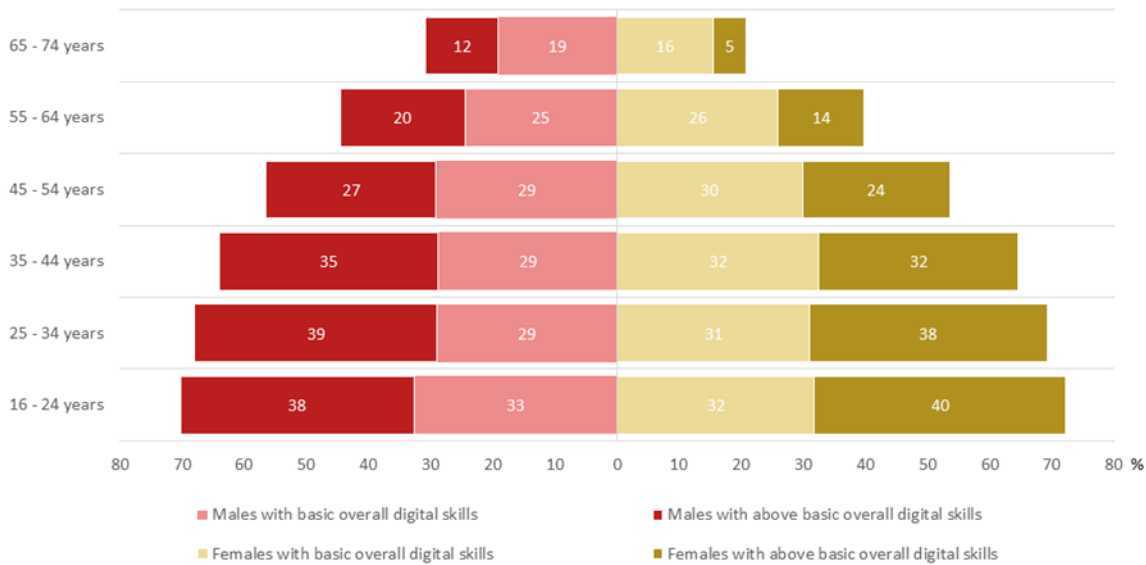
General European Union Insights

Digital transformation is high on the European policy agenda, being one of the European Commission's main political priorities for the coming years. On 9 March 2021, the Commission presented the Digital Decade Communication, which sets a vision and targets for a successful digital transformation of Europe by 2030 (E. Commission, 2023). The Commission proposed a Digital Compass, which sets out concrete targets for achieving the EU's digital ambitions, evolving around four cardinal points: skills, digital transformation of businesses, secure and sustainable digital infrastructures and digitalisation of public services (D., 2021) (E. Commission, 2021). Progress towards these 2030 targets is measured by a monitoring system based on the Digital Economy and Society Index (DESI) (E. Commission, 2022).

The European Commission has been monitoring Member States' digital progress through the Digital Economy and Society Index (DESI) reports since 2014. The DESI 2022 reports are based mainly on 2021 data and track the progress made in EU Member States in digital. Member States dedicated, on average, 26% of their Recovery and Resilience Facility (RRF) allocation to the digital transformation, above the compulsory 20% threshold. Member States that chose to invest more than 30% of their RRF allocation to digital are Austria, Germany, Luxembourg, Ireland and Lithuania (E. Commission, 2022) (European Commission, 2023).

The ambitions set for the area of skills in the Digital Compass are that, by 2030, at least 80 % of all adults should have at least basic digital skills and that there should be 20 million employed ICT specialists in the EU, with increased women's participation. In 2021, 54% of EU citizens aged 16-74 had at least basic overall digital skills. Digital literacy is crucial for people to benefit from the ongoing digital transformation and the vast variety of services available online, thus preventing them from being digitally excluded. Having digital skills is also critical to protect oneself from cyber threats stemming from the increasingly digitalised world (Eurostat, 2023).

The highest proportions of people aged 16-74 who had at least basic overall digital skills were found in the Netherlands and Finland (both 79 %), followed by Ireland (70 %), Denmark (69 %) and Sweden (67 %). On the other hand, the lowest were recorded in Romania (28 %) and Bulgaria (31 %). In most Member States, the shares of people with at least basic digital skills were higher among men than among women. In 6 Member States, the situation was reversed, with higher shares of women with at least basic digital skills, with the biggest difference in Latvia and Cyprus. The lowest shares were observed among 65–74-year-olds, where 31 % of men and 21 % of women had at least basic digital skills. The biggest gender gap is visible in the older age groups, where among 65-74-year-olds the share of women with at least basic digital skills was 10 pp points lower than among men in this age group (Figure 5. Individuals with at least basic overall digital skills, by age and sex, EU, 2021 (% of individuals) (Eurostat, 2023)).



Source: Eurostat (online data code: isoc_sk_dskl_i21)

eurostat

Figure 5. Individuals with at least basic overall digital skills, by age and sex, EU, 2021 (% of individuals) (Eurostat, 2023)

The Digital Compass sets goals for the EU’s digital transformation of businesses. By 2030, three out of four EU companies should use cloud computing services, big data or artificial intelligence, and more than 90 % of small and medium-sized enterprises (SMEs) should reach at least a basic level of digital intensity. In 2021, 34 % of EU businesses used sophisticated or intermediate cloud computing services. The highest shares of sophisticated or intermediate cloud services users among businesses were in Sweden (69 %) and Finland (66 %), followed by Denmark (62 %) and the Netherlands (60 %). In 14 Member States, the shares of enterprises using sophisticated or intermediate cloud computing were below the EU average, with the lowest proportions recorded in Bulgaria (10 %) and Romania (11 %) (Eurostat, 2023).

Artificial intelligence (AI) can bring many benefits to businesses, such as improved decision-making, productivity or efficiency gains, and optimized and more sustainable energy or resource management. In 2021, 8 % of EU enterprises used at least one AI technology - of text mining, speech recognition, natural language generation, image recognition or processing, machine learning (incl. deep learning) for data analysis, technologies automating different workflows or assisting in decision-making (AI based software robotic process automation), technologies enabling machines to physically move by observing their surroundings and taking autonomous decisions. The highest share of enterprises using AI was recorded in Denmark (24 %), followed by Portugal (17 %) and Finland (16 %), while the lowest shares were recorded in Romania (1 %) and Cyprus, Greece, Estonia, Poland, Hungary and Bulgaria (all 3 %) (Eurostat, 2023).

All key public services should be available online by 2030, according to the Digital Compass. All citizens should also be able to access their e-medical records, and 80% of citizens should use an eID solution. In 2021 year,

51% of EU citizens aged 16 to 74 had contacted or interacted with public authorities or services online for personal reasons. People in Denmark (92%), Finland (91%), and the Netherlands (82%) were the most likely to use e-government websites for things like citizen duties (taxes or address change), rights (social benefits), official documents (birth certificate or ID card), public educational services (libraries and enrolling in schools), and public health services. Germany (33%), Bulgaria (19%), and Romania (14% each) had the least amount of e-government use (Eurostat, 2023).

In 2022, 24 % of EU citizens aged 16-74 reported having accessed their personal health records online, 33 % made an appointment with a practitioner via a website, and 52 % of EU citizens were seeking health-related information online. All three rates were highest in Finland, with 81 % of citizens consulting the internet in search of health-related information, 79 % accessing their health records online, and 65 % making a doctor's appointment via the internet (Eurostat, 2023).

The European Green Deal has made the European Commission start to think about how to make Europe greener. It also brings up the idea of the "digital transition," which is the move to a more digital world. The Digital Europe Programme (DIGITAL) is a new EU funding program that aims to help businesses, people, and the government use digital technology. The Digital Europe Programme will help solve the problems by giving strategic funding to projects in next key areas: supercomputing, AI, cybersecurity, and advanced digital skills. It will also make sure that digital technologies are used widely in society and the economy, for example through Digital Innovation Hubs (E. Commission, 2023) (E. Commission, 2023).

The Digital Decade Policy Programme establishes a framework for multi-country projects (MCPs), i.e., large-scale projects facilitating the achievement of the general objectives and digital targets. In addition, the Digital Decade Policy Programme introduces the European Digital Infrastructure Consortia (EDICs) as a new means to facilitate the establishment of MCPs. EDICs combine the advantages of a rapid set up, a flexible internal structure and the leading role of Member States in their set up and operations (E. Commission, 2023).

Adopting technology is a key part of making sure that people can use technology. Almost every part of work and life depends on being able to use technology. From filling out a government form to talking to people at work, it's hard to think of a task or job that doesn't require some basic digital skills. Policies that are meant to help people get used to the Internet need to take into account how they learn and live their lives, as there is no "one-size-fits-all" answer (Nations, 2012).

Wellbeing and Quality of Life aligned with digital technologies

Understanding quality of life (QOL) is relevant for improving care, symptom relief, and rehabilitation of patients (Haraldstad, 2019). Patients' self-reported QOL may reveal problems that can lead to modifications and/or improvement in treatment/care or may indicate that some treatments or practices offer little or no benefit. QOL has become a significant target for research and practice in the fields of health and medicine (P. M. M. D. Fayers, 2016). Traditionally, medical outcomes have been the principal endpoints in medical and health research. However, in the last decades, more research has focused on patients' QOL (Haraldstad, 2019).

Sharing and gathering information on QOL in different diseases can be used to identify the range of problems experienced by the patients. This kind of information can be helpful to future patients to understand their disease and the treatment pathway, as well as to long-term survivors facing problems long after their treatment is completed. Moreover, QOL is a predictor of treatment success, thus has a prognostic importance, shown to be strong predictor of survival (P. M. M. D. Fayers, 2016).

Despite QOL importance in medicine and general health, there is still an ongoing methodological debate on meaning of QOL and how is to be quantified, i.e. measured. The World Health Organization (WHO) offers a definition of QOL; "An individual's perception of their position in the in the life in the context of the culture in which they live and in relation to their goals, expectations, standards and concerns" (Group, 1995). While the health-related quality of life (HRQOL) is described as:

"A term referring to the health aspects of quality of life, generally considered to reflect the impact of disease and treatment on disability and daily functioning; it has also been considered to reflect the impact of perceived health on an individual's ability to live a fulfilling life. However, more specifically HRQOL is a measure of the value assigned to duration of life as modified by impairments, functional states, perceptions, and opportunities, as influenced by disease, injury, treatment and policy" (Mayo, 2015).

E-health has become an integral part of the healthcare systems changing the management of data, service appointments and delivery, treatment prescription, and health monitoring, leading to more efficient workflows at all levels, less errors and more efficient and timely treatment (Fonseca, 2021). For example, the use of electronic medical records, with all patient information stored centrally, prevents inappropriate prescription and administration of medication during medical care and ensures more efficient treatment and insight into patient medical history (C. De Grood, 2016).

The success of e-health in a country is related to four stakeholders involved in the process: entrepreneurs/public health governing bodies, healthcare professionals, patients, and the bodies responsible for health insurance and assistance policies (I. Swinkels, 2018). To implement information technologies in healthcare, e-health strategies have to occur in an integrated manner, by development of norms, laws, or regulations.

Around 2.5 billion people worldwide own a mobile phone opening a huge potential for mHealth and unprecedented access to clinical diagnostics and treatment advice [47]. In the US 56% of physicians talked about mHealth with patients and 26% have been asked about mHealth by a patient (PWC Provider Survey) (Rowland, 2020). mHealth brings the largest improvement margin to the people in rural and developing areas, due to the long time needed to ensure service delivery. It can overcome the lack of diagnostic infrastructure availability and expertise at local community levels, as long as smartphone adoption in rural areas is rather similar to that of urban or developed areas (K, 2015).



Available at: <https://www.net4age.eu/d8-final-report-digital-innovation-and-implementation>

7. EXPLOITATION AND BUSINESS MODELS

Business models for addressing the needs of the ageing population, particularly through the integration of digital services, devices, and tools into open platforms, are essential to creating Smart Healthy Age-Friendly Environments (SHAFE). The SHAFE framework incorporates diverse business models to support sustainable, inclusive, and age-friendly services and infrastructure. These models aim to create integrated health and social care pathways, promote assistive technologies, stimulate job creation and social innovation, and develop nature-based architectural solutions.



Integrated Health and Social Care Pathways

Emphasize the integration of health and social services to provide coordinated, person-centered care. It includes collaborative networks of healthcare providers, social services, and digital health platforms, ensuring continuity of care and supporting both clinical and non-clinical needs. These pathways require clear governance structures, sustainable financing, and community involvement to maintain long-term impact and accessibility.

These models focus on structuring services that combine healthcare and social support with technology, creating seamless care pathways. Revenue models vary from public-private partnerships to subscription services, often subsidized by healthcare institutions or insurance providers. By integrating telemedicine, remote monitoring, and data-driven health insights, these pathways can deliver personalized care cost-effectively.



Business Models for Assistive Technologies

Such as mobility aids, smart home sensors, and health-monitoring wearables, enable people to live independently and safely. Business models in this area often involve partnerships with device manufacturers, service providers, and insurance companies to make these devices accessible. Financing options include device rental models, service bundles, and premium subscriptions, enhancing affordability and accessibility.



Business & Social Innovation

SHAFE's focus on business and social innovation drives job creation within health, social care, and technology sectors. Through cross-sector collaborations, the SHAFE framework fosters new roles in care coordination, technology support, and community health, contributing to economic growth and improved healthcare accessibility. Social innovation efforts, such as community-driven care models and co-creation initiatives, enhance the value and inclusivity of age-friendly services.



Architecture and Urban Nature-Based Solutions

SHAFE also extends to architecture and urban planning through nature-based solutions (NBS). These solutions involve integrating green spaces, accessibility features, and sustainable materials in building designs to promote well-being for older adults. Implementing NBS requires collaborative governance, involving stakeholders from local governments, private firms, and communities to design, fund, and maintain these spaces. Financing models range from public funding to private investment and community-based initiatives. By leveraging these models, SHAFE promotes a holistic, economically viable approach to age-friendly environments, ensuring that health, independence, and well-being are prioritized in both built and natural spaces for the aging population.

Ante and post-evaluations of social, economic and environmental impacts

SHAFE realisation would best mature in local or regional ecosystems, where public authorities, academia, businesses/civil society organisations and citizens collaborate. SHAFE facilitators could be social innovators who fully understand the local or regional situation, can bring parties together and are result-oriented. Public authorities play an important role in the realisation and implementation of SHAFE, either as facilitators, bringing together stakeholders and the administrative pillars of policymaking, creating awareness and support or as well as financers of its implementation. One of the main questions, however, remains and that is: what are the benefits of SHAFE, and how can we measure them? How can you define the impact of SHAFE, and who and what will be impacted?

To enable the impact assessment of a holistic approach such as smart healthy age-friendly environments, the members of the COST Action members dusted off an old instrument, the Social Economic and Environmental

Impact tool (SEE-IT) developed within the Horizon AFE-INNOVNET project¹ and overhauled it. The new tool is called SHAFE SEE-IT. The SHAFE SEE-IT² considers the potential impacts of various solutions within the framework of Smart Healthy Age-Friendly Environments (SHAFE). This includes large-scale programs, such as community revitalization initiatives (encompassing both physical infrastructure and social structures) as well as agendas focused on healthy lifestyles and preventive measures. Additionally, smaller-scale projects, such as digital applications for social connectivity, the presence of social workers and coaches within neighbourhoods, and adaptations in home and infrastructure construction, align with SHAFE's approach and impact considerations. The SHAFE SEE-IT tool is designed to impact citizens across all age groups, with the scope of impact assessments limited only by the geographical level or the specific target group(s) defined for each program or initiative.

SHAFE SEE-IT assessment process

The SHAFE SEE-IT process foresees 5 steps to perform the ex-ante or ex-post evaluations.



Figure 6. The SHAFE SEE-IT 5 steps

¹ https://www.agefriendlyeurope.org/sites/default/files/AFE-INNOVNET_D4.2_FINAL_0.pdf

² <https://zenodo.org/records/10210296>

SHAFE SEE-IT process in sum:

AIM: Before starting the process of impact assessment, it is important to bring together a multidisciplinary and diverse group of stakeholders. This diverse group starts with identifying the core problem and to define the aim and objectives it wants to achieve. This work is quite crucial: it sets the overall direction and extent for the assessment.

SCOPE: The second step is the definition of the scope of the assessment. The question is what, who and when will be assessed. The scope starts with the zero-base situation: to define the current situation and which solutions can be found.

ASSESSMENT: The next step is the actual assessment phase. In this phase, the group chooses which domains and features of the social, economic and environmental impacts are applicable. With this list, the group defines the direction of each item: is it positive, neutral or negative? Is the impact neutral, strong or very strong? And finally, who or what is directly or indirectly impacted?

In this assessment phase, the group can also identify the quantity of the impacts. Such as the scale, significance, monetisation, costs, gains and losses, quality-adjusted years or costs of illness.

ANALYSIS: Having all the details from the assessment phase, the group will work on the analysis of the findings. In this phase, they will consider every possible solution, impact, and quantity to come to a joint decision on the advice the group would give to the decision-makers.

RESULTS: In the final phase of the SHAFE-SEE IT, the group presents and discusses the findings with the decision-makers.



Social, Economic and Environmental Impacts of SHAFE, published in November 2023, by Willeke van Staalduinen, Carina Dantas, Lucia Thielman and Luiza Spiru. <https://zenodo.org/records/10210296>


8. MODULES

This section presents a summary and the link to each of the following 5 learning modules:

NET4
Age-Friendly

Module
Digital Innovations and Implementation

Working Group 3



COST
European Cooperation in Science and Technology


COST (European Cooperation in Science and Technology) is a funding agency for research and innovation activities. Our Actions help connect research infrastructures across Europe and enable scientists to promote their work by interacting with their peers. To discover their research, contact and proposals: <https://www.cost.eu>

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NET4
Age-Friendly

Module
Business and Evaluation Models on SHAFE

Working Group 5



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NET4
Age-Friendly

Module
Integrated health and wellbeing pathways

Working Group 2



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NET4
Age-Friendly

Module
Policy, Strategies And Funding

Working Group 4



COST
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NET4
Age-Friendly

Module
User-Centered Design (UCD) in Smart, Healthy, Age-Friendly Environments (SHAFE)

Working Group 1



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9. SHAFE-RELATED STANDARDS AND GUIDELINES

Smart Healthy Age-Friendly Environments are “smart, adaptable and inclusive solutions that can help improve and support independent life throughout the course of life, regardless of age, gender, disabilities, cultural differences and personal choices.”³ Based on this conceptualisation, intensive desk research was performed in Spring 2024 to explore and include relevant standards and guidelines to support the development of these solutions.

A **standard** is “a document that provides requirements, specifications, guidelines or characteristics that can be used consistently to ensure that materials, products, processes and services are fit for their purpose”.⁴

“Standards allow technology to work seamlessly and establish trust so that markets can operate smoothly.

They:

- provide a common language to measure and evaluate performance,
- make interoperability of components made by different companies possible, and
- protect consumers by ensuring safety, durability, and market equity.”

A **guideline** is “information intended to advise people on how something should be done or what something should be”.⁵

The relevant **SHAFE stakeholders** that may use the standards and guidelines presented as results of this desk research are the defined personas in NET4Age:



SHAFE Health & Social Care

Professional carers providing or coordinating the provision of health and social care services to people.

³ <https://shafe.eu/what-is-shafe/>

⁴ <https://guides.library.umass.edu/c.php?g=719645&p=5126968>

⁵ <https://dictionary.cambridge.org/us/dictionary/english/guideline>

SHAFE Policymakers at all geographical levels

People who contribute to the definition of public policies, strategies and funding programmes.



SHAFE Multi-disciplinary project teams

Groups of practitioners from multiple domains involved in designing, planning, implementing, integrating and maintaining SHAFE.



SHAFE Promoters/developers

People or companies developing a building or a service to be used by people.



Figure 7. SHAFE-related Standards and Guidelines - Relevant Stakeholders

The desk research started with collecting standards organisations. Standards' information was obtained from the standardisation organisations CEN CENELEC, ISO, ETSI, IEEE, ANSI, AFNOR and DIN. The desk research further concentrated on the publications of the World Health Organization in the IRIS library.⁶

In total, 215 standards and guidelines were identified and reported in an [Excel spreadsheet](#). The standards and guidelines cover topics such as ageing, disease, education, healthcare, sustainability and technology. The standards and guidelines also became part of the Repository of the SIRENE project.⁷

⁶ <https://iris.who.int/>

⁷

<https://app.powerbi.com/view?r=eyJrIjoiaWJlYMDY1ZjMtNmMzYi00ODRILWE0ODYtMDE2Mm14ZDgxNTkklwidCI6IjJYjFjNzU3LWY1ZDAtNGQ3Ny1iYzg5LWY5OWQ4MTlwZmZlMyIsImMiOj9>



FOR MORE INFORMATION

- https://www.net4age.eu/sites/default/files/2024%20Guidelines%20and%20standards%20on%20SHAFE%20final%20report_final%20version.pdf
- https://view.officeapps.live.com/op/view.aspx?src=https%3A%2F%2Fwww.net4age.eu%2Fsites%2Fdefault%2Ffiles%2F2024%2520Overview%2520existing%2520SHAFE%2520related%2520standards%2520and%2520guidelines_final%2520version.xlsx&wdOrigin=BROWSELINK

10. THE REFERENCE FRAMEWORK

The Reference Framework aims to collect the knowledge and experience from multidisciplinary teams in addressing concrete problems or challenges while engaging relevant stakeholders in the co-creation process.

SHAFE

The original approach on SHAFE is conceptualised as follows:



Figure 8. SHAFE Concept

THEMATIC TOPICS

During the development of NET4Age-Friendly the further expansion of some topics led to this matrix:

Health and social care integration

At the core of SHAFE is the seamless integration of health and social care services, enabling individuals, particularly people in vulnerable situations, to access continuous and comprehensive support.

Architecture and urban planning

Creating environments that promote health and well-being requires careful planning and design to make spaces more accessible, inclusive, and sustainable.

Participatory approaches

Successful SHAFE implementation depends on involving communities in decision-making processes, ensuring that solutions meet the needs of all stakeholders.



Digital technology integration

Technology plays a transformative role in SHAFE, supporting independent living, enhancing connectivity, and enabling efficient care management.

Green and sustainable practices

A key component of SHAFE is ensuring environmental sustainability, which contributes to the overall health of communities and the planet.

Viable business models and practical implementation

For SHAFE to be scalable and sustainable, it must be supported by viable financial models and practical approaches.

Figure 9. Thematic topics derived from the NET4Age-Friendly work



This involves:

- **Interdisciplinary collaboration:** health professionals, social workers, and care providers must collaborate to deliver holistic care and prevent care fragmentation.
- **Community-based health services:** decentralising health services into community settings can improve accessibility and make healthcare more approachable and preventive.
- **Personalised health plans:** leveraging digital health records and analytics, personalized plans can tailor care based on individual needs and enhance outcomes through targeted interventions.



This involves:

- **Telemedicine and remote monitoring:** widespread adoption of telemedicine allows individuals to access healthcare remotely, reducing barriers for rural and less mobile populations.
- **Smart homes and assistive technologies:** homes equipped with IoT devices, such as fall sensors and automated lighting, help maintain independence and safety.
- **Data privacy and security standards:** ensuring robust cybersecurity measures and compliance with GDPR standards is essential to protect personal data and maintain public trust in digital solutions.



This involves:

- **Universal design principles:** buildings, public spaces, and transportation systems should be designed to be accessible to all, including people with disabilities and older adults.
- **Green spaces and recreational areas:** access to green areas, parks, and safe walking paths promotes physical and mental well-being, contributing to active lifestyles and social interaction.
- **Sustainable infrastructure:** implementing green building practices, energy-efficient designs, and eco-friendly materials supports both environmental sustainability and healthier living spaces.



This involves:

- **Energy-efficient and eco-friendly design:** implementing renewable energy sources, water conservation systems, and waste reduction practices reduces environmental impact.
- **Climate-resilient infrastructure:** preparing urban and rural areas for climate change, through flood-resistant designs and heat-mitigation strategies, protects communities, driving long-term viability.
- **Promotion of active mobility:** developing pedestrian- and cycle-friendly infrastructures encourages physical activity, reduces emissions, and fosters a more vibrant, healthy environment.



This involves:

- **Co-design and co-creation:** residents, especially vulnerable people, older adults and persons with disabilities, should be actively involved in designing and refining SHAFE solutions.
- **Public awareness and education:** providing education about healthy lifestyles, digital literacy, among others empowers people to make informed decisions, promoting community buy-in.
- **Stakeholder collaboration:** bringing together government agencies, NGOs, private companies, and community groups fosters an inclusive approach that benefits from diverse perspectives and expertise



This involves:

- **Universal design principles:** buildings, public spaces, and transportation systems should be designed to be accessible to all, including people with disabilities and older adults.
- **Green spaces and recreational areas:** access to green areas, parks, and safe walking paths promotes physical and mental well-being, contributing to active lifestyles and social interaction.
- **Sustainable infrastructure:** implementing green building practices, energy-efficient designs, and eco-friendly materials supports both environmental sustainability and healthier living spaces.

STAKEHOLDERS

Where the following stakeholders are relevant and conceptualised as follows:

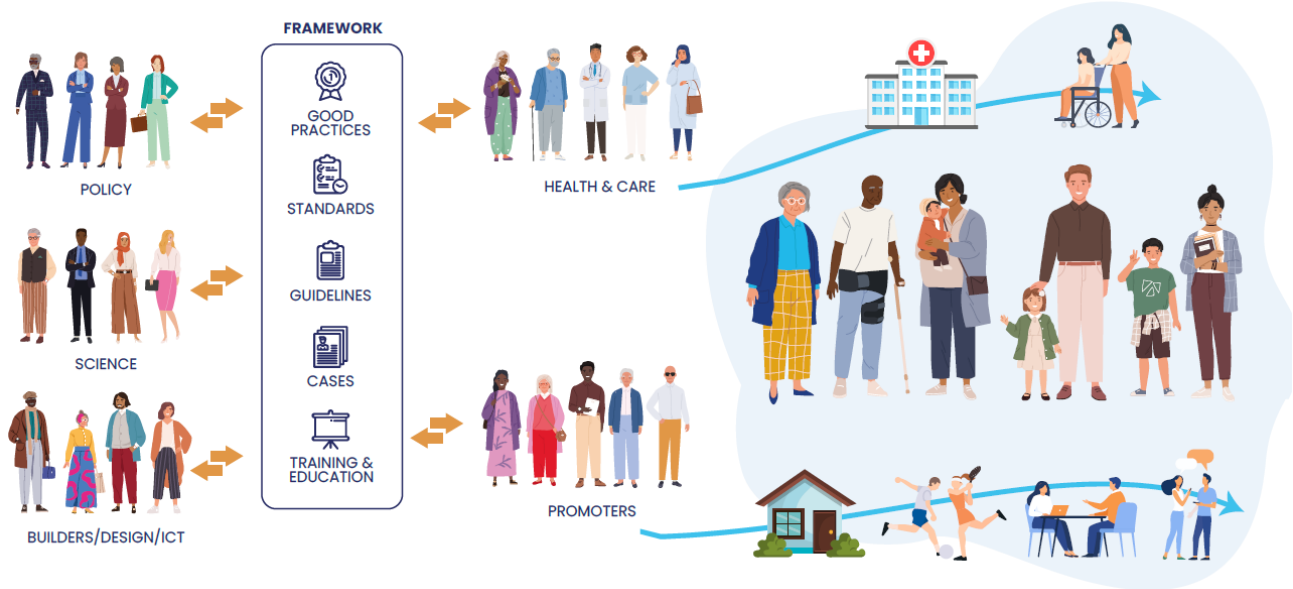


Figure 10. SHAFE Stakeholders Concept



SHAFE users

SHAFE users - an exemplary family with a pregnant woman, a baby, a pre-teen child, adolescent, a 40-year-old man and grandparents, one of them with a disability. This highlights a life course approach.



SHAFE Health & social care

SHAFE Health & social care – professional carers providing or coordinating the provision of health and social care services to people. This professional can work in a hospital, a primary care center, a daily care or residential care unit for older adults, but it can also work, for example, in dedicated rehabilitation centres for adults or youngsters. Integrator of health and care.

The character of SHAFE health and care is the so-called SHAFE integrated case manager of patients. He/she is the linking pin between health and social care and the patient and his family, providing support to patients in the sense of bringing together hospital care, long-term care, social care, community support on a person-centred basis. He/she oversees the full field of health and care, digital solutions and sustainable environments and can co-define the best solutions at home or in sheltered housing facilities.



SHAFE Policy makers

SHAFE Policy makers (at local, regional, national, or wider levels) - people that contribute to the definition of public policies, strategies, and funding programs for, e.g., urban regeneration, built environments, smart cities and communities, integrated care.

The SHAFE policymaker is characterised as someone who can define and facilitated SHAFE policies at all geographical levels. He/she oversees the fields of social and physical environments and can advise and promote governmental facilities and support, including funding, information and person-centred solutions for citizens, bringing together the different field of policymaking in public authorities.



SHAFE R&I and Academia

SHAFE R&I and Academia – researchers, students and professors in multiple domains interested in addressing societal challenges through sustainable, ergonomic, and ethical approaches mingling social sciences, technology, design, health and care, built environments, urban planning, architecture, materials, and community engagement.

The SHAFE scientist is the general scientist that can combine SHAFE relevant fields in research, such as social sciences, technology, architecture and built environments and community engagement and communication. He/she tracks down from relevant fundamental sciences the elements to apply into further research, practices and education.



SHAFE Multi-disciplinary project teams

SHAFE Multi-disciplinary project teams – groups of practitioners from multiple domains involved in designing, planning, implementing, integrating, and maintaining healthy environments, with technology-enabled services to be experienced by people, including those with special needs.



SHAFE Promoters/Developers

SHAFE Promoters/Developers - people or companies developing a building a service to be used by people (it can be a residential care centre, a rehabilitation centre, a hospital, a house, an apartment building, or a public space, for example), including real estate promoters, AI developers, tech SMEs, architecture offices, etc.
Business men/women

The SHAFE developer/provider is the person who is offering products and services to citizens. He/she is a business provider or entrepreneur. Products and services can be health and care, digital solutions, housing, built environments, culture or leisure.

The opportunities of SHAFE offerings are huge.

RESOURCES

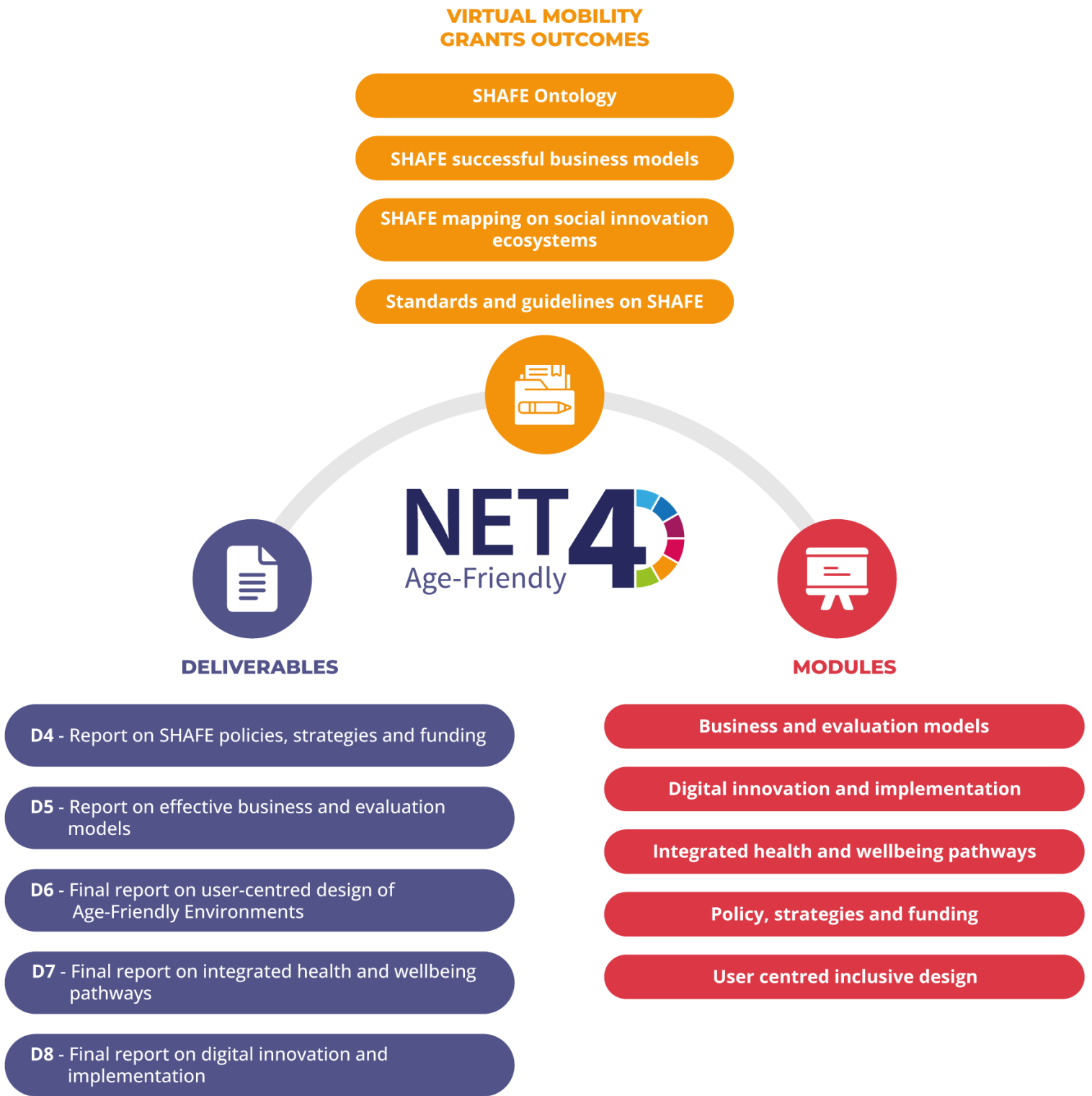


Figure 11. NET4Age-Friendly Results

11. GOING INTO ACTION

As with any innovation project, after defining the problem (identified as **Challenges**), it is crucial to understand the current state-of-the-art by examining past interventions that addressed similar aims. Both the NET4Age-Friendly public deliverables D4 to D8 and the SIRENE project documents and repository serve as excellent starting points for creating contextual awareness. These sources benefit from the diversity of their authors, who come from multiple countries, cultures, age groups, and community sizes. Additionally, they provide multiple perspectives, including those of researchers, clinicians, caregivers, technologists, urban planners, and architects, among others.

<p>Challenges <i>What challenge are you addressing and why? What is the state-of-the-art that supports it?</i></p>	<p>Target audience <i>Who is your target audience? How would you describe them and their specific needs?</i></p>	<p>User-Centred Design <i>What methods will you use to involve users in the design process, and how will their feedback influence development? How will you communicate with your target audience, and which channels will you use to reach them effectively?</i></p>	<p>Sustainability <i>What activities, networks, or resources can be employed to ensure the long-term sustainability of the solution?</i></p>
	<p>Personas <i>Select Personas from SIRENE Social Innovation Framework. What are their pains (biggest frustrations, problems) and gains (opportunities and benefits) they might experience?</i></p>		<p>Impact <i>How will you ensure economic, social, and knowledge impacts? What indicators will you use to measure and benchmark these impacts?</i></p>
	<p>Technology <i>Which technology will be used and how will it be implemented? How will it alleviate audience pains and create benefits? What are the main adoption challenges?</i></p>		

Figure 12. CANVAS for bringing SHAFE to Action

After defining the Challenge, whether it is a problem to solve or an ambition to achieve, it is crucial to identify the **Target Audience** for whom we are planning the solution and to understand their specific needs. This definition should, whenever possible and applicable, consider widely accepted classification scales, as this will facilitate subsequent impact analysis and benchmarking. The target audience may or may not be the direct beneficiaries of an intervention. For instance, addressing family members might be necessary to meet a specific need of a population. The SIRENE Social Innovation Framework categorizes stakeholders using Garcia Family characters and includes other groups such as health and social care professionals, policymakers, researchers and academics, and promoters and developers.

Direct beneficiaries of our actions may be framed into **Personas**. User personas help design solutions to meet user needs. They are fictional characters representing real target audiences and summarizing audience research concisely by including relevant data like age, gender, job type, marital status, financial status, personality traits, motivations, and goals. Though hypothetical, these attributes should be based on real-world data to accurately reflect the audience's thoughts and intentions. The SIRENE project Garcia family provides a relevant starting point for this process of clustering typical aspects of normal families in Europe.

Technology, particularly digital technology, is an important factor to consider. It is crucial to select candidate solutions that address the initial problem and ensure they will be accepted and adopted. This involves several aspects like those mentioned in (Venkatesh, Morris, Davis, & Davis, 2003), some of which have been referenced in previous sections. Technology solutions must consider main adoption challenges (for instance, usability, cost, or access to infrastructure) and provide tangible benefits to users, whether they are primary end-users or the target audience.

As mentioned previously, planning **User-Centred Design** process is fundamental to ensure that the resulting action, product or solution is able to address the problem or challenge, but, most importantly, that is adopted by those that ultimately should benefit from it. Empowering users, collecting and implementing with their feedback is a critical part of the social innovation process.

Lastly, ensuring long-term **sustainability** of the solution is essential. This depends on the business model employed, and more importantly, on the channels, partnerships, and initial engagement with customers that are established. Additionally, it may also rely on processes related to regulation or reimbursement schemes. Therefore, it is crucial to identify the necessary networks and resources to secure the long-term sustainability of our process.

Impact assessment is always an important aspect of any project. In some cases, it is now being required for reimbursement, an economic and health assessment of benefits from the solution. Identifying accepted KPI is also extremely important to benchmark the planned solution with other similar scenarios.

This canvas aims creating a structured approach to the co-creation process which multidisciplinary teams should conduct to develop and implement innovative solutions using SHAFE approach and tools.

12. NEXT STEPS – SHAFE FOUNDATION

The results from NET4Age-Friendly and other initiatives such as the SIRENE project⁸ will be transferred to the SHAFE Foundation (registration number NL 82637393, <https://shafe.eu/>). The current directors of the SHAFE Foundation are the CEOs of the project coordinator SHINE 2Europe and AFEdeMy. The SHAFE Foundation guarantees the open access and public availability of the SIRENE results for the coming five years.

The SHAFE Foundation's mission is to research, develop, network and promote the implementation of Smart Healthy Age-Friendly Environments (SHAFE) in Europe and in other regions of the world. To achieve the goals of this mission, the Foundation will:

- 1) Develop fundamental and applied research, creating and collaborating on research reports, publications and other forms of research in the scope of SHAFE or adjacent fields.
- 2) Create, maintain and promote cooperation in a network of all types of stakeholders from every region of the world, working in the field of SHAFE or related areas.
- 3) Develop and promote the creation of political strategies and training, actions and activities related to policy making and skills development, enabling the promotion and implementation of SHAFE at all levels.
- 4) Promote by all means the implementation of societies that are inclusive and fit for all people, regardless of their age, gender, race, culture or specific needs through a coordinated approach to the combination of the built environment, ICT, health and care and the personal and social context.
- 5) Communicate and disseminate SHAFE and related areas in all possible ways. And
- 6) Fund relevant initiatives in the field of SHAFE and make efforts to obtain the necessary donations and public and private funds.

The short-term actions of the SHAFE Foundation are to select and appoint Ambassadors of SHAFE in the world and to offer the opportunity to SIRENE and NET4Age-Friendly members to become a Network member of the SHAFE Foundation. The Network members will be invited for SHAFE-related events, proposals, projects and other opportunities. The Foundation further considers appropriate funding opportunities at regional, national and European levels and will apply (in partnership) for them.

For the longer term, the SHAFE Foundation aims to organise networking events to keep the network alive, fund local or regional pilot initiatives, and actively participate in projects. The first project was gained in the field of Erasmus+: Artificial Intelligence in for healthcare professionals (2024-2026).

⁸ <https://sireneproject.eu/>

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MAIN CONTACTS AND LEADERSHIP

Action Chair	Ms Carina DANTAS
Action Vice Chair and Grant Holder	Ms Wilhelmina VAN STAALDUINEN
WG1 Leader	Dr Oscar ZANUTTO
WG2 Leader	Prof. Aurelija BLAZEVICIENE
WG3 Leader	Mr Kenneth BONE
WG4 Leader	Prof Luiza SPIRU
WG5 Leader	Mr Pedro ROSEIRO
Training Coordinator	Dr Ivan CHORBEV
Science Communication Coordinator	Dr Maddalena ILLARIO
Grant Awarding Coordinator	Dr Milica SOLAREVIĆ
Grant Awarding Committee Member	Dr Tatjana LONČAR-TURUKALO

WORKING GROUP MEMBERS

Prof William KEARNS	Prof Joost VAN HOOFF	Dr Blanca DEUSDAD	Ms Sonja HANSEN
Prof Kazumasa YAMADA	Mr Kenneth BONE	Dr Aleksandra MLADENOVIC DJORDJEVIC	Dr Viera BASTAKOVA
Dr Lela MIRTSKHULAVA	Dr Lenka LHOTSKA	Dr Matteo MOSCATELLI	Mr Hossein CHAVOSHI
Prof Avni REXHEPI	Dr Leonardo ANGELINI	Dr yael BENVENISTI	Dr Hamdi TEKIN
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Dr Helen KELLY	Dr Lucie VIDOVICOVA	Prof Jochen BAUMEISTER	Mr Muhammet Talha UZUN
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