U.PORTO

2ºCICLO DE ESTUDOS
MASTER IN PUBLIC HEALTH

Human-Centred Design in a digital health literacy intervention for older adults: The case of the SMARTageCARE project

Tainá Costa de Souza

M

2026

FACULDADE DE **MEDICINA**

Tainá Costa de Souza

Human-Centred Design in a digital health literacy intervention for older adults: The case of the SMARTageCARE project

Dissertação de candidatura ao grau de Mestre em Saúde Pública apresentada à Faculdade de Medicina da Universidade do Porto

Supervisor: Doutor Bruno Giesteira

ID+ Instituto de Design Media e Cultura, grupo Design4Health

Departamento de Design, Faculdade de Belas Artes, Universidade do Porto**,** Porto, Portugal

Co-Supervisor: Doutora Ana Lúcia Nunes Henriques

EPIUnit - Instituto de Saúde Pública, Universidade do Porto, Portugal

Laboratório para a Investigação Integrativa e Translacional em Saúde Populacional (ITR), Universidade do Porto, Porto, Portugal

Departamento de Ciências da Saúde Pública e Forenses e Educação Médica, Faculdade de Medicina, Universidade do Porto, Porto, Portugal

Porto, 2026

This work was supported by the ERASMUS+ programme of the European Union (KA220-ADU, ref. 2023-1-PT01-KA220-ADU-000166402).

Acknowledgements

Dedico este trabalho à minha mãe, que sempre acreditou no poder da educação para transformar vidas. A educação foi algo que a senhora sempre priorizou na minha vida, e hoje eu sou a primeira da família a se tornar mestre! Obrigada por acreditar que eu sou capaz de estar onde eu estou.

Quero agradecer a todos que estiveram comigo nessa caminhada.

Em primeiro lugar, ao Professor Bruno Giesteira, por ter acreditado em mim e por ter me proporcionado a oportunidade de integrar um projeto europeu tão singular como o SMARTageCARE. Agradeço igualmente à Professora Ana Henriques, por todo o apoio prestado ao longo deste trabalho.

A toda a equipe do projeto, em especial a equipe de Portugal. Trabalhar com vocês foi uma experiência extraordinária de aprendizagem e troca.

À Ediane, Ana Luiza e Kathi, as amizades que o mestrado me trouxe e que tornaram este percurso mais leve e divertido.

À minha família e aos meus amigos, que são como família, em especial à Thaís, Sabrina, Geórgia e Juan, e a todos os outros do Brasil e Portugal, que estiveram comigo, me dando apoio de diferentes formas e me lembrando de que não estou só.

Por fim, ao meu grande amor e companheiro, Kelvin Campelo, por todo o apoio, a paciência e o cuidado ao longo dessa jornada. Sem você, nada disso teria sido possível.

Table of contents

Resumo (PT) 9
Abstract 10
1. Introduction 11
1.1 Population ageing as global health challenge 11
1.2 Digital transformation in health 12
1.2.1 The rise of digital health: concepts and policies 12
1.2.2 The impact of the digital transformation in health 14
1.3 Digital health literacy (DHL) 14
1.3.1 Digital health literacy as digital determinant of health 16
1.3.2 Digital health literacy in older adults 16
Individual barriers 17
Technological barriers 17
Social and contextual barriers 17
Implications for interventions 18
1.3.3 Digital health literacy interventions for older adults 18
1.4 Design in health 19
2. Objectives 22
3. Methodology 23
3.1 The SMARTageCARE Project 23
3.1.1 The Ikigai Play Toolkit 24
3.2 Study design 25
3.2.1 Researcher positionality 25
3.3 State of the art on HCD applied to digital health for older adults 26
3.3.1 Delimitation and method 26
3.3.2 HCD methods in the identified studies 28
3.3.3 From digital exclusion to a design problem 29
3.3.4 Participation as method and learning experience 30
3.3.5 Recurring requirements and scope of evaluations 31
3.4 Participants and engagement strategies 32
3.5 HCD methods and techniques 33
3.5.1 Phase 1: Discover (March 2024 to May 2025) 33
Participatory Workshops 33
Affinity Mapping 33
Technology Use Questionnaire 34
Meta-narrative literature review 34
3.5.2 Phase 2: Ideation (June to September 2025) 35
Personas and Scenarios 35
Design Requirements 36
3.5.3 Phase 3: Prototyping (September 2025 to March 2026) 36
Brainstorm Sessions 36
3.5.4 Phase 4: Validation and Refinement (March to May 2026) 37
3.6 Pilot Evaluation 37
3.6.1 Pilot evaluation data 37

3.6.2 Pilot evaluation analysis 38
3.7 Ethical considerations 39
4. Results 40
4.1 The HCD development process of the Ikigai Play Toolkit 40
4.1.1 Characterisation of the user and context 40
Results from Participatory Workshops 40
Affinity Map 40
Technology Use Questionnaire 42
Results from Meta- Narrative Literature Review 43
4.1.2 Ideation results 45
Personas and Scenarios 45
Design requirements 50
4.1.3 Prototyping outcomes 50
Structure 50
Direct contributions to toolkit activity design 52
4.2 Pilot evaluation and refinement 53
4.2.1 Pilot evaluation results 55
4.2.2 Toolkit refinement 56
5. Discussion 58
5.1 HCD applied to the promotion of digital health literacy among older adults 58
From the identification of needs to design decisions 58
Exploratory evaluation of the pilot implementation across three national contexts 59
From pilot evaluation to prototype refinement 61
5.2 Strengths and limitations 62
5.3 Towards a hybrid model of intervention development 63
6. Conclusion 65
References 67
Appendix A. Checklist for Reporting Health Research Involving Design 75
Appendix B. Complete Search Strings 77
Appendix C. Technology use questionnaire 79
Appendix D. Pilot assessment questionnaire applied to the older adults. 83
Appendix E. Consortium Synthesis Report on Toolkit Structural Limitations and Module Development. 84
Appendix F. A qualitative observational synthesis from a transnational feedback meeting 88
Appendix G. Feedback report documenting facilitator observations across the Polish pilot implementation sessions. 90
Appendix H. Affinity Mapping Results. 100
Appendix I. Descriptive Statistics from the Technology Usage Questionnaire 113
Appendix J. Representative Sample of the final version of Ikigai Play Toolkit 115
Appendix K. Published Book Chapter 145
Appendix L. Published Conference Paper 183

List of Abbreviations and Acronyms

CeHRes – Centre for eHealth and Wellbeing Research

DDoH – Digital Determinants of Health

DHL – Digital Health Literacy

DHLI – Digital Health Literacy Instrument

EBCD – Experience-Based Co-Design

EHDS – European Health Data Space

eHEALS – eHealth Literacy Scale

EU – European Union

GDPR – General Data Protection Regulation

HCD – Human-Centred Design

ICT – Information and Communication Technologies

ISO – International Organization for Standardization

KPI – Key Performance Indicator

MRC – Medical Research Council

PLAY – Game Usability Heuristics

SAC – SMARTageCARE Project

SHARE – Survey of Health, Ageing and Retirement in Europe

SWOT – Strengths, Weaknesses, Opportunities, Threats

TAM – Technology Acceptance Model

UCD – User-Centred Design

WHO – World Health Organization

List of Figures

Figure 1. PRISMA flow diagram of the literature search and selection process..... 28
Figure 2. Affinity diagramming session with the Portuguese partner group..... 43
Figure 3. Affinity diagramming session with the Slovenian partner group..... 43
Figure 4. User persona card for Digital Transition: Manuel Oliveira (72, Portugal)..... 47
Figure 5. Usage scenario for Digital Transition (Manuel Oliveira, 72, Portugal)..... 47
Figure 6. User persona card for eHealth: Teresa Marciniak (76, Poland)..... 47
Figure 7. Usage scenario for eHealth (Teresa Marciniak, 76, Poland)..... 48
Figure 8. User persona card for Citizenship: Rajko Ostronič (78, Slovenia)..... 48
Figure 9. Usage scenario for Citizenship (Rajko Ostronič, 78, Slovenia)..... 49
Figure 10. Facilitator persona card: Daniela Lucia (33, Italy)..... 50
Figure 11. Usage scenario for Facilitator (Daniela Lucia, 33, Italy)..... 50
Figure 12. High-fidelity prototype components of the Ikigai Play Toolkit..... 53
Figure 13. Pilot session in Italy: "Who Decides?" activity..... 55
Figure 14. Pilot session in Poland: "What Does It Do?" activity..... 55

List of Tables

Table 1. Consortium partners by country within the SAC project..... 24

Table 2. Frameworks, Methods/Tools and HCD phases of the reviewed studies 29

Table 3. Pain points and solutions identified per thematic axis 42

Table 4. Descriptive results from the Technology Use Questionnaire (n=57)..... 44

Table 5. Evaluation responses by dimension, country and module (scale 1–5, n=318)..... 56

Resumo (PT)

A crescente digitalização dos sistemas de saúde tornou a literacia digital em saúde uma competência cada vez mais relevante para o acesso à informação e aos serviços de saúde digitalizados. Contudo, os adultos mais velhos enfrentam barreiras acentuadas decorrentes da interação entre fatores individuais, tecnológicos e contextuais, posicionando a literacia digital em saúde como um determinante digital de saúde. As intervenções existentes neste domínio foram frequentemente concebidas sem a participação ativa dos seus destinatários e tendem a privilegiar competências técnicas, negligenciando dimensões motivacionais e psicossociais que a literatura identifica como determinantes para a adoção e envolvimento. O Design Centrado no Humano tem vindo a ser adotado no desenvolvimento de intervenções de saúde digital pela sua capacidade de gerar soluções alinhadas com as necessidades reais dos utilizadores; contudo, a sua aplicação ao desenvolvimento de intervenções educativas de promoção da literacia digital em saúde entre adultos mais velhos encontra-se ainda insuficientemente documentada.

A presente dissertação tem como objetivo geral analisar como os princípios e métodos do Design Centrado no Humano orientaram o desenvolvimento, a implementação piloto e o refinamento do Ikigai Play Toolkit, uma intervenção lúdico-educativa concebida para promover a literacia digital em saúde entre adultos mais velhos no âmbito do projeto SMARTageCARE, uma iniciativa financiada pelo programa Erasmus+ que operou em oito países europeus. Especificamente, pretende-se analisar o processo de desenvolvimento do toolkit, desde a identificação das necessidades dos adultos mais velhos até às decisões de design que orientaram a prototipagem da intervenção, e realizar uma avaliação exploratória da implementação piloto em Portugal, Itália e Polónia.

Foi conduzido um estudo metodológico de desenvolvimento e avaliação piloto da intervenção, orientado pelos princípios do Design Centrado no Humano, integrando workshops participativos, revisão meta-narrativa da literatura, criação de personas e cenários, requisitos de design e prototipagem iterativa, seguidos de uma avaliação piloto exploratória que recolheu 318 questionários pós-atividade em quatro dimensões: desempenho, eficácia percebida imediata, eficiência e usabilidade.

O processo de desenvolvimento resultou num toolkit predominantemente analógico e modular, ancorado na filosofia Ikigai e no framework Positive Play, composto por 43 atividades distribuídas por quatro módulos temáticos. A avaliação piloto revelou que o desempenho foi consistentemente a dimensão melhor avaliada enquanto a usabilidade foi a mais baixa, que a relevância percebida variou conforme o contexto nacional e que as mecânicas competitivas foram percecionadas como estigmatizantes, conduzindo à remoção de cinco atividades e à redução para 38 atividades na versão final. Estes resultados sugerem que o Design Centrado no Humano pode contribuir para o desenvolvimento de intervenções de promoção da saúde mais alinhadas com as condições reais da população-alvo e que a promoção de competências digitais pode não exigir que a própria intervenção seja mediada por um meio digital. Investigações futuras devem aplicar instrumentos validados de literacia digital em saúde em designs pré-pós e longitudinais, recolher dados sociodemográficos desde o início e investigar o papel da mediação do facilitador na escalabilidade de intervenções desta natureza.

Palavras-chave: Design Centrado no Humano, Literacia Digital em Saúde, Adultos Mais Velhos, Design Participativo, Intervenção Educativa

Abstract

The increasing digitalisation of healthcare systems has made digital health literacy an increasingly relevant competency for access to information and digitalised health services. However, older adults face pronounced barriers arising from the interplay of individual, technological, and contextual factors, positioning digital health literacy as a digital determinant of health. Existing interventions in this domain have frequently been designed without the active participation of their intended recipients and tend to prioritise technical competencies, neglecting motivational and psychosocial dimensions that the literature identifies as determinants of adoption and engagement. Human-Centred Design has been increasingly adopted in the development of digital health interventions due to its capacity to generate solutions aligned with users' real needs; however, its application to the development of educational interventions promoting digital health literacy among older adults remains insufficiently documented.

This dissertation aims to analyse how the principles and methods of Human-Centred Design guided the development, pilot implementation, and refinement of the Ikigai Play Toolkit, a ludic-educational intervention designed to promote digital health literacy among older adults within the SMARTageCARE project, an Erasmus+-funded initiative that operated across eight European countries. Specifically, it seeks to analyse the toolkit's development process, from the identification of older adults' needs to the design decisions that guided the prototyping of the intervention, and to conduct an exploratory evaluation of the pilot implementation in Portugal, Italy, and Poland.

A methodological study of intervention development and pilot evaluation was conducted, guided by the principles of Human-Centred Design, integrating participatory workshops, a meta-narrative literature review, the creation of personas and scenarios, design requirements, and iterative prototyping, followed by an exploratory pilot evaluation that collected 318 post-activity questionnaires across four dimensions: performance, immediate perceived effectiveness, efficiency, and usability.

The development process resulted in a predominantly analogue and modular toolkit, anchored in the Ikigai philosophy and the Positive Play framework, comprising 43 activities distributed across four thematic modules. The pilot evaluation revealed that performance was consistently the highest-rated dimension whilst usability was the lowest, that perceived relevance varied according to national context, and that competitive mechanics were perceived as stigmatising, leading to the removal of five activities and a reduction to 38 activities in the final version.

These findings suggest that Human-Centred Design can contribute to the development of health promotion interventions more closely aligned with the actual conditions of the target population, and that promoting digital competencies may not require the intervention itself to be mediated by a digital medium. Future research should apply validated digital health literacy instruments within pre-post and longitudinal designs, collect sociodemographic data from the outset, and investigate the role of facilitator mediation in scaling interventions of this nature.

Keywords: Human-Centred Design, Digital Health Literacy, Older Adults, Participatory Design, Educational Intervention

1. Introduction

1.1 Population ageing as global health challenge

The global demographic landscape is undergoing an unprecedented transformation, driven by increasing longevity and a sustained decline in fertility rates (1,2). This scenario has produced a progressive reconfiguration of the age structure of the world's population, with profound implications for health systems, public policies and the organisation of societies (3,4).

It is currently estimated that approximately 12% of the world's population is aged 60 or over (4). United Nations projections indicate that, by 2030, one in every six people worldwide will have reached this age, representing 1.4 billion individuals, and that this figure will reach 2.1 billion by 2050, at which point this proportion is expected to nearly double, reaching 22% (4–6). This demographic transition is particularly pronounced in Europe, the region with the highest concentration of older adults in the world. In January 2025, the population of the European Union (EU) was estimated at 450.6 million inhabitants, of whom 22.0% were aged 65 or over, a significant increase from 2004, when this proportion stood at 16.4% (7), with projections indicating that this age group is expected to represent nearly 30% of the EU population by 2050, reaching 129.8 million (1). In southern Europe, this concentration is even more pronounced, with Italy (24.7%) and Portugal (24.3%) recording the highest proportions of older adults in the EU (7).

Several factors contribute to this transformation. The reduction in infant mortality, advances in public health and medical technologies, greater awareness of the benefits of a healthy lifestyle, and the overall improvement in living conditions have collectively contributed to a sustained increase in longevity (8). In concrete terms, life expectancy at birth in the EU reached 81.5 years in 2024, surpassing pre-pandemic levels, although significant disparities persist between Member States, with a gap of approximately eight years between the countries with the highest and lowest life expectancy (8,9).

However, living longer does not necessarily mean living in good health. According to the most recent data, healthy life years at birth in the EU stood at an average of 63.1 years in 2023, meaning that a considerable proportion of years lived is marked by activity limitations and loss of autonomy (10). This disparity between longevity and functionality constitutes, as Liotta et al. argue, one of the central tensions of contemporary ageing, as the increase in life expectancy has not been matched by a proportional increase in healthy life years, largely owing to the functional decline associated with frailty, influenced by physical, mental, social and economic factors (11).

In this context, ageing is regarded as a global health challenge due to the increasing volume and complexity of care demands. Multimorbidity, defined as the coexistence of two or more chronic diseases (12), constitutes one of the central concerns. The available evidence shows that multimorbidity is strongly associated with functional limitations in basic and instrumental activities of daily living, greater utilisation of health services, more frequent hospitalisations and a significant reduction in quality of life (13,14).

Reducing the challenge of ageing to the biomedical dimension alone would be insufficient. Social isolation and loneliness represent equally critical dimensions, with documented impacts on both physical and mental health. Longitudinal studies conducted within the framework of the Survey of Health, Ageing and Retirement in Europe (SHARE) have demonstrated that social isolation increases

the risk of diagnosis of multiple chronic diseases in European older adults, with this effect being cross-cutting across different macro-regions of the continent (15). More recent data reinforce this association by identifying severe loneliness as a factor significantly associated with multimorbidity, suggesting that the impoverishment of social networks is both a consequence of chronic disease and a predictor of its onset and worsening (16).

To these clinical and social vulnerabilities is added digital exclusion, since, in a society in which access to public services, health information and social support networks is increasingly mediated by digital technologies, the inability to use these means constitutes an additional form of marginalisation. For a significant proportion of the older population, barriers such as unfamiliarity with electronic devices, the absence of technical support and the inadequate design of platforms result in exclusion from care, information and social participation (17).

Population ageing thus constitutes a challenge that demands responses that go far beyond increasing hospital beds or managing multimorbidity. It requires policies and interventions that recognise the heterogeneity of the older population, that articulate health, social participation and digital inclusion, and that do not treat old age as a uniform category of frailty. It is within this framework that the digital transformation of health systems acquires particular relevance, as it simultaneously represents an opportunity to broaden access to care and a risk of deepening existing inequalities.

1.2 Digital transformation in health

Health is one of the sectors in which digital transformation has advanced most markedly. More than the mere digitalisation of existing processes, such as the shift from paper to electronic records, digital transformation refers to a reconfiguration of the way in which care is delivered, clinical information is managed and citizens relate to health services (18). This reconfiguration is driven both by technological progress and by the institutional recognition of its potential to improve the access, quality and efficiency of health systems (19).

However, digital transformation does not constitute a neutral process. It is a phenomenon that redistributes opportunities and responsibilities, the equity of which depends, to a large extent, on the capacity of citizens to interact with technologies in a safe, critical and effective manner. The following subsections present the conceptual and political framework of this transformation and examine its impacts, both in terms of the opportunities it creates and the inequalities it may deepen.

1.2.1 The rise of digital health: concepts and policies

It is within this context of digital transformation that the concept of digital health emerges. The World Health Organization (WHO) defines it as the field of knowledge and practice associated with the development and use of digital technologies to improve health (18). Under this broad concept, more specific terms are subsumed. Electronic health (eHealth) refers to the use of information and communication technologies (ICT) in health, encompassing electronic health records, patient portals and clinical decision support systems (20). Mobile health (mHealth) designates the use of mobile devices, such as smartphones, tablets and wearables, for health purposes, including monitoring apps, medication reminders and programmes to promote healthy lifestyles (21). Telemedicine comprises the delivery of clinical care at a distance, mediating teleconsultations, telemonitoring and teleassistance (22).

These concepts are not mutually exclusive. A teleconsultation is simultaneously an act of telemedicine, eHealth and digital health. Their distinction matters because each level of technological mediation requires different competences from citizens and specific policy responses.

At a global level, the WHO published the Global Strategy on Digital Health 2020–2025 in 2021, subsequently extended to 2027, establishing a framework for action to promote healthy lives through the application of digital technologies, integrating financial, organisational, human and technological resources into national digital health strategies, grounded in four priorities, namely the strengthening of global collaboration and governance, the support for national strategies through interministerial approaches, the building of robust digital ecosystems, and the promotion of person-centred digital services that empower individuals and communities. Among the proposed actions, the strategy explicitly calls for the promotion of digital health competences in the training curricula of professionals and, more broadly, within populations (18).

Within the European space, this global commitment has been translated into progressively more ambitious policies. In 2018, the European Commission published the Communication on enabling the digital transformation of health and care in the Digital Single Market, identifying three priority axes, namely the secure access of citizens to their health data, including in cross-border contexts; the use of data to promote research, prevention and personalised medicine; and the development of digital tools for citizen empowerment and person-centred care (19). This vision was substantially deepened with the proposal for a Regulation on the European Health Data Space (EHDS), presented in May 2022 and formally adopted in 2025, constituting the first European sectoral data space (23–25). The EHDS aims to establish a common framework for the use and sharing of electronic health data in the EU, reinforcing individuals' access to and control over their personal data (primary use), promoting the interoperability of electronic health records and facilitating the re-use of data for research, innovation and policy formulation (secondary use). Of particular relevance to the present work, the European Parliament itself acknowledges that the success of this initiative depends not only on the capacity to implement the legal framework, but also on broader conditions such as connectivity, social trust and, above all, citizens' digital competences (24).

These political ambitions found accelerated expression with the COVID-19 pandemic. Faced with the need to reduce face-to-face consultations, telemedicine emerged as a privileged tool for ensuring continuity of care, enabling remote access to specialist medical services (26). Its integration into multidisciplinary models evolved from a circumstantial necessity into an opportunity to rethink care delivery (27). In parallel, patient portals, mobile health applications, appointment booking systems and electronic access to examination results became established realities in many European health systems. The pandemic compressed transitions that, under other circumstances, would have taken years into a matter of months, making digital mediation a condition of access to care.

Nevertheless, the accelerated implementation also revealed structural weaknesses, among which technological barriers, deficiencies in the training of professionals and users, difficulties in the clinical relationship mediated by technology, and inequalities in access, particularly among more vulnerable populations, stand out (26,28). These weaknesses demonstrate that the digital transformation of health, when not accompanied by policies of inclusion and capacity-building, can deepen the very inequalities it seeks to reduce.

1.2.2 The impact of the digital transformation in health

Accordingly, the digital transformation of health presents two sides. On the one hand, it offers considerable benefits, such as greater citizen autonomy in managing their health, improved access to services regardless of geographical location, and new possibilities for participation in clinical decisions. Eurostat data illustrate this trend. In 2025, the proportion of individuals in the EU who used the internet to seek health-related information reached 60.3%, a historic high compared to 28% in 2008, with Portugal recording 53.9% (29).

On the other hand, the growing technological mediation creates new competence requirements, without which citizens may not benefit from these opportunities and risk being excluded from essential services. It is here that the concept of digital exclusion acquires particular relevance for public health.

Digital exclusion is not limited to the lack of access to devices or the internet. The literature distinguishes at least three levels. The first concerns physical access to infrastructure and devices. The second relates to the competences needed to use technologies effectively. The third refers to the capacity to derive real benefits from such use (30). In the field of health, these three levels interact cumulatively. Having internet access is not sufficient if one cannot assess the credibility of an information source, and knowing how to navigate a platform is not sufficient if the content is not comprehensible.

The evidence shows that digital exclusion in health is shaped by socioeconomic, geographical, generational and functional factors. An older person with low educational attainment, living in a rural area and with sensory limitations, accumulates multiple layers of exclusion that are mutually reinforcing (17). As access to care becomes increasingly mediated by technology, the inability to perform routine digital tasks, such as booking appointments online, accessing test results, or understanding digital health information, translates directly into exclusion from the health system.

The digital transformation of health thus constitutes an ambivalent phenomenon. It expands the possibilities of access and participation for those who possess the necessary competences, but may exacerbate the marginalisation of those who do not. It is within this framework that the following section examines the concept of digital health literacy (DHL), the competence that mediates the relationship between citizens and the digital health ecosystem, and its particular relevance for older adults.

1.3 Digital health literacy (DHL)

To understand the competences required for the use of digital technologies in health contexts, it is important to situate DHL within the broader framework of health literacy. Health literacy has been the subject of growing scientific and political attention since the late twentieth century. In its original formulation, Nutbeam et al. proposed a progressive conceptualisation of this competence, distinguishing three levels. The functional level corresponds to the basic reading and writing skills necessary to understand health information. The interactive level involves more advanced cognitive and social competences that enable active participation in everyday situations, the extraction of meaning from different forms of communication, and the application of new information to varying circumstances. The critical level refers to the capacity to critically analyse information and use it to exert greater control over life decisions and circumstances. This typology demonstrated that health

literacy is not limited to understanding medical instructions, but involves a continuum of capacities that sustain progressively greater degrees of autonomy and empowerment (31).

In an attempt to integrate the diversity of definitions that had meanwhile emerged in the literature, Sørensen et al. conducted a systematic review that identified 17 definitions and 12 conceptual models of health literacy. From this analysis, the authors proposed an integrated model in which health literacy is understood as the body of knowledge, motivations and competences that determine a person's capacity to access, understand, appraise and apply health-related information across the domains of healthcare, disease prevention and health promotion (32). This model, widely adopted in international research, articulates the individual dimensions of literacy with the contextual, social and systemic factors that condition it, recognising that health literacy does not depend solely on the individual's capacities, but also on the complexity and accessibility of the systems and information with which they interact.

The progressive digitalisation of health services and information, described in the preceding section, has made it evident that the competences traditionally associated with health literacy are no longer sufficient. Navigating a health portal, evaluating the reliability of information found online, using a symptom-monitoring application or communicating with health professionals through digital means requires a set of competences that goes beyond what classical models envisaged. It was in this context that Norman and Skinner introduced the concept of DHL, defining it as the ability to seek, find, understand and appraise health information from electronic sources and to apply the knowledge gained to address a health problem. The proposed model, termed the "lily model", presents DHL as the outcome of the convergence of six interrelated types of literacy: traditional literacy, health literacy, information literacy, scientific literacy, media literacy and computer literacy (33).

As the digital ecosystem evolved, with the proliferation of mobile devices, interactive applications, social networks and participatory health platforms, the original model was subject to revisions and refinements. Norman revised the lily model and proposed eHealth Literacy 2.0, a reformulation that incorporates the participatory dimension of Web 2.0, recognising that users are no longer mere consumers of information but also producers and sharers of content (34). This reformulation reflected the need to encompass both information access competences (Health 1.0) and interaction and participation competences (Health 2.0). More recently, Milanti et al. proposed the "eHealth Literacy 3.0" model, redefining DHL as the ability to interact with digital technologies in an effective, safe and useful manner in order to achieve health objectives, a formulation that simultaneously emphasises efficacy, safety and orientation towards concrete outcomes (35). The operationalisation of these conceptual advances has been accompanied by the development of measurement instruments. The eHealth Literacy Scale (eHEALS), developed by Norman and Skinner (36), remains the most frequently used tool for assessing DHL across different countries and populations, whilst the Digital Health Literacy Instrument (DHLI), proposed by Van der Vaart and Drossaert (37), broadened the scope of assessment to encompass both Health 1.0 and Health 2.0 competences.

DHL is distinct from both health literacy and digital literacy, although it incorporates elements of both. Health literacy provides the knowledge to understand and act within the health domain. Digital literacy provides the technical competences to use devices and navigate the internet. DHL emerges at the intersection of these two domains but is not reducible to their sum, as it requires specific competences that manifest only when technology and health converge (33,38).

1.3.1 Digital health literacy as digital determinant of health

DHL has increasingly been recognised not only as an individual competence, but also as a matter of public health. Van Kessel et al. argued that DHL should be understood as a "super-determinant of health", insofar as it conditions individuals' capacity to benefit from digitalised health systems, to mitigate the risks of misinformation, and to exercise control over their personal data. In this perspective, DHL constitutes an emergent construct that integrates, beyond digital literacy and health literacy, civic literacy, that is, the capacity to participate meaningfully in the community and in the decision-making processes that affect health (38).

This perspective is situated within the broader debate on the Digital Determinants of Health (DDoH). Chidambaram et al. proposed a formal definition of this construct, understanding DDoH as the factors intrinsic to technology that influence health disparities and the challenges of accessibility and quality of care, and identified DHL as one of its central dimensions (39). The distinction from the classical social determinants of health is relevant. Whereas the latter refer to the external conditions in which people live, DDoH relates to characteristics of the technological ecosystem itself, such as interface complexity, personalisation, algorithmic bias and informational asymmetry. Petretto et al. reinforce this reading, showing that, regardless of the theoretical model adopted, DHL consistently appears as a cross-cutting DDoH, present at the individual, community and societal levels (40). Both sets of authors converge on a critical finding. DDoH and social determinants influence one another in reinforcing cycles, producing what Petretto et al. term the "digital paradox", whereby the populations that could most benefit from the digitalisation of health services are precisely those that face the greatest barriers to its effective use (39,40). This paradox is compounded at the interface level, where many health technologies present complexity that exceeds the capacities of users with average DHL, generating a cycle in which the technology itself produces the exclusion it ought to reduce (39).

Situating DHL within the DDoH framework carries a direct implication. Promotion strategies cannot be limited to individual training. They require multilevel approaches that act simultaneously on users' competences, the design of technologies and the regulatory frameworks that govern them (39,40). This perspective is supported by growing empirical evidence. Arias López et al. concluded that individuals with higher levels of DHL exhibit better self-management of disease, greater participation in clinical decisions and improved quality of life, whereas low DHL is associated with difficulties in accessing services, lower therapeutic adherence and greater vulnerability to misinformation (41).

Yet DHL is not distributed homogeneously across the population. Factors such as age, level of education, socioeconomic conditions and prior experience with technology significantly influence digital health competences, configuring a gradient in which those who possess these competences access more and better care, whilst those who lack them are progressively excluded from a system that is digitalising at an accelerating pace. It is among older adults that this exclusion becomes most visible.

1.3.2 Digital health literacy in older adults

Research on the DHL of older adults has produced convergent results. Jiang et al. demonstrated that the average level of DHL in this population was considerably lower than the threshold deemed adequate. The same review identified substantial variability within the older population, with particularly low levels among women, people aged 80 or over, individuals without a spouse and older adults living alone (42). In parallel, Xie et al. concluded that the DHL of older adults was positively

associated with more favourable health behaviours, including better self-management of disease and greater therapeutic adherence (43). These findings suggest that investing in the digital competences of older adults can translate into tangible health gains.

It is important, however, to resist a homogenising and deficit-based narrative. The older population is, in reality, characterised by considerable heterogeneity with regard to the relationship with digital technologies. Prior experiences with technology throughout life, educational and professional trajectories, socioeconomic conditions, health status, social and family support networks, the degree of confidence and self-efficacy, and even the perceived relevance of technologies for everyday life all shape very diverse usage profiles within this age group (44,45). To understand this heterogeneity, the literature has organised the barriers to DHL among older adults across different levels of analysis:

Individual barriers

At the individual level, the most frequently documented barriers include insufficient prior digital competences, low confidence in the use of technologies and reduced digital self-efficacy, that is, the belief in one's own capacity to perform tasks in a digital environment (44). Added to these are difficulties in critically evaluating the quality and reliability of information found online, as well as sensory, motor and cognitive changes associated with the ageing process that may affect interaction with digital interfaces (46). It is important to note, however, that these barriers do not operate in isolation. More recent literature has identified feedback loops in which low self-efficacy generates technological anxiety, which in turn reinforces avoidance behaviours, which limit exposure to technology and, consequently, impede the development of competences (47). This circular pattern suggests that interventions focused exclusively on technical training may be insufficient if they do not simultaneously address the emotional and motivational dimensions of older adults' relationship with technology.

Technological barriers

At the technological level, the barriers relate to the characteristics of the digital health tools themselves. Usability problems, excessive interface complexity, inadequate text and button sizes, unintuitive navigation, unadapted technical or medical terminology, and lack of design consistency constitute recurrent obstacles (46,48). To these are added concerns relating to privacy and data security, which constitute a frequently underestimated but important barrier to adoption and trust identified in the literature (47). It should be emphasised that these technological barriers are not socially neutral, insofar as they frequently reflect design decisions taken without the participation of older users and that privilege younger, more educated and more digitally familiar usage profiles (46).

Social and contextual barriers

At the social and contextual level, inequalities in access to devices, in the quality and stability of internet connections, and in the material conditions of use continue to constitute relevant barriers, particularly in rural contexts and among populations with fewer socioeconomic resources (46). The presence or absence of social support, whether from family members, friends, health professionals or peers, likewise plays a determining role. In this domain, the presence of trusted individuals can significantly facilitate the learning and adoption of technologies, whilst their absence can reinforce digital isolation (44,48). These social and contextual barriers do not, however, operate in isolation. Wu et al. concluded that the digital exclusion of older adults results from the convergence of

socioeconomic disadvantages, health vulnerabilities and contextual barriers, configuring a structural and cumulative phenomenon with a direct impact on health outcomes (17).

Implications for interventions

The articulation between these three levels has important implications for the way in which the promotion of DHL among older adults is conceived. An approach centred exclusively on individual competences tends to place responsibility on users and to disregard the role of technologies and contexts in creating the very difficulties experienced. Conversely, an approach that is limited to improving the usability of tools does not resolve the issues of trust, motivation and social support that condition their adoption. The literature thus points to the need for interventions that act simultaneously at multiple levels, that recognise the diversity of profiles and needs within the older population, and that involve users themselves in identifying barriers and co-creating solutions (46,47). This finding naturally leads to the question of what interventions have been developed to promote DHL among older adults and what evidence exists regarding their effectiveness.

1.3.3 Digital health literacy interventions for older adults

In light of the barriers identified, research has sought to develop and evaluate interventions that promote DHL among older adults. These interventions take various formats and have been implemented in diverse contexts, although the evidence on their effectiveness remains fragmented and still limited in quantity and methodological rigour.

Dong et al. concluded that DHL interventions have positive effects on participants' knowledge and self-efficacy. The content of these interventions typically centres on competences such as basic device use, navigation of search engines, access to health portals and participation in peer support forums (49). However, the authors emphasise that the small number of studies, variability in methodological quality and heterogeneity of designs limit the generalisability of results. Yang et al. reinforced these conclusions, adding the need for interventions grounded in theoretical models and for approaches that integrate face-to-face and digital components, in order to facilitate both guided learning and autonomous practice. The same authors identified that the majority of interventions evaluated focused on information-seeking and access competences, neglecting more complex dimensions such as the critical appraisal of information quality or privacy protection (50).

In the European context, the meta-narrative review conducted within the SMARTageCARE (SAC) project, which synthesised evidence from eight European countries, enabled the identification of a significant diversity of interventions already implemented or under development (50). Among these, community-based digital training programmes, typically structured as face-to-face workshops in which older adults receive guided instruction on device use, internet navigation and access to digital services, stand out, such as AUDID and OITO in Portugal, DigitalPakt Alter in Germany, Simbioza in Slovenia and Senioru Skola in Latvia. Television-based platforms adapted to older adults' habits, such as +TV4E, were also identified, as well as solutions based on digital games, digital storytelling and intergenerational programmes that combine technological learning with social connection and a sense of purpose (51). A relevant aspect of this review is the finding that the interventions with the greatest perceived impact are not limited to the transmission of technical competences but incorporate psychosocial dimensions such as trust, motivation and a sense of community belonging. Intergenerational programmes, in which young volunteers or family members accompany older adults in digital learning, proved particularly effective in building self-efficacy and reducing technological anxiety.

These findings are corroborated by Sinanan et al., who confirmed that peer and intergenerational mentoring approaches are associated with the strengthening of confidence and social connectivity. The same authors identified that blended approaches, combining face-to-face training with complementary digital resources, allow participants to consolidate competences through both guided instruction and independent practice. However, challenges persist relating to access to digital infrastructure, the long-term sustainability of interventions and the difficulty in reaching the most vulnerable older adults with the lowest baseline literacy (52).

Notably, these findings suggest that the medium of delivery is itself a design decision with implications for equity. While digital-first interventions may inadvertently replicate the access barriers they seek to address (40), analogue or hybrid formats, such as facilitated workshops using physical materials, can offer an entry point that meets older adults where they are, before gradually introducing digital skills in a supported environment (50,52).

Despite these advances, the effectiveness and scalability of existing interventions are constrained by important limitations. Many interventions were conceived without the active participation of older adults themselves, resulting in solutions that do not always respond to their actual needs and life contexts. The majority of studies evaluate only short-term outcomes, with scant evidence on the retention of competences over time. Moreover, the predominant focus on usability has been shown to be insufficient, given that the successful implementation of interventions with older adults requires attention to the organisational context, social dynamics and structural conditions in which use occurs (53,54). The under-representation of the oldest old (aged 80+), rural contexts and groups with lower educational attainment further limits the understanding of the most appropriate interventions for those who most need them.

These observations suggest that the development of future interventions requires a shift in approach: from models that design solutions *for* older adults to models that develop them *with* older adults. This shift implies adopting design approaches that place users at the centre of the design process, that value their experiences and knowledge, and that enable the iterative creation of solutions tailored to their realities. It is in this context that the Human-Centred Design (HCD) approach presents itself as particularly relevant and is the subject of the following section.

1.4 Design in health

The preceding sections demonstrated that the DHL of older adults depends not only on individual capacities, but also on the appropriateness, accessibility and context of the technologies, and that many existing interventions were conceived without the active participation of their intended recipients. These findings point to the need for design approaches that place users at the centre of the development process. It is within this framework that HCD presents itself as a particularly relevant approach.

HCD is an approach to the development of interactive systems formalised in the international standard ISO 9241-210 (55). According to this standard, HCD aims to make systems usable and useful by focusing on people, their needs and their contexts, and by applying knowledge and techniques from ergonomics, usability and human factors throughout the entire system lifecycle. The standard establishes a set of fundamental principles, among which the following stand out: the explicit understanding of users, their tasks and their use environments; the active involvement of users throughout the entire design process; the iterative refinement of solutions based on user-centred

evaluation; attention to the totality of the user experience; and the constitution of multidisciplinary teams (55). It should be emphasised that HCD does not constitute a specific method, but rather a frame of reference and a set of principles that can be operationalised through different methodologies and tools.

The application of HCD to the field of health has been growing, although in a still uneven manner. Bazzano et al. mapped HCD applications in global health contexts and identified a diversity of projects that employed human-centred methods to develop interventions. The authors concluded that, despite promising results in terms of acceptability and appropriateness, the majority of studies presented gaps in the documentation of design processes, in the description of methodological decisions and in the evaluation of outcomes beyond usability (56). This finding led the same authors to propose a guideline for the reporting of health research involving design (57), responding to the need to create a communicational bridge between design conventions and the demands for rigour and transparency of public health research.

This tension between the two fields is relevant to the framing of the present work. Design privileges rapid iteration, methodological flexibility and a focus on user experience, whereas public health demands justified sampling, validated instruments and the evaluation of outcomes according to established criteria for complex interventions (58). The integration of the two logics is not resolved by the subordination of one to the other, but by the identification of the moments in which each field best responds to the distinct demands of the development process.

Among the methodological traditions that enact the principles of HCD, two merit particular attention. The first is Design Thinking, a creative problem-solving process popularised by IDEO and the Stanford d.school, organised into phases such as empathising with users, defining the problem, generating ideas, prototyping solutions and testing iteratively (59). Design Thinking privileges the deep understanding of users' experiences and motivations, the divergent generation of solutions and rapid experimentation through low-fidelity prototypes, constituting a practical means of operationalising HCD principles in innovation contexts. The second tradition, with distinct and complementary roots, is Participatory Design, originating from the Scandinavian movement of the 1970s and 1980s, which arose as a response to the need to involve workers in decisions about the technological systems they would use (60). Participatory Design, and its contemporary evolution frequently termed co-design or co-creation, is distinguished by positioning users not as informants or test subjects, but as active partners in design decision-making. As Sanders and Stappers argue, the evolution from user-centred design (UCD) to co-design transforms the roles of the designer, the researcher and the person formerly designated as "user", according the latter the status of expert in their own experience (61).

The distinction between these two orientations is particularly relevant to the present work. Whereas classical HCD may be limited to consulting users, observing them and testing them in order to inform design decisions taken by professionals, co-design implies an effective sharing of power in the design process, valuing participants' experiential knowledge and involving them in the generation of solutions and decision-making (61). It is, therefore, the difference between developing *for* users and developing *with* users. Within the domain of digital health and ageing, this distinction has concrete implications, insofar as older adults possess knowledge, experiences and perspectives about their own needs, barriers and preferences that are not accessible to designers and researchers by other means (62).

The application of HCD and co-design to the development of digital health technologies for older adults has been gaining recognition. Tzimourta et al. argue that this approach is essential for developing technologies that are not only usable but also acceptable and effective in care delivery contexts. In the case of older adults, co-design has demonstrated the potential to overcome barriers such as the inadequacy of interfaces, the lack of trust in technology and the absence of perceived relevance (63). Backåberg et al. add that this approach also promotes the empowerment of participants, although they caution about specific methodological challenges, such as the need to adapt participatory tools and dynamics to participants' capacities and to manage expectations regarding the degree of influence over final decisions (62).

Despite this growing recognition, the majority of HCD applications in health have focused on the development of technological products, such as applications, platforms, dashboards and digital agents, and not on interventions whose primary purpose is the promotion of competences (56). The use of HCD in the development of educational interventions for DHL among older adults thus remains poorly documented. The few studies that approximate this intersection tend to employ co-design in the initial phases of needs assessment, without accompanying the full cycle of design, development and evaluation. None of the identified works combines, within a single process, physical and digital components, gamified learning and implementation across different national contexts. It is this gap, simultaneously procedural (how HCD is operationalised) and evaluative (what outcomes it produces), that justifies the state of the art presented in the Methodology chapter (section 3.3).

It is within this space that the SMARTageCARE project is situated. Central to the project is the Ikigai Play Toolkit, a ludic educational intervention grounded in the Japanese concept of Ikigai, broadly understood as a sense of purpose or "reason for being" (64). The adoption of this philosophy reflects the growing recognition that barriers to digital engagement among older adults are not solely technical, but also motivational and psychosocial, and that effective interventions must address purpose and meaning as drivers of learning (65,66). Developed primarily in analogue format, comprising activity cards, facilitation guides and hands-on exercises, the toolkit was designed to promote digital health literacy through face-to-face, facilitated sessions. This was a deliberate design choice informed by the recognition, discussed above, that a purely digital delivery would risk reproducing the very barriers it seeks to overcome. The conceptual foundations of Ikigai, the operationalisation of the toolkit and the rationale for its format are detailed in the Methodology (section 3.1.1).

By analysing how HCD guided the development of this intervention and by examining its pilot implementation with older adults in Portugal, Italy and Poland, this dissertation can contribute on two fronts. The first is procedural, seeking to make explicit how needs, suggestions and difficulties were converted into decisions and refinements of the educational intervention. The second is evaluative, relating this trajectory to the performance, immediate perceived effectiveness, efficiency and usability observed. The interest of this case lies in understanding whether a transnational design process was capable of preserving participation, accessibility and educational relevance as it traversed different contexts.

2. Objectives

The general objective of this thesis is to analyse how the principles and methods of Human-Centred Design guided the development, pilot implementation and refinement of the Ikigai Play Toolkit, an educational intervention designed to support digital health literacy amongst older adults within the SMARTageCARE project.

Specifically, we aim to:

- Analyse the development process of the Ikigai Play Toolkit, from the identification of older adults' needs to the definition of requirements, content, format and other design decisions that guided the prototyping of the intervention;

- Conduct an exploratory evaluation of the pilot implementation of the Ikigai Play Toolkit in Portugal, Italy and Poland, considering the dimensions of performance, immediate perceived effectiveness, efficiency and usability, as well as the barriers, facilitators, contextual variations and refinements arising from feedback from participants, facilitators and local teams.

3. Methodology

This study is based on data collected within the scope of the SMARTageCARE (SAC) project — *Toolkit for Caring and Empowering European Older Adults: Ecosystem, Handbook and Digital Platform in Digital Transition, eHealth and Citizenship* — an initiative funded by the Erasmus+ programme (KA220-ADU, ref. 2EF90A35), which ran from September 2023 to August 2026 and operated in 8 European countries[1]. A detailed description of this project is provided below.

3.1 The SMARTageCARE Project

The project is based on the recognition that the accelerating digital transition in European societies has exacerbated inequalities in access to and use of digital technologies, with a particular impact on the older population. In this context, the SAC project aims to develop the concept of smart ageing as a new paradigm for active and healthy ageing.

Smart ageing emerges from technological and digital innovation, positioning itself in relation to previously institutionalised paradigms, such as healthy and active ageing, as a reconfiguration centred on intergenerational solidarity, identities, and cultures of ageing, recognising ageing as a stage of intellectual maturity and individual and social development (67,68). This approach aligns explicitly with the objectives of the European Digital Strategy and the Digital Decade 2030, positioning the project at the intersection of education, public health, and European citizenship.

The core objective of SAC is to create a training ecosystem that overcomes digital literacy barriers hindering access to healthcare, ICT-based care, and European citizenship. The project is anchored in three interconnected thematic areas:

- **Digital Transition:** Promoting literacy and reducing technological isolation.
- **eHealth (Digital Health):** Empowering users to utilise digital health tools.
- **Active Citizenship:** Encouraging social participation and valuing the cultural heritage of older adults.

It operates through a transnational consortium of nine partners across eight European countries. This transnational collaboration facilitates the exchange of complementary technical expertise, and also offers a deeper understanding of the diverse cultural and social realities that shape the European ecosystem. The consortium partners in each country are presented in Table 1.

Table 1. Consortium partners by country within the SAC project.

Countries	Consortium Partners
Portugal	University of Porto, More Than Humans
Belgium	ALL DIGITAL AISBL
Cyprus	IMS Research & Development Center
Latvia	CONNECT Latvia
Poland	HIPOKAMP – Centre for Intergenerational Integration
Slovenia	Education Centre Geoss Ltd.
Germany	Adult Education Center Schrobenhausen
Italy	Centro Provinciale Istruzione Adulti

[1] For more information about the SMARTageCARE project, see: https://smartagecare.fba.up.pt/

The project is inherently interdisciplinary, merging expertise from public health, gerontology, education and design. It encompasses three main interventions:

1. The development of an Ecosystem composed of an Ambassadors' Network, an Advisory Board, a Strategic Plan, and an Awareness Campaign aimed at supporting dissemination and long-term sustainability.
2. Design and development of a ludic educational toolkit, composed of a Handbook, Game Box and a Digital Platform, to improve skills in Health & Care, Digital, and Citizenship, drawing on the IKIGAI approach to support meaningful and active ageing.
3. The implementation of a large-scale, pan-European pilot study designed to test and evaluate the usability, feasibility and acceptability of the SAC toolkit in real-world settings.

The Portugal team coordinated the project and led the development of the IkigaiPlayToolkit throughout its phases. The project adopts the Japanese concept of Ikigai as its educational foundation, combining it with HCD approaches through participatory design methods, directly involving stakeholders and end users (older adults) in the data collection and development phases to ensure that the intervention meets their real-life needs and expectations. This ensures the initiative's sustainability and scalability as it allows the intervention to be adapted to local cultural and social contexts.

3.1.1 The Ikigai Play Toolkit

The project's central outcome is to develop the Ikigai Play Toolkit, a ludic educational toolkit designed to promote skills across the project's three thematic areas, namely, digital transition, eHealth and active citizenship. The Toolkit consists of a training programme structured around the Ikigai philosophy, a Japanese term formed from iki (life) and gai (value or merit), commonly translated as "reason for being" or "what makes life worthwhile" (64), adopted as the Toolkit's overarching motivational foundation, anchoring learning in personal purpose and linking to these three thematic areas as domains of personal and social fulfilment (69). The Ikigai Play Toolkit is the physical artefact; its facilitated implementation constitutes the educational intervention.

The choice of Ikigai stems from the latest scientific findings, which have shown that barriers to digital engagement among older adults are related to physical and psychological capabilities, the context in which the older adult lives and the implications for their abilities interfere with access to digital tools, highlighting the importance of designing personalised interventions that take these interconnected factors into account and focus on motivation as the basis for learning (65).

In this project, Ikigai serves as a framework that anchors learning in personal purpose, lifelong engagement, and connection with the community (70), enabling a personalised learning path adaptable to different psychosocial contexts and resonant with older adults' intrinsic motivations.

The operationalisation of this philosophy within the toolkit's activities was achieved by adopting the Positive Play game design framework. Rooted in Positive Computing, which addresses the design of technology to support psychological well-being, Positive Play focuses on designing games as a way for empowerment, inclusion, autonomy, resilience, knowledge, and quality of life (71,72). This game design approach is widely used in playful health interventions, as it nurtures and expands players' human potential.

In this way, the SAC project can create an ecosystem to integrate older Europeans as socially connected citizens, ensuring that increased longevity is accompanied by quality of life and a sense of purpose. The goal is to make learning digital and health skills a fun and less intimidating experience.

3.2 Study design

This dissertation adopts a single case study design, understood as an empirical inquiry that investigates a contemporary phenomenon in depth within its real-world context (73). The SAC project constitutes the case, with the unit of analysis limited to the development process and pilot evaluation of the Ikigai Play Toolkit. Within the pilot evaluation, analysis focuses on data collected in Portugal, Italy, and Poland.

The case study approach is appropriate because the research question is descriptive and analytical, seeking to understand how a process unfolded rather than test a hypothesis. Moreover, the project's transnational and participatory nature makes it a particularly rich case for exploring how HCD is operationalised in global health contexts.

The case study design does not support statistical generalisation of the findings to populations or contexts beyond SAC. Instead, the value of this study lies primarily in analytical generalisation and in the depth and transparency with which the toolkit development process and pilot evaluation results are described, offering a detailed, contextually grounded account that may inform reflection on similar HCD-based interventions, while findings and recommendations remain centred on strengthening the toolkit itself.

The structure follows the Guideline for Reporting Design in Health Research proposed by Bazzano et al.(57), which provides a systematic framework for documenting and critically appraising HCD processes in health intervention development.

This design choice directly addresses the identified gap: the absence of a methodological and communicational bridge between design and public health. Within the design field, there is a lack of documentary rigour, and within public health, a lack of methodological flexibility. Selecting a concrete HCD project applied to health and following it, while rigorously documenting the process from the perspective of both disciplines, makes it possible to test, in practice, where these tensions arise and how they can be managed, and to generate the kind of empirical evidence currently missing from the literature.

3.2.1 Researcher positionality

A central consideration in this study is the researcher's positionality as a member of the SAC project team. Insider research, that is, research conducted by someone who is a member of the team or organisation under study, offers advantages in terms of data access, contextual knowledge, and familiarity with the processes being analysed (74).

The researcher's involvement in the project included participating in design team meetings and collaborating on the meta-narrative literature review that resulted in a co-authored book chapter published by IGI Global (Appendix K) (51); in addition, she contributed to the definition of the toolkit's design requirements, resulting in a co-authored scientific article (Appendix L) (69); collaborated in developing specific toolkit activities; was present at co-design and pilot evaluation

sessions in Portugal; participated in the final consortium event in Brussels and Portugal; and produced personal field notes across these engagements. This level of involvement affords privileged access to process knowledge but heightens the need for systematic strategies to maintain critical distance.

To manage these risks, the Guideline for Reporting Design in Health Research (57) is an important tool for reducing reliance on subjective interpretation, as it is a well-established instrument developed independently of the SAC project. Its structured, detailed format enables a systematic description of the development process against criteria established in the literature, which is particularly relevant given the researcher's position as an active member of the project team.

All applicable items from the guideline are available in Appendix A.

3.3 State of the art on HCD applied to digital health for older adults

The promotion of DHL requires interventions that respond directly to the capabilities, cultural contexts and technological limitations of end users. The preceding section argued that HCD constitutes the reference approach for this development, but that its application specifically to the design of educational interventions for DHL among older adults remains poorly documented. The present state of the art was constructed to examine this body of work, seeking to answer the following question: *How has HCD been operationalised in the development of digital solutions and educational interventions aimed at older adults, and what evidence does this process offer for DHL?*

This is a critical mapping guided by the research problem, and not a systematic review. The studies reviewed address different questions, such as qualitative co-design studies, application evaluations, large-scale user comment analyses and secondary reviews, and the comparison was organised so as to respect this diversity.

3.3.1 Delimitation and method

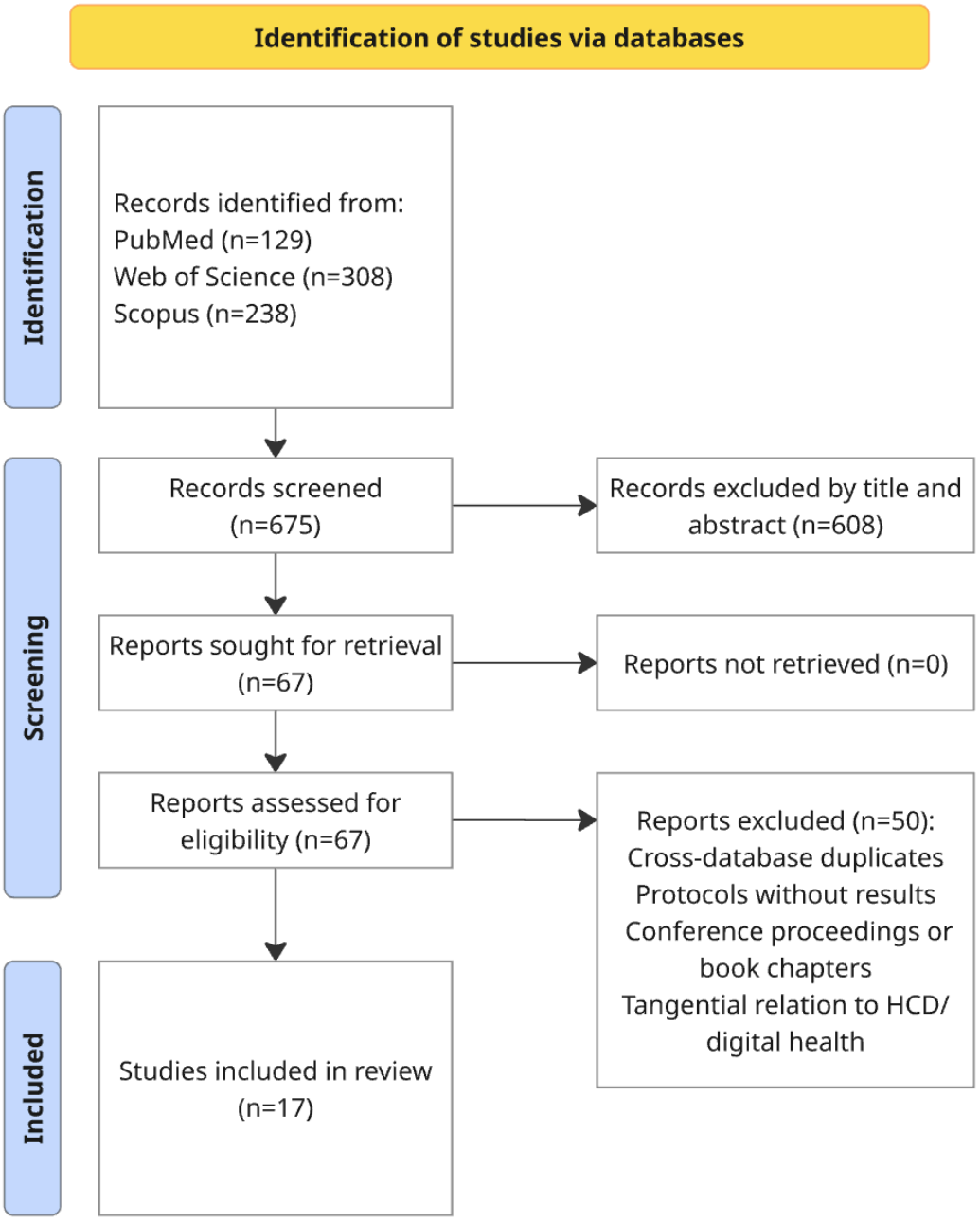
The bibliographic search was conducted across three indexed databases, selected for the complementarity of their thematic coverage. PubMed/MEDLINE was chosen for its comprehensive indexing of the literature on public health, ageing, health literacy and digital interventions. Scopus was included to extend this coverage to the social sciences, technology and design. Web of Science complemented the multidisciplinary retrieval and enabled the tracking of citation networks across studies.

The search was carried out in two rounds. The first employed a more restrictive combination of descriptors, articulating three axes: older population, DHL and HCD approaches. This initial search returned 50 records (3 in PubMed, 36 in Web of Science and 11 in Scopus), of which only 4 were selected after reading titles and abstracts. Given the low yield, a second round was conducted with expanded vocabulary across all three dimensions, including additional terminological variants for the population, literacy and design approaches. The second round identified 625 records (126 in PubMed, 272 in Web of Science and 227 in Scopus), of which 63 were selected. Across both rounds, a total of 675 records were retrieved and 67 articles were selected after screening by title and abstract. The complete search expressions, adapted to the syntax of each database, are presented in Appendix B.

Following the removal of duplicate records across databases and the application of exclusion criteria, namely protocols without results, duplicate or translated records of the same article, publications

exclusively in proceedings or chapters, and texts whose relationship with HCD, digital health or the older population was merely tangential, the resulting corpus comprised 17 international articles published between 2021 and 2026, including 15 empirical or methodological studies and two literature reviews. Priority was given to works that describe the participation of older adults in the identification of needs, idea generation, prototyping or evaluation of technologies and interventions related to health, digital literacy or ageing. The selection process is illustrated in Figure 1, adapted from the PRISMA 2020 flow diagram (75).

Figure 1. PRISMA flow diagram of the literature search and selection process.



Note. Search conducted in two rounds: 1st round with restrictive descriptors (n = 50); 2nd round with expanded vocabulary (n = 625). Duplicate removal was performed after title and abstract screening. Full search strings are available in Appendix B.

3.3.2 HCD methods in the identified studies

A central concern of this review was to identify how HCD is operationalised in studies that involve older adults in the development of digital health solutions. Table 2 synthesises, for each empirical study in the corpus, the declared framework or approach, the participatory techniques employed and the phases of the HCD cycle in which older adults effectively participated.

Table 2. Frameworks, Methods/Tools and HCD phases of the reviewed studies (2021–2026). Source: own elaboration.

Study	Framework / Approach	Methods/Tools	HCD cycle phases with older adult participation
LaMonica et al. (2021) (76)	Participatory Design	Workshops (4×3h), guided discussion, descriptive artefacts, user journeys	· Understanding · Requirements
Dias, Costa & Mealha (2022) (77)	Design Based Research + Double Diamond	Co-design thinking (2 iterative cycles), A/B comparison (co-designed vs. designer-only artefacts)	· Understanding · Solutions · Evaluation
Darley & Carroll (2022) (78)	Iterative participatory co-design	Remote focus groups (Zoom), telephone interviews, older researcher in team, prior digital literacy questionnaire, technical training sessions by telephone (30–50 min), illustrated guides with plain language, community mediators/gatekeepers, non-digital alternatives	· Understanding · Requirements
Sheahan et al. (2023) (79)	Co-design (Scenario Personarrative Method)	Scenario Personarrative Method, workshops, personas, scenario mapping, concept mapping	· Understanding · Requirements · Solutions
Paluch et al. (2023) (80)	Participatory Design / Co-design	Workshops (29 sessions: 5 in-person + 24 online), participant observation, interviews, co-creation of didactic prototypes, participant diaries, briefing sessions	· Understanding · Requirements · Solutions · Evaluation
Teh et al. (2024) (81)	HCD / UCD	Hands-on training workshop (1h), usability testing (2 weeks), semi-structured interviews	· Evaluation
Ahmed et al. (2024) (82)	UCD / Co-design	Semi-structured interviews with stakeholders, thematic analysis, mock-ups and illustrative videos	— *
Spencer, Shariff & Dale (2025) (83)	Experience-Based Co-Design (EBCD)	Trigger film, process mapping, emotion mapping, participant-led coding, iterative prototyping, vignette-based role-play, feedback forms	· Understanding · Requirements · Solutions · Evaluation
Zonneveld et al. (2025) (84)	CeHRes Roadmap	Stakeholder mapping, semi-structured interviews, focus groups, brainstorming, future-use scenarios, online preference questionnaire, prior digital competence assessment, multidisciplinary meetings, continuous formative evaluation	· Understanding · Requirements
Kastl (2025) (85)	HCD (hybrid personas)	Focus groups, PATHY technique (empathy mapping + personas), iterative proto-personas, user profile canvas, photo stories, AI-generated persona images	· Understanding
Saragosa et al. (2025) (86)	Participatory approach	Community-based focus groups, World Café, deliberative dialogues, content analysis (SEM)	· Understanding · Requirements
Chung, Lee & Jung (2025) (87)	UCD / Double Diamond	Survey, thematic analysis, wireframing, prototyping (low and high fidelity), pilot usability testing, focus groups, pre-post surveys, activity logs	· Understanding · Requirements · Solutions · Evaluation
González-González et al. (2026) (88)	Co-creation	Gamified online co-creation, Activity Design Cards, collaborative storytelling, focus groups, structured observation, SWOT analysis, iterative prototyping, adapted TAM (pre-, mid- and post-co-creation)	· Understanding · Requirements · Solutions · Evaluation

Study	Framework / Approach	Methods/Tools	HCD cycle phases with older adult participation
Piera-Jiménez et al. (2026) (89)	Participatory HCD / Design Thinking	Co-creation workshops (24+7 sessions), journey mapping, storytelling, future scenarios, system maps, facilitated ideation and collaborative prioritisation, group interviews, affinity mapping, participant validation	Understanding · Requirements · Solutions
Philpot et al. (2026) (90)	HCD / Design Thinking	Thematic analysis of 1,012 comments (Grounded Theory), patient journey mapping, stakeholder sessions, design synthesis	Understanding · Requirements

Note: Only the 15 empirical or methodological studies are included. The two reviews in the corpus (Amouzadeh et al., 2025; Arslan et al., 2026) are excluded as they did not apply primary HCD methods. Phases follow ISO 9241-210: Understanding the context of use, Specifying requirements, Producing design solutions and User-centred evaluation. * Ahmed et al. (2024): older adults did not participate in this analytical scope.

The analysis of these data permits the identification of three relevant patterns. The first is the considerable terminological fragmentation. The 15 empirical studies employ at least nine distinct designations, such as co-design, participatory design, UCD, design thinking, EBCD, design-based research, CeHRes Roadmap, HCD and participatory approach, to frame processes that share common principles but differ in the extent of participation and the moments in the cycle at which users are involved.

The second pattern concerns the concentration of participatory techniques in the initial phases. Interviews, focus groups and workshops are the most frequent techniques and are primarily centred on understanding the context and specifying requirements. Prototyping and iteration techniques appear in a more restricted subset. Furthermore, while older adults are frequently involved in validating design solutions, their effective participation in actually generating these solutions is documented much less frequently.

The third pattern relates to the depth of participation across the HCD cycle. Only five studies document the participation of older adults across all four phases of the cycle: Paluch et al., Spencer, Shariff and Dale, Chung, Lee and Jung, González-González et al. and, partially, Dias, Costa and Mealha (77,80,83,87,88). In the majority of cases, participation is concentrated at the beginning and the end, with under-representation in the intermediate phases of ideation and development. This pattern raises the question of the extent to which processes that declare themselves as co-design effectively correspond to a sharing of decision-making throughout the cycle.

Beyond these methodological patterns, the reviewed studies also converge around three thematic dimensions that cut across the corpus. The following sections examine the reframing of digital exclusion as a design problem, the role of participation as a learning experience in itself, and the scope and limitations of existing evaluations.

3.3.3 From digital exclusion to a design problem

The first inflection point identified in the literature lies in the manner of framing the problem. Rather than attributing low technological adoption to a supposed inherent resistance to old age, the studies ask to what extent solutions were designed without considering routines, capacities, support networks and material inequalities. This shift is decisive, as chronological age does not function as a reliable proxy for digital competence. In the study by LaMonica et al., for example, the older participants were regular technology users and exhibited high digital literacy, whereas the workshops of Sheahan et al. brought together profiles distributed between low and high ICT familiarity. Kastl, in turn, showed that

similar needs take on different meanings depending on whether the person lives independently, is in rehabilitation, resides in an institution or depends on carers (76,79,85).

This heterogeneity has methodological consequences. When selection is concentrated among people who are already connected, the HCD process may produce a solution that is satisfactory for those who can reach the research and, at the same time, keep invisible those who most need support. The problem appears explicitly in studies with habitual smartphone users or participants with high levels of education and digital competence (76,87,88). Personas and empathy maps can attenuate this limitation when supported by diverse data, but they do not substitute for the effective presence of people in situations of exclusion. The literature therefore recommends segmenting the population by experience, life context, functional condition and available support, as opposed to rigid chronological criteria.

The review by Amouzadeh et al. consolidated interface recommendations that are already relatively stable, such as simple navigation, larger text and touch targets, voice commands, clear feedback and error tolerance (91). These are necessary but insufficient. Saragosa et al. and Piera-Jiménez et al. situate equity beyond the screen, arguing that factors such as cost, internet access, trust, data use, training, governance and continuity of support interfere with the actual possibility of use (86,89). A solution may thus fulfil accessibility criteria and still remain inaccessible in everyday life. The state of the art shifts the focus from *adapting the interface to the older adult* to *understanding the sociotechnical system in which learning and care take place*.

3.3.4 Participation as method and learning experience

The second trend concerns the shift from one-off consultation to denser forms of participation. Workshops, interviews, focus groups, journey maps, storyboards, role-plays and prototypes appear combined to transform experiences into design decisions (76–80,83–90). However, the presence of users in an activity is not sufficient to characterise co-creation. The review by Arslan et al. is particularly revealing in this regard, insofar as, among the studies of dashboards for older adults, frameworks were named inconsistently and the problem definition stage was frequently under-reported (92).

The works of Darley and Carroll and of Paluch et al. help to understand what sustains a less exclusionary form of participation (78,80). Assessing digital competences beforehand, offering training, maintaining alternative telephone or face-to-face channels, building rapport and mobilising mediators are not provisions external to the method. These practices determine who is able to participate, how long they remain engaged and under what conditions their contribution is produced. In the ACCESS project, digital literacy was simultaneously a condition of entry and an outcome of participation itself, since, by collaborating, participants also learnt to use the digital resources that mediated the process (80).

This finding is central to educational interventions. If support is treated merely as a response to an operational difficulty, the opportunity to recognise it as a formative component is lost. The workshops of Dias, Costa and Mealha showed that audiovisual content produced with older adults was better received than materials developed without their participation (77). Sheahan et al. observed that peer exchange broadened the capacity to discuss ICT risks and solutions (79). In both cases, user knowledge does not enter at the end to validate a solution; it shapes the vocabulary, pace, examples and criteria by which the content makes sense.

It is also necessary to acknowledge the cost of such commitment. Sustained participation requires time, accessibility, comprehensible feedback and clarity about which decisions can be shared. Studies that involve older adults only in the initial collection of needs contribute to understanding the context, as occurred in the exploratory phases of Zonneveld et al.; more comprehensive processes, such as the Double Diamond employed by Chung et al., bring research, prototyping and testing closer together (84,87). Even in the latter case, the short duration and selection of smartphone users limited the evaluation.

3.3.5 Recurring requirements and scope of evaluations

Despite the diversity of objects, such as mental health platforms, intergenerational applications, digital agents, home-based rehabilitation, video visits and educational interventions, there is convergence around certain requirements. Simplicity and predictability of navigation must be accompanied by reliable content, personalisation, data protection, the possibility of hybrid care and access to human support (76,81,84,87–91). The recurrence of these elements suggests that HCD should not be reduced to the appearance of screens. It articulates information, task, context of use and care relationships.

The study of the AGATHA agent, conducted in Malaysia, comes closest to the problem addressed in this dissertation. After training and use for up to two weeks, participants reported that the tool was informative and could foster understanding about health and digital confidence; at the same time, they requested greater personalisation, peer interaction and better decision support (81). The finding is promising, but does not permit the inference of sustained literacy gains, because the study was brief, qualitative and did not establish a robust before-and-after comparison. This combination, good initial acceptability and limited evidence of learning, recurs across part of the field.

Spencer, Shariff and Dale offer a useful counterpoint. The GP-MATE intervention was co-designed with older adults and carers to support health literacy following hospital discharge, organising the material around continuity of care, medication safety, information and the role of carers (83). The process demonstrates how concrete experiences can define the architecture of educational content. However, the intervention is not digital and still lacked an impact evaluation. The study reinforces the relevance of co-design for health literacy, but leaves open the question of how this logic behaves when the technological mediation itself is part of what needs to be learnt.

The works of LaMonica et al., Zonneveld et al. and González-González et al. explore values such as autonomy, privacy and personalisation (76,84,88). They show that such values cannot be added after the product is functional: they need to guide choices from the problem definition stage. Complementally, the analysis of 7,155 responses about video visits conducted by Philpot et al. showed that technical difficulties concentrated the majority of barrier-related comments, whilst human factors, convenience and service organisation sustained positive reports (90). The scale of the study strengthens the relevance of these problems in real-world use, although its design synthesis was subsequent to data collection and does not correspond to direct co-design.

The greatest weakness lies in the scope of evaluations. Small and purposive samples, short-duration tests and outcomes measuring usability, satisfaction, intention to use or perceived utility predominate (76–81,84–88). Even when the design process is well described, it is rarely monitored whether the intervention modifies competences, behaviours or access to care over time. The review by Amouzadeh et al. found methodological heterogeneity and weaknesses in sample reporting; Arslan et al. identified geographical concentration and low standardisation in the description of HCD phases (91,92). Thus,

the maturity of the field is greater in the production of design recommendations than in the demonstration of educational effectiveness and sustainability.

A joint reading allows for the establishment of four propositions. The first is that older adults do not constitute a single user profile, and that recruitment and analytical strategies need to accommodate differences in digital competence, educational attainment, functional condition, culture and social support. The second is that training, mediation and peer support form part of both the intervention and the participatory method itself. The third is that equity depends as much on accessibility and usability as on cost, infrastructure, trust and governance. The fourth is that the quality of HCD needs to be demonstrated through the linkage between identified needs, design decisions, modifications made and outcomes observed, which cannot rest on claims of user involvement alone.

However, three relevant gaps persist. There are few studies that follow older adults throughout the entire cycle of an educational intervention for DHL; even fewer combine physical and digital components, gamified learning and implementation across different countries. Furthermore, a large proportion of evaluations remain centred on acceptability and usability, without integrating task performance, learning effectiveness and efficiency of use. Finally, multicentre studies tend to examine the implementation ecosystem or broad groups, without rendering comparable the experiences of the older users themselves across distinct national contexts (81–83,89,92). Moreover, the procedural integration of HCD and public health remains under-theorised. The literature documents either design processes that lack the evaluative rigour expected in health research, or public health evaluations that omit the iterative, user-driven logic of the design cycle, but rarely examines how and at what points the two disciplines can be articulated within a single development process. These gaps informed the methodological choices that follow, beginning with the participants and engagement strategies adopted to ensure the inclusion of older adults throughout the process.

3.4 Participants and engagement strategies

The SAC project involved older adults in two functionally distinct stages of the HCD process. The discovery phase, conducted through the Senior Ambassador Network, and the pilot implementation phase, carried out in three countries, involved participants whose level of prior involvement in the project varied by national context.

During the discovery phase, the Ambassadors' Network structured older adults’ involvement as the human and social foundation of the SAC ecosystem. Local partner organisations recruited this Network through neighbourhood networks, senior clubs, and community initiatives already established in each country. The Ambassadors' involvement in this HCD phase was facilitated through structured participatory workshops called "Ambassadors' Challenges".

The eligibility criteria were defined by the consortium and included awareness of the rights associated with ageing; interest or prior experience in the areas of digital transition, health, and citizenship; active involvement in the community as leaders, activists, caregivers, or volunteers; willingness to participate on a voluntary basis; and the absence of any conflict of interest with regard to the partner organisations.

The pilot implementation was conducted in three countries: Italy, Poland, and Portugal. Recruitment contexts varied by country. In Italy, the sessions were held with members of the Ambassadors Network; in Poland, the pilot involved both Ambassadors and other older adults recruited outside that

network; in Portugal, the sessions took place at a residential facility for older adults, involving institutionalised residents with no prior connection to the project.

3.5 HCD methods and techniques

The team in Portugal coordinated the HCD process for developing and evaluating the Ikigai Play Toolkit. To ensure that the intervention effectively addressed the real needs and sociocultural context of the older adult population, the methodological approach was structured in an iterative and non-linear form and was implemented in four phases: Discover; Ideation; Prototyping; and Validation and Refinement.

3.5.1 Phase 1: Discover (March 2024 to May 2025)

The first phase aimed to foster empathy by understanding the social context of older adults in the eight consortium countries and exploring their needs in a society undergoing digital transformation.

Participatory Workshops

Gaining direct insight into the lived experiences of older adults across eight European countries required a data collection method that could be simultaneously participatory and operationally scalable. Participatory workshops, a method widely used in HCD to engage end users as active contributors to the identification of problems and solutions (93), were selected as the primary mechanism for this purpose.

The decision to opt for participatory workshops, rather than more immersive ethnographic methods such as prolonged contextual observation, cultural probes, or diary studies, resulted from a deliberate trade-off between depth and scalability. Whilst such methods would have yielded richer individual accounts, they would have required the researcher's prolonged presence in each national context, something that was logistically unsustainable across eight countries with distinct institutional frameworks. The workshops made it possible to condense data collection into structured and replicable sessions, which could be facilitated by local partners, whilst maintaining the participatory nature of the process and ensuring cross-national comparability through a standardised protocol.

Organised locally by the consortium partners under Portugal's coordination, the workshops took the form of "Ambassadors' Challenges", collaborative sessions with the project's network of Senior Ambassadors. Each session included identifying needs and solutions through affinity diagramming and administering the Technology Use Questionnaire. The sessions were structured as co-creation events led in each country by the local partner, who served as a facilitator. They took place between March and December 2024, following a standardised protocol that included an introductory and check-in phase, a co-creation phase lasting approximately 60 minutes, and the systematic recording of data produced in a shared document for transnational synthesis. The study also collected photographic and, where applicable, audiovisual records.

Affinity Mapping

The participatory workshops generated a substantial volume of qualitative contributions across the eight countries, requiring a method capable of organising this material into meaningful patterns without imposing predefined analytical categories. Affinity mapping, a qualitative and inductive method widely used in design research, was adopted for this purpose. By externalising insights,

usually in the form of statements or short notes on Post-it notes, and grouping them into clusters based on thematic similarity, this method supports a bottom-up analytical process that allows data-driven interpretations to inform design decisions (93).

This method was chosen over alternative approaches to qualitative analysis for two principal reasons. Firstly, its inductive nature avoids the imposition of predefined categories on diverse cultural realities, a critical consideration when analysing data from eight countries where the experience of ageing and the use of technology carry distinct meanings. Secondly, the affinity diagram serves as a collaborative and democratic analytical tool, in which any team member can participate in the spatial organisation of the notes, regardless of their background in qualitative research methods. This methodological accessibility was crucial in a consortium where consistency in data collection and interpretation depended on the operational simplicity of the method.

In practice, participants were invited to identify and record pain points and potential solutions related to the project's three thematic areas using Post-it notes. The team then grouped these contributions by thematic similarity to identify recurring challenges and opportunities. The results from each country were recorded by the partners in a shared spreadsheet, and the analysis was conducted by the coordination team by aggregating the topics most frequently mentioned across countries, prioritising the most relevant and recurring issues. This process translated individual contributions into structured insights and guided the definition of user needs.

Technology Use Questionnaire

Whilst the affinity mapping captured the contextual richness and subjective dimensions of older adults' experiences with digital technologies, the process required complementary quantitative evidence to characterise patterns of technology use across the consortium countries. A Technology Use Questionnaire was therefore developed and administered as a structured research instrument designed to collect self-reported information from participants regarding their characteristics, perceptions, and behaviours (93).

The decision to supplement the qualitative data with a structured questionnaire reflects a strategy of methodological triangulation. The questionnaire made it possible to quantify patterns of use, frequency of use, and perceived barriers, thereby generating comparable data across the eight national contexts. This complementarity is particularly relevant when addressing a heterogeneous population in which older adults in Europe do not constitute a homogeneous group, and the quantitative dimension made it possible to identify significant variations between countries that might have gone unnoticed in an exclusively qualitative analysis.

The Technology Use questionnaire was used to characterise the Senior Ambassadors' patterns of technology use and identify specific barriers and difficulties in using digital devices. Administered via Google Forms, it covered aspects such as the frequency of computer and smartphone use, the main difficulties experienced, predominant uses, and familiarity with common digital applications. The data collected helped characterise user profiles, which then informed the development of the toolkit. The questionnaire is available in Appendix C.

Meta-narrative literature review

Alongside the primary data gathered through participatory methods, the discovery phase required a synthesis of existing scientific knowledge to ground the toolkit in a solid theoretical and empirical

foundation. A literature review, a secondary research method used to collect, analyse, and synthesise existing knowledge on a given topic (93), was conducted to understand the sociocultural and technological context of the participating countries and to explore how Ikigai values and approaches can be integrated with active and healthy ageing, digital transition, and European citizenship, aiming to inform the development of a culturally appropriate training toolkit for older adults.

The adoption of a meta-narrative approach, rather than a conventional systematic review, was a deliberate methodological choice. A systematic review, whilst more standardised, tends to favour a single disciplinary lens and homogeneous study designs, which would be inappropriate for a project that intersects the digital transition, eHealth, and citizenship. The meta-narrative approach accommodates the diversity of research traditions and epistemological perspectives present in the literature on ageing and technology, enabling the mapping of how different disciplines have framed and studied the same phenomena. The PRISMA guidelines were adopted as a framework for transparency, ensuring the traceability and reproducibility of the selection process amongst the consortium partners.

The review was conducted collaboratively by the consortium partners based on a unified methodological guide, the Paper Collection Guide, and ran between January and May 2025. It was structured in four stages: identification, screening, eligibility, and inclusion. Semantic Scholar was designated as the common database for reasons of cross-border accessibility; each partner conducted complementary searches in national databases and, in the case of the University of Porto, as the coordinating partner, on additional platforms such as Web of Science, PubMed, and the institutional repositories of the WHO and the European Commission. The keywords were standardised around five thematic areas (eHealth, Healthy & Active Ageing, Digital Transition, Older Adults, and the respective country) using Boolean operators for various combinations.

From an initial corpus of 330 identified studies, 168 were selected for analysis after applying the eligibility criteria. The synthesis was organised around three pillars of the project and a specific review of the literature on Ikigai, conceptually integrated into the project's framework. The results of this synthesis informed the development of the theoretical and conceptual framework that would underpin the design of the Ikigai Play Toolkit activities, culminating in the publication of the chapter "Ikigai Play – Towards an Ikigai Paradigm of Healthy and Active Ageing in Europe" by IGI Global. Appendix K.

3.5.2 Phase 2: Ideation (June to September 2025)

At this stage, the data collected during the participatory workshops and the findings from the meta-narrative literature review were analysed by the design team in Portugal, which synthesised the research findings and identified the challenges that needed to be addressed to develop the first prototype, through weekly design team meetings, combining ideation and validation tools and methods.

Personas and Scenarios

Translating the diverse and country-specific insights from the discovery phase into a coherent design direction required a method capable of synthesising cross-national patterns into actionable user representations. Personas are evidence-based representations of target users that capture key characteristics, needs, behaviours, and goals identified during the discovery phase, and were

developed for this purpose. Based on personas, scenarios provide situational representations that illustrate how users interact with a product or system in specific contexts (93).

The personas served as tools for cross-cultural synthesis, consolidating behavioural patterns and needs that transcend national borders into operational archetypes. This choice entailed a conscious compromise, accepting some loss of cultural specificity in favour of representations that the entire international team could use as a common reference for design decisions. The scenarios, in turn, were selected as a method of bridging the gap between the discovery phase and the ideation phase, precisely because they make design implications testable prior to prototyping. In a project with multiple stakeholders, scenarios serve as a method for aligning teams with a shared vision and objective for the solution.

Synthesising the information collected during the discovery phase led to the development of Personas representing older adults, based on the identified patterns. Scenarios were then developed after defining the toolkit, illustrating how the Personas would engage with it in specific use contexts.

Design Requirements

Whilst personas and scenarios captured the user perspective, the transition from understanding the problem to creating a solution required an intermediary layer that could translate empirical findings into actionable design guidelines. Design requirements fulfil this function. They operate as design guides that translate user needs, contextual constraints, and research findings into actionable principles (94).

Between June and August of 2025, seven design requirements were developed through the synthesis of findings from the meta-narrative literature review and participatory workshops conducted during the Discover phase. Through data triangulation, these sources were analysed to enable the identification of recurring patterns related to barriers, needs, and opportunities across the three axes of the project. These insights were then articulated with the theoretical frameworks of Ikigai and Positive Play, resulting in the formulation of 7 design requirements to guide the subsequent prototyping phase.

The design requirements thus served a dual function. They translated the empirical evidence gathered from users and the scientific literature into actionable guidelines for the creation of the toolkit's activities, whilst simultaneously establishing a coherent reference framework anchored in the project's theoretical underpinnings. In this way, the requirements operated as a methodological bridge between research and prototyping, ensuring that the transition from problem understanding to solution creation was grounded in evidence.

3.5.3 Phase 3: Prototyping (September 2025 to March 2026)

Prototyping is the tangible creation of artefacts at various levels of resolution to develop and test ideas within design teams and with clients and users (93). The ideas generated during the brainstorming sessions were transformed into the toolkit's activities, which were structured into a high-fidelity prototype for testing in the following phase.

Brainstorm Sessions

The transition from a defined problem space to the creation of concrete activity proposals required a generative method capable of producing a broad range of ideas whilst remaining anchored in the

evidence gathered during the previous phases. Brainstorming, a widely used ideation method in design processes, was adopted for this purpose. It encourages creative thinking through collaborative, non-judgmental exploration, supports the exploration of alternative solutions, and promotes the combination and refinement of concepts (93).

This technique was used to develop the format and structure of the toolkit activities. During the brainstorm sessions, new activities were created, and existing activities identified were adapted to the project's context. In addition to the design team, the author of this dissertation participated in these sessions, contributing expertise in the public health field to support the elaboration of the toolkit's activities.

These sessions served to generate the largest possible number of ideas based on the challenges and needs identified in the previous phases, functioning as a transition from problem understanding to the creation of a solution.

3.5.4 Phase 4: Validation and Refinement (March to May 2026)

This phase was organised with the aim of testing the toolkit in different settings, identifying errors and collecting feedback from users to inform the refinement and support the scalability of the final version. In this way, the Toolkit was submitted to pilot implementation sessions in three consortium countries, Portugal, Italy, and Poland, and conducted by local partners with the participation of older adults in real-world settings. The tools developed to assess the Toolkit during this phase, along with the procedures for data collection and analysis, are described in the section that follows.

3.6 Pilot Evaluation

The pilot evaluation is a small-scale test of a solution prior to its official launch, functioning as a final quality checkpoint to ensure the final product aligns with what was defined in the earlier phases of the process (55).

The decision to carry out pilot implementation in three of the eight consortium countries was driven by practical constraints on time and resources within the project's timetable, but also by a strategy of purposive sampling. Portugal, Italy, and Poland represent distinct positions across the spectrum of digital infrastructure, ageing demographics, and institutional support for older adults, thereby maximising the diversity of contexts within a manageable evaluation scope.

The details on how the pilot evaluation data was collected and analysed are presented below.

3.6.1 Pilot evaluation data

This pilot evaluation is based on quantitative and qualitative data. At the quantitative level, an evaluation questionnaire was developed to assess the user experience and implementation flow among older adults during the pilot implementation sessions.

The instrument was derived from the PLAY heuristics framework (95), which organises game usability evaluation criteria across three categories: Game Play, Coolness/Entertainment/Humor/Emotional Immersion, and Usability & Game Mechanics.

Drawing on these categories, and aligned with the formal specifications of the SAC project proposal, which define four Key Performance Indicator (KPI) dimensions, Performance, Effectiveness, Efficiency, and Usability, the design team anchored each item to a specific PLAY heuristic code. Not all PLAY heuristics were incorporated; the design team selected those applicable to a physical, non-digital educational toolkit, excluding categories specific to digital game environments.

The four dimensions were defined as follows:

- **Performance**: evaluates whether participants can successfully execute tasks, complete challenges, and engage actively during the session.
- **Immediate Perceived Effectiveness (referred to as 'Effectiveness' in the SAC project KPIs)**: measures the immediate perceived benefits in terms of knowledge, skill acquisition, and engagement.
- **Efficiency**: assesses whether the materials, activity flow, and facilitator guidance allow task completion without unnecessary friction.
- **Usability**: evaluates the clarity, intuitiveness, and accessibility of the physical dynamics and game mechanics.

Within the context of Public Health implementation frameworks (such as the MRC Framework for Complex Interventions), these KPIs do not aim to measure long-term epidemiological health outcomes. Instead, they evaluate the operational feasibility, pedagogical flow, and user acceptability of the intervention toolkit, essential preconditions for ensuring user adoption and subsequent empowerment in digital health literacy.

For each activity, a 16-item questionnaire was administered to older adult participants, the items were rated on a five-point Likert scale (1 = Strongly Disagree; 5 = Strongly Agree). For a subset of activities, the instrument also included prior knowledge self-assessment items administered before the session began, enabling an intra-session comparison between participants' knowledge state before and after the activity.

The instrument was applied immediately after the end of each activity, capturing perspectives on the user experience. The data collected formed the empirical basis of the Toolkit usability study and informed an iterative refinement cycle of its final version. The evaluation questionnaire for participants is provided in Appendix D.

The qualitative data corpus comprised three documents, namely, a synthesis of testing phase findings produced by the design team (appendix E); a qualitative observational synthesis from a transnational feedback meeting, which served as a complementary source of evaluative input for activities not directly evaluated with participants (appendix F); and a feedback report documenting facilitator observations across the Polish pilot implementation sessions (appendix G).

3.6.2 Pilot evaluation analysis

For each dimension, mean scores were calculated per country and per module, enabling cross-country comparison within the constraints of a pilot evaluation. The qualitative documentary was used to contextualise and triangulate the quantitative findings. For activities not directly evaluated through the questionnaire, it also provided evaluative input in its own right.

A deductive qualitative approach was used to contextualise and triangulate the quantitative findings, using the qualitative reports to illuminate specific operational friction points or cross-country divergences identified in the survey metrics.

Relevant passages were used to illuminate the conditions under which pilot implementation sessions took place, the challenges encountered by facilitators, the concerns raised by the Polish partner regarding the toolkit's design, and, where applicable, facilitators' evaluations of activities that had not been assessed via the questionnaire. This triangulation follows the logic of the case study design in which multiple sources of evidence build a coherent account rather than parallel independent analyses.

Although the questionnaire included prior knowledge self-assessment items for a subset of activities, the resulting data did not yield a sufficient basis for intra-session comparison and were therefore not included in the analysis.

3.7 Ethical considerations

The study was conducted in strict accordance with the ethical principles outlined in the Declaration of Helsinki and the European Union's General Data Protection Regulation (GDPR). All participants, including older adults and stakeholders, were provided with clear and accessible information regarding the study's objectives, the voluntary nature of their participation, and their right to withdraw at any time without penalty. Informed Consent was obtained in writing from all individuals involved in the participatory workshops and the pilot testing. To ensure confidentiality and anonymity, all data collected was pseudonymised, and any identifying information was stored securely, accessible only to the design team.

4. Results

This chapter is dedicated to presenting the results obtained through the application of HCD methods and tools, highlighting the contribution of this approach to the development and pilot evaluation of the intervention.

4.1 The HCD development process of the Ikigai Play Toolkit

In line with the first specific objective, this section outlines the development process of the Ikigai Play Toolkit and demonstrates how the principles and methods of Human-Centred Design guided its various stages. The results are organised to highlight the progression from identifying the needs of older adults to defining personas, scenarios and design requirements, as well as the decisions relating to the format, content and structure of the activities that made up the first prototype of the intervention.

4.1.1 Characterisation of the user and context

This section presents the results from the Discovery phase. In this phase, the combination of participatory workshops with a meta-narrative literature review provided insights into the socio-cultural context of older adults and identified their digital health literacy needs, grounding the creation of the toolkit.

Taken together, the methods and tools applied in this phase converged on a profile of the target user across the eight consortium countries, characterised as an older adult with a utilitarian and conservative relationship with digital technology, proficient in and dependent on the smartphone for direct contact (calls and SMS), but facing clear barriers when navigating more advanced features such as installing applications or engaging with social media, and reporting a marked concern about cybersecurity.

This context was compounded by structural and psychosocial factors identified across the three axes of the project, namely, institutional fragmentation and low digital literacy limiting access to digital services, particularly in rural contexts; the technical complexity of eHealth platforms as a barrier to autonomous use; and a risk of exclusion from participatory processes migrating to digital channels, disproportionately affecting isolated or socioeconomically vulnerable older adults.

Below are presented the results of the discovery phase, highlighting the HCD approach in each method and tool.

Results from Participatory Workshops

This HCD approach constituted the primary mechanism for direct engagement and immersion in the reality of European older adults, operationalised through two complementary tools applied simultaneously: affinity mapping and the administration of a technology use questionnaire.

Affinity Map

The affinity mapping process allowed for the identification and organisation of qualitative evidence regarding pain points and proposed solutions, structured around the project's three axes. The final sample consisted of 96 ambassadors, 63 women and 33 men, all aged 65 or older, distributed across

the participating countries: Belgium (n=4), Cyprus (n=10), Portugal (n=26), Germany (n=8), Italy (n=18), Poland (n=16), Latvia (n=6), and Slovenia (n=8).

A synthesis of the affinity map highlighting the main pain points and solutions is presented below. Table 3 presents the quantitative distribution identified for each axis, while the complete affinity maps, along with detailed qualitative descriptions and thematic zoom-ins, are available in Appendix H.

Table 3. Number of pain points and solutions identified per thematic axis through the Ambassadors' Challenges affinity mapping exercise.

Theme	Pain Points (N)	Solutions (N)
Digital Transition	95	82
eHealth	79	96
Citizenship	94	94
Total	**268**	**272**

- **Digital Transition**: Lack of familiarity with the digital environment generates insecurity and dependence on others, limiting older adults' autonomy. Among the 95 pain points identified within this axis, the most frequently mentioned concerns fear of technology and of making mistakes, limited access to affordable devices and stable internet connections, and concerns about cybersecurity and the risk of scams. In response, the 82 solutions proposed most often centred on hands-on computer and smartphone lessons, peer-learning groups for digital skills, and the creation of permanent follow-up support networks.

- **eHealth:** Digital health systems frequently fail to communicate in accessible terms, creating barriers for those who most need them. Among the 79 pain points identified, the most recurrent were low digital literacy and lack of confidence, complex technological vocabulary and unfamiliar operating logic, and the overall complexity of eHealth platforms. The 96 solutions proposed most frequently involved co-design and co-creation of tools with the target audience, digital skills training programs tailored to older adults, and hands-on workshops demonstrating tool functionality.

- **Citizenship:** The migration of public services and participation channels to digital environments risks marginalising older citizens, particularly those in rural areas or in situations of socioeconomic vulnerability. Among the 94 pain points identified, the most prominent concerned the intersectionality of vulnerabilities (age combined with linguistic, social, and economic constraints), the lack of guarantees of digital citizenship in exclusively digital spaces, and the under-representation of older adults in participatory processes. Correspondingly, among the 94 solutions proposed, the most recurrent included accessible co-creation of tools (e.g., voice commands and screen readers), the empowerment of older adults as "Digital Ambassadors" and peer mentors, and community workshops held in familiar locations.

Illustrative photographs of the affinity diagramming activities conducted across the participating countries of the project are presented in Figure 2 and Figure 3. Each country identified and recorded pain points and potential solutions related to the project’s three thematic areas using Post-it notes.



Figure 2. Affinity diagramming session with the Portuguese partner group. Participants identified and categorised pain points and potential solutions across the project's three thematic areas.



Figure 3. Affinity diagramming session with the Slovenian partner group. Participants organised and discussed pain points and solutions across thematic boards.

Technology Use Questionnaire

The Technology Use Questionnaire was completed by 57 respondents in all consortium countries except Belgium. This questionnaire provides quantitative evidence regarding the use of technology among older adults. They proved to be proficient and reliant on smartphones for direct

communication, particularly phone calls (93%) and text messaging (91%). However, they exhibited severe barriers in navigating and operating more advanced features, such as installing new applications and interacting on social networks. In addition to interface limitations, evidenced by an average icon recognition score of just 4.77 on a 0-to-10 scale, the results revealed that 26% of participants experienced a generalised fear of the device, driven by the apprehension of falling victim to digital fraud, schemes, and scams. A summary of these descriptive results is presented in table 4, with the remaining data detailed in Appendix I.

Table 4. Descriptive results from the Technology Use Questionnaire administered to Senior Ambassadors across seven consortium countries (n=57).

Dimension	Result
Frequent computer use	Yes (54%) / No (46%)
Frequent smartphone use	Yes (91%) / No (9%) — (88%) "several times a day"
Length of smartphone use	5–9 years: 32%; 10–19 years: 28%; <5 years: 12%; ≥20 years: 9%; no use/not applicable: 7%
Reported difficulties	Yes (35%) / No (65%)
Self-rated difficulty — making calls (1–10)*	Median = 1; M = 2.26 (SD = 2.42); 14% report meaningful difficulty
Self-rated difficulty — sending texts (1–10)*	Median = 1; M = 2.70 (SD = 2.72); 18% report meaningful difficulty
General fear of smartphone	Yes (26%) / No (74%)
Use for entertainment	Yes (49%) / No (51%)
Social media use	Yes (49%) / No (51%)
Knows the concept of an "app"	Yes (70%) / No (30%)
App recognition (0–10 icons)	M = 4.77 (SD = 3.2); median = 5.0
Most frequent purposes of use	Calls (93%), Texts (91%), Internet (75%), Photos (67%), Social media (44%), Music (26%)

***Note:** Likert scale from 1 to 10, where 1 = No difficulty / Very easy, and 10 = Extreme difficulty / Very difficult.

Results from Meta- Narrative Literature Review

The meta-narrative literature informed the theoretical grounding of the toolkit, particularly the integration of the Ikigai philosophy. Given that the full review has been published as a co-authored book chapter (Appendix K), it is not reproduced here. This section summarises the main findings identified in each consortium country, their impact on the older adult population, and ongoing local initiatives, culminating in the proposal of the Ikigai framework as a cross-cutting response to these realities.

Beyond the country-specific realities, the review identified structural barriers to digital health adoption across Europe that directly shaped the toolkit's rationale. Four categories of obstacles were mapped, namely legal, ethical, financial, and technical, alongside a pattern of regional polarisation in digital skills across 179 European regions. The pandemic further accelerated these disparities, with evidence that rapid digitalisation across 30 European countries exacerbated inequalities by offering few analogue alternatives for already excluded populations. Taken together, these findings framed the problem the toolkit sought to address not as a deficit of digital tools, but as a misalignment between the tools available and the capabilities, motivations, and contexts of the older population.

The expansion of digital health infrastructures coexists with persistent inequalities in access and use by older adults, revealing itself as a recurring pattern in the 8 countries analysed. These inequalities are unevenly mitigated by local digital literacy and inclusion initiatives that share a common characteristic of treating technology as an enabler of human connection.

- **Portugal:** Institutional fragmentation and low digital literacy limit older adults' access to infrastructure and public health services, particularly in rural areas. Initiatives such as Ageing@Coimbra and +TV4E have promoted digital inclusion through mobile units and television-based platforms adapted to habits already familiar to users.

- **Poland:** The development of digital health strategies has not uniformly reached the older adults, with gaps in digital literacy and distrust in public services persisting, demonstrating the fragility of the integration of digital and social policies. Programs such as Aktywni+ and Senior+ invest in digital education and intergenerational activities aligned with values of purpose and social connection.

- **Slovenia:** The integration of electronic health records and platforms such as zVEM proved essential during the pandemic, but limitations in infrastructure and professional training persist. The Simbioza programme stands out for its successful intergenerational mentoring in strengthening digital skills.

- **Latvia:** Despite progress in telemedicine and patient portals, older adults in rural regions face digital exclusion and economic precarity. Initiatives such as Senioru Skola rely on peer learning to bridge skills gaps.

- **Italy:** The digital health system reveals a clear North-South disparity in telemedicine adoption, with southern regions systematically excluded from eHealth services. Digital storytelling projects such as Nonni Digitali have fostered a sense of purpose through meaningful life narratives and intergenerational connection.

- **Germany:** An advanced digital health system coexists with regional differences in implementation between urban and rural areas. The DigitalPakt Alter programme seeks to bridge these gaps through community-based digital learning centres.

- **Cyprus:** Digital health adoption is growing through EU-funded platforms and projects, but health literacy and confidence in digital tools remain low, especially among those over 70. Programmes such as e-Inclusion and Active Ageing Cyprus aim to address this gap, in a context where older adults place strong value on family and spiritual engagement.

- **Belgium:** The national digital health strategy is among the most coordinated in the consortium, with well-established telehealth and patient portals. The emphasis is on solutions co-created with users, aligned with citizen-centred design principles, including evidence that internet use significantly mitigates feelings of loneliness among older adults.

The review also included a dedicated synthesis of the empirical literature on Ikigai, which provided the evidence base for adopting this philosophy as the toolkit's educational framework. Longitudinal studies from Japan found a positive correlation between ikigai and lower mortality rates among older adults. Crucially, research on individuals aged 75 and older found that ikigai was significantly more sensitive to loneliness, social support, and participation than standard measures of life satisfaction, and that social support and frequent participation buffered the negative effects of loneliness on ikigai. This

finding aligned directly with the user profile emerging from the participatory workshops and reinforced the decision to structure the toolkit around collective activities and facilitator mediation rather than individual self-instruction. Cross-national validation studies further supported the cultural adaptability of the ikigai construct in Western contexts, a necessary precondition for its application across eight European countries.

It is in response to this convergence of evidence that the review proposed the Ikigai Play framework, structured around four interconnected pillars: Digital Inclusion, Access, and Literacy; Health and Well-being; Citizenship and Participation; and Psychosocial Resilience and Purpose. This framework provided the conceptual foundation that, combined with the findings from the participatory workshops, informed the subsequent ideation and prototyping phases of the toolkit.

4.1.2 Ideation results

This section outlines the insights resulting from the second phase of the project and details how they informed the development of the toolkit. The ideation phase is a creative phase, where we produce many ideas to address a problem statement.

Patterns identified in the first phase, specific to each country, were synthesised to ensure the result remained relevant across user experiences. Fundamental to this conceptualisation was the integration of the Ikigai philosophy and Positive Play game design. Decisions regarding the toolkit's approach were structured around the alignment between personal purpose, community needs, and practical engagement, establishing a holistic foundation for activities. Below are the results of the ideation phase.

Personas and Scenarios

To operationalise these insights, the design team developed four distinct personas representing the project's three axes alongside a dedicated facilitator/educator profile. Each persona was paired with an illustrative usage scenario to delineate real-world application contexts where the toolkit would yield the highest impact, functioning as the primary reference point for the project's user stories.

The complete personas, encompass four descriptive dimensions (*struggles, interests, ambitions, and desires*). Throughout the iterative design process, these Personas and Scenarios served as validation tools, anchoring activity mechanisms to realistic user profiles and guiding the overall thematic scope.

Figures 4 to 11 present the four developed personas and their corresponding usage scenarios. Manuel Oliveira (72, Portugal) represents the Digital Transition axis (Figures 4 and 5); Teresa Marciniak (76, Poland) represents the eHealth axis (Figures 6 and 7); Rajko Ostronič (78, Slovenia) represents the Citizenship axis (Figures 8 and 9); and Daniela Lucia (33, Italy) represents the Facilitator profile (Figures 10 and 11). Each persona captures a distinct set of struggles, interests, ambitions, and desires relevant to their thematic area, while the accompanying scenarios depict realistic interactions with the toolkit.



Figure 4. User persona card for Digital Transition: Manuel Oliveira (72, Portugal)

Manuel is a grandfather and he had a full day to spend with his grandkids, who are constantly on their phones. Wanting to do something fun together, he decided to try some games he had learned about at his Senior University from the SmartAgeCare Toolkit. With the help of the kids, Manuel visited the Toolkit's website and printed two games: "Guess the App" and "Online Safety".

After going through the rules on how to play the game, Manuel gathered is grandkids and started the first game. together, they took turns asking questions to guess the mobile application or website shown on each other's cards. After several rounds, one of the grandchildren won the game by guessing the most cards, and they all decided to go onto the second game.

While playing "Online Safety", Manuel's grandkids proved to be strong players, quickly answering all questions about cybersecurity. They also helped Manuel with some tricky questions, explaining concepts and guiding him through the answers.

After a full afternoon of laughing and playing with his grandkids, Manuel's daughter arrived to pick up the children. Once they left, Manuel stayed in the living room, going through the cards again and taking time to learn more about mobile apps and cybersecurity on his own.

Figure 5. Usage scenario for Digital Transition (Manuel Oliveira, 72, Portugal)



Figure 6. User persona card for eHealth: Teresa Marciniak (76, Poland)

Teresa often feels lost when using medical apps or speaking with her doctor during online appointments. She gets confused with unclear interfaces and the steps required to book or attend online doctor appointments. However, she is motivated to learn more about digital access to healthcare.

At the Senior University, Teresa was introduced to the SmartAgeCare toolkit and its activities. That day, each student received a character card describing fictional health issues, symptoms, and health situation. Teresa's task was to record a video as if she were speaking to a doctor online. She had to practice holding the phone, camera position, and paying attention to important aspects of the video appointment, such as explaining the symptoms and showing relevant areas on the camera.

Although she felt embarrassed at first, she quickly grew more confident and aware of what she needed to do. After everyone finished their recordings, the group reviewed and discussed the videos together. With guidance from the facilitator, they all highlighted the positive aspects and what could be improved, helping participants become more prepared for future online appointments.

Figure 7. Usage scenario for eHealth (Teresa Marciniak, 76, Poland)



Figure 8. User persona card for Citizenship: Rajko Ostronič (78, Slovenia)

Rajko was on his way to the Senior University with a friend when the bus got delayed. While waiting, they both manifested their disappointment with one another. With the delay of the bus, they both took the time to talk with one another and what is going on on their lives, how their pensions are low while general prices go up, how the public transportation doesn't work well on their areas and even about their health issues. After the bus arrived, they kept conversing during the ride.

Upon arriving at their class, their professor announced that the day's session would focus on the topic of "Citizenship". the first activity was "Community Mapping". Working in a group, Rajko helped create a visual map of the group's community, marking local shops, public services, and other relevant places. The professor then asked each group to add sticky notes highlighting positive and negative aspects of these community spaces. Remembering the conversation he had earlier at the bus stop, Rajko began listing the issues that have been bothering him.

Once the map was complete, the class moved into an opened discussion about the community, how people feel about where they live, what concerns they share, and what changes could be made to start improving their social and community environment. Through this discussion, Rajko gained a deeper understanding of the issues affecting his community and began to see potion improvements.

To finish the session, the Professor introduced a second activity, "Who decides?". The group was presented with a series of community scenarios, and asked to identify who has the power to make those decisions. As the discussion progressed, the professor encouraged the group to think about how these power dynamics affect their daily lives and what influence they can have on the decisions. Rajko started reflecting on the issues he had talked about earlier at the bus stop, and began to see how decision-making processes connect to those problems. The activity helped him recognize now only who holds power and who gets make the important decisions.

Figure 9. Usage scenario for Citizenship (Rajko Ostronič, 78, Slovenia)

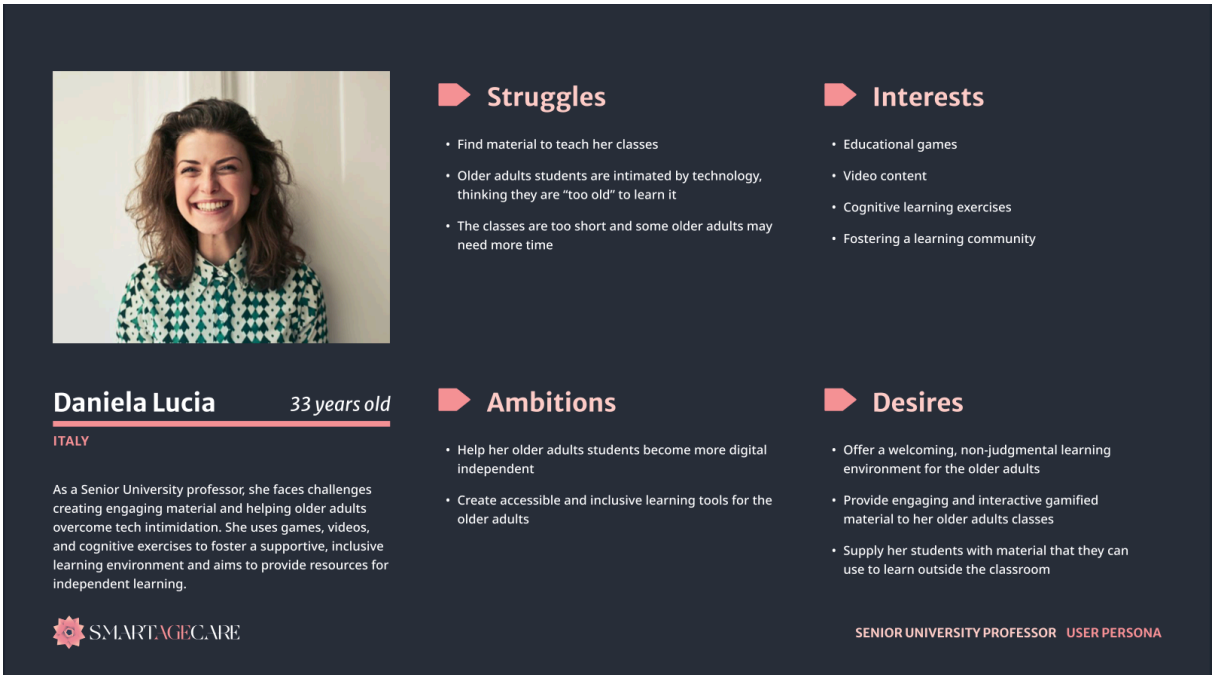


Figure 10. Facilitator persona card: Daniela Lucia (33, Italy)

Daniela is a professor at a Senior University, where she teaches two classes of older adults. Although both groups are made of seniors, one class is older and less digital literate. After learning about the SmartAgeCare project and its toolkit, designed to empower older European adults with engaging activities, shd immediately recognized the material's potential to be used her classes.

On the day Daniela had the two classes, Daniela introduced the toolkit to them. She explaining that throughout the semester, they would participate in a series of activities and games designed to strengthen their understanding of the key themes , such as "Digital Transition", "Citizenship", and "e-health". She showed the classes some examples of the activities and games.

Daniela shared her hope that by using the toolkit, the students would be able to improve their digital skills, become more active, confident and aware citizens, and better understand the topic of digital health. She also aims at creating a friendly, supportive, and stimulating learning environment, where the students could feel motivated and engaged.

Figure 11. Usage scenario for Facilitator (Daniela Lucia, 33, Italy)

Design requirements

In parallel with the development of personas and scenarios, the synthesised evidence was articulated with the theoretical frameworks of Ikigai and Positive Play to formulate seven functional requirements. Detailed in Appendix L, and formally published as a conference paper, these requirements work as design guidelines that guide the iterative prototyping of the toolkit activities:

1. **Utility, simplicity, and adaptability of activities**: activities should be perceived as useful, intuitive, and adaptable to individual needs and goals, reducing barriers to engagement, particularly for users with limited digital experience.
2. **Progress visualisation and tracking**: the Toolkit should enable users to monitor their progress and reflect on their actions, reinforcing a sense of purpose and continuity.
3. **Safe environment for experimentation and learning**: activities should foster a safe and supportive environment in which errors are framed as learning opportunities, promoting confidence and the gradual acquisition of digital competencies.
4. **Integration with daily routines and behavioural continuity**: the Toolkit should be embedded in users' everyday lives, encouraging the maintenance of meaningful habits and supporting long-term behavioural sustainability.
5. **Promotion of flow and challenge balance**: activities should be designed to promote a state of flow, balancing challenge and competence levels to avoid frustration or disengagement.
6. **Safe simulation of digital risk scenarios**: the Toolkit should include scenarios that simulate real digital risks, such as misinformation or online fraud, within a controlled and guided environment, supporting the development of critical awareness.
7. **Inclusion of content relevant to older adults and caregivers**: content should be meaningful and relevant not only to older adults but also to their support networks, including caregivers, thereby strengthening social connectivity and broadening the intervention's impact.

4.1.3 Prototyping outcomes

The development of the toolkit's prototype followed an iterative, non-linear process structured around brainstorming sessions. These sessions aimed to translate the results of the Discovery and Ideation phases into activity proposals, subsequently validated by the team in Portugal, composed of designers, health professionals, and ageing specialists, and converted into a high-fidelity prototype.

Structure

The initial concept considered a single serious game organised around the project's three thematic axes, however, given the breadth of needs and contexts surfaced in the participatory workshops, the team opted instead for a set of 43 activities distributed across four thematic modules (Ikigai, Digital Transition, eHealth, and Citizenship), allowing the toolkit to remain personalised and adaptable to different environments:

- **Module A - Ikigai:** Through reflective exercises and creative sessions such as clay sculpting, painting, karaoke, and movement-based activities, this module helps participants identify sources of purpose and fulfillment. Its aim is to promote emotional well-being, creativity, and self-awareness as a foundation for the learning process.

- **Module B - Digital Transition:** This module aims to strengthen the confidence and competence of older adults in using digital technologies, promoting digital literacy for the safe

and autonomous digital engagement. Activities engage participants with tasks involving app recognition, identification of online scams and misinformation, digital safety practices, and hands-on use of smartphones.

- **Module C - eHealth:** The goal of this module is to empower older adults in using digital health services with autonomy and informed decision-making, by exploring the use of digital tools in health management and promoting healthy lifestyle practices. It addresses both technological and behavioural dimensions of health. Activities include use of wearable devices, nutrition-related games, and discussions on healthy ageing.

- **Module D - Citizenship:** This module focuses on critical reflection on social participation, community identity, and civic rights to encourage older adults to recognise their role as active contributors to their communities. Activities include community mapping, storytelling, and discussions on topics such as identity, gender, and ageism.

This modular structure was reinforced by two decisions grounded directly in fieldwork. An analogue format was prioritised over digital delivery, given the heterogeneity of the target population, ranging from institutionalised to fully independent older adults, for whom a purely digital tool risked reproducing the very barriers to access identified in the characterisation phase.

Also, specific activities were developed in direct dialogue with domain experts, evidence-based literature, and targeted methodological frameworks, for example, the teleconsultation simulation activity was informed by research conducted with physicians on the structure, content, and common concerns raised during online medical consultations, while the nutrition-themed activity was validated with a nutritionist to ensure the accuracy and appropriateness of its content.

More broadly, content development drew upon the convergence of field insights and the meta-narrative literature review, reflecting the national variations in technological maturity and ageing policies across partner countries. The physical toolkit was engineered according to strict visual accessibility standards, employing high-legibility typography (*IBM Plex Sans*) and high-contrast colour palettes.

Given the transnational nature of the project, English served as the pivot language for all educational modules, teaching materials, and data collection instruments. Translation into the national languages of the eight partner countries was carried out internally by the local partners themselves, using a shared collaborative spreadsheet as a centralised repository.

The toolkit was designed for use across a wide range of contexts, including family settings, residential and nursing care facilities, day care centres, community programmes, municipal initiatives, senior universities, and informal group gatherings, with facilitators encouraged to adapt each activity to the needs, interests, and dynamics of their specific group. Some activities were designed primarily for group interaction, while others focus on individual reflection, dialogue, or hands-on practical engagement.

It combines a variety of learning materials, including activity cards, tables and charts, exercise sheets, and digital tools such as smartphones, and supports individual, group, and hybrid formats of participation, in which instructions may be delivered collectively while tasks are completed individually.

The prototype comprises four physical components. The Card Sets serve as interactive, prompt-based triggers designed to stimulate discussion and hands-on engagement during the sessions. The Manual provides facilitation guidance for each activity, including participant instructions and facilitation notes. Facilitators may follow the guidance closely or adapt it to the dynamics of the group. The Solutions Book offers answers and contextual explanations for selected activities; it is intended as a selective reference tool rather than a prescriptive guide, given that many exercises prioritise discussion and experiential learning over fixed outcomes. The Photocopies Book contains all printable materials, including exercise sheets and templates, which facilitators reproduce and distribute as needed. These physical components are presented in Figure 12.

The high-fidelity prototype resulting from this process was submitted to a pilot evaluation across Portugal, Italy, and Poland, with the aim of testing the toolkit in different implementation spaces, identifying errors, and collecting feedback from users and facilitators to ensure that the final version was both safe and useful.



Figure 12. High-fidelity prototype components of the Ikigai Play Toolkit, including physical books, card sets, and activity materials.

Direct contributions to toolkit activity design

Within the broader scope of the toolkit's prototyping, I contributed to the creation of several educational activities, with a particular focus on the direct development of four of them in the eHealth and Citizenship modules:

- **eHealth — *Digital Health Detectives* (Activity 3.6):** Designed to combat online health misinformation using Inoculation Theory and prebunking strategies, which build cognitive resilience through controlled exposure to weakened manipulation techniques. Utilising data from the project's *Technology Use Questionnaire*, common manipulation tactics (e.g., emotional appeals, fake authority) were embedded into realistic mockups of email, Facebook, and WhatsApp interfaces. Learning objectives focus on evaluating source credibility, recognising manipulation indicators, and understanding the risks of unverified health self-management.
- **eHealth — *Wearables in Elderly Health Care* (Activity 3.10):** Introduces participants to ten wearable technologies selected from the literature, to support health monitoring, physical

activity tracking, and emergency assistance. The activity addresses a common awareness gap, helping older adults recognize wearables as accessible tools for independence.

- **Citizenship — *You Are Probably Wrong About Ageism* (Activity 4.11):** Adapted from Gapminder's "You Are Probably Wrong About" methodology, this activity confronts personal biases with empirical facts. Grounded in data from the WHO *Global Report on Ageism*, it translates statistical insights and conceptual definitions into interactive, myth-busting exercises to increase public awareness.

- **Citizenship — *You Are Probably Wrong About Elder Abuse* (Activity 4.12):** Built on the same Gapminder framework, this activity uses statistical data from the European Report on Preventing Elder Maltreatment to address a critical yet underrepresented topic. Given the sensitive nature of the subject, the activity incorporates specialised support materials and localised resource directories to ensure awareness transitions into safe, practical action.

The results presented demonstrate that the development of the Ikigai Play Toolkit did not stem from a pre-defined solution. The identification of the difficulties and the solutions proposed by older adults, supplemented by the Technology Use Questionnaire and a review of the literature, provided the basis for the development of the personas, scenarios and the seven design requirements. These elements guided the choice of a predominantly physical, accessible and adaptable format, as well as the initial organisation of 43 activities into four modules. Thus, the first specific objective was met by demonstrating how the evidence generated during the discovery phase was progressively translated into design decisions and concrete components of the prototype.

4.2 Pilot evaluation and refinement

In line with the second specific objective, this section presents an exploratory evaluation of the pilot implementation of the Ikigai Play Toolkit in Portugal, Italy and Poland. The analysis considers the quantitative results relating to performance, immediate perceived effectiveness, efficiency and usability, linking them to the qualitative data provided by participants, facilitators and local teams. This integration enables the identification of barriers, facilitators and contextual variations, as well as demonstrating how the feedback obtained during the pilot informed the refinement of the final version of the toolkit.

Figures 13 and 14 illustrate the implementation of these pilot testing sessions conducted with older adults in Italy and Poland, respectively, highlighting the dynamic and collaborative nature of the activities.

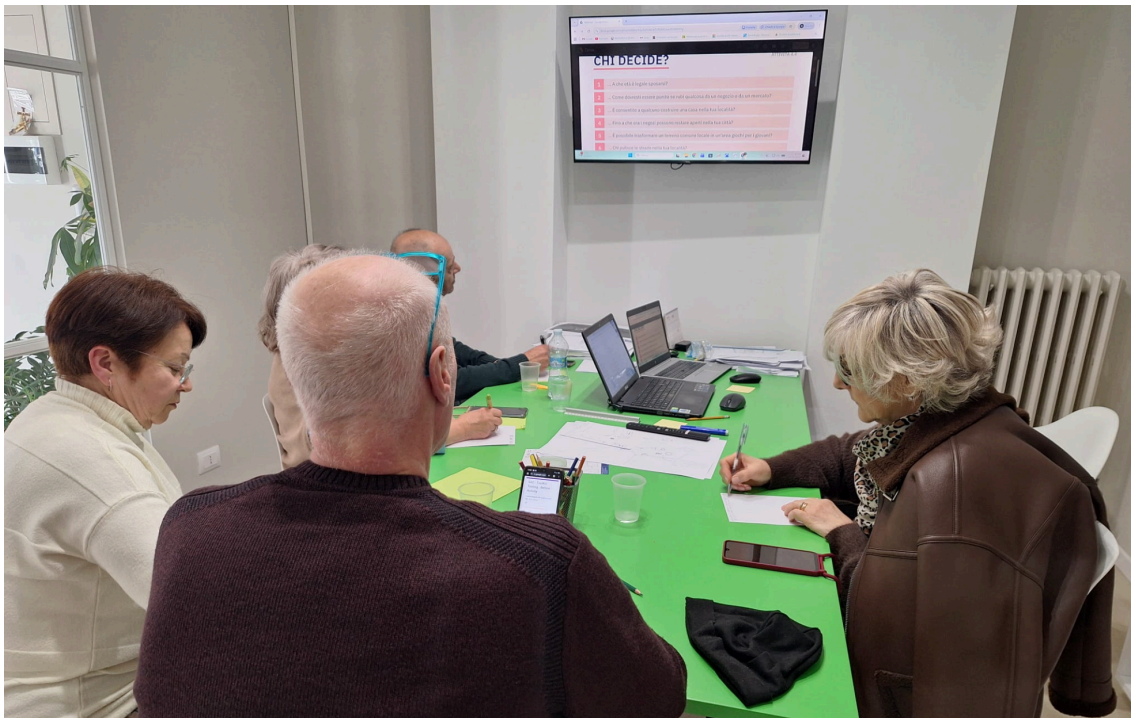


Figure 13. Pilot implementation session in Italy: participants engage with the "Who Decides?" activity, exploring concepts of power and decision-making.



Figure 14. Pilot implementation session in Poland: participants engage with the "What Does It Do?" activity, interacting with digital devices to identify interface components.

4.2.1 Pilot evaluation results

The pilot implementation was conducted in Italy, Poland, and Portugal, a scope shaped by logistical constraints. Within each context, time constraints during the pilot implementation sessions limited the number of activities that could be evaluated directly with participants: Italy implemented 22 activities and Portugal 13 activities covering all four modules, Poland implemented 20 activities across Modules 1, 2, and 3. In total, 318 evaluation questionnaires were collected, constituting the main quantitative indicator of the scope of implementation, distributed across Italy (n=133), Portugal (n=100), and Poland (n=85).

The participants' responses to the assessment instrument were operationalised in four dimensions: performance, immediate perceived effectiveness, efficiency and usability. The composite scores by country were calculated as arithmetic means of the corresponding items, on a scale of 1 to 5. Table 5 presents the results by country and module.

Table 5. Evaluation responses by dimension, country and module (scale 1–5, N=318 questionnaires)

Italy				
	Performance	**Immediate Perceived Effectiveness**	**Efficiency**	**Usability**
Module 1	4.61	4.55	4.00	3.45
Module 2	4.46	4.11	4.07	3.84
Module 3	4.85	4.60	4.34	3.90
Module 4	4.56	4.27	4.20	4.03
Total	**4.54**	**4.25**	**4.13**	**3.88**
Poland				
	Performance	**Immediate Perceived Effectiveness**	**Efficiency**	**Usability**
Module 1	4.21	3.24	3.37	3.61
Module 2	4.40	4.26	4.16	4.32
Module 3	4.34	3.91	3.70	3.57
Total	**4.32**	**3.83**	**3.78**	**3.90**
Portugal				
	Performance	**Immediate Perceived Effectiveness**	**Efficiency**	**Usability**
Module 1	4.03	4.02	3.83	3.14
Module 2	3.79	3.70	3.79	3.83
Module 3	3.94	3.75	3.72	3.64
Module 4	4.60	4.48	4.44	3.87
Total	**3.93**	**3.86**	**3.83**	**3.57**
Total all countries				
	4.29	**4.01**	**3.94**	**3.79**

Across all participating countries and modules, Performance achieved the highest overall mean score (4.29). This indicates that older adult participants were consistently able to complete the proposed tasks, felt safe, and maintained an active, receptive role throughout the sessions.

Conversely, Usability registered the lowest aggregate score (3.79). This lower rating revealed operational friction in the clarity and intuitiveness of the physical mechanics, particularly in abstract

exercises, such as card-sorting to simulate digital screens, instructional rule complexity, and within contexts characterised by higher dependency and lower prior technology familiarity, as observed among institutionalised participants in Portugal (3.57).

The Immediate perceived effectiveness dimension, which captures immediate perceived benefits rather than demonstrated competence gains, yielded a score of 4.01, suggesting that participants recognised practical value, knowledge benefits, and everyday utility in the activities. Immediate perceived effectiveness was rated higher in modules directly aligned with participants' immediate needs, such as Module 2 and Module 3. Finally, the Efficiency score (3.94) revealed a critical reliance on facilitator guidance, indicating that session pacing and fluidity were heavily supported by the facilitators' capacity to guide participants through structural complexities.

National results highlighted distinct contextual engagement profiles:

- **Italy:** Module 3 achieved the highest evaluations (Performance: 4.85; Immediate perceived effectiveness: 4.60), suggesting that health and well-being topics generated deep personal engagement when approached through reflective, dialogue-based dynamics.

- **Poland:** Module 2 stood out across all metrics (Immediate perceived effectiveness: 4.26; Usability: 4.32), pointing to a strong participant preference for practical digital tasks with direct everyday applications.

- **Portugal:** Module 4 recorded exceptional scores (Performance: 4.60; Immediate perceived effectiveness: 4.48), suggesting that exercises focused on citizenship, ageism, and community roles stimulated meaningful, high-level reflection.

4.2.2 Toolkit refinement

The qualitative assessment, together with the results of the pilot evaluation, provided the empirical basis for structural improvements to the toolkit. This iterative review led to the removal of five activities and the elimination of the competitive mechanisms originally incorporated into the prototype, reducing the overall toolkit from 43 to a final total of 38 activities.

The testing phase revealed a marked contrast among older adult participants in terms of skills, motivation, and learning preferences. Digital literacy ranged from individuals with no prior experience with digital technologies to advanced users already integrating artificial intelligence tools into daily routines. This wide spectrum made it difficult to calibrate a single complexity level within the same session, highlighting that the toolkit's implementation depends heavily on the facilitator's capacity for adaptation, flexibility, and contextual knowledge. Participants also exhibited diverse learning styles, spanning structured step-by-step guidance to autonomous, exploratory approaches.

Engagement levels varied significantly by activity type. Practical and contextually relevant exercises generated high participation, whereas theoretical or simulated tasks were perceived as overly basic or unengaging by more experienced participants. In practical tasks such as vacation planning, participants bypassed step-by-step scripts entirely to interact directly with AI tools (e.g., Gemini) to address concrete needs, such as real budgets and travel criteria. Similarly, scam awareness activities proved most effective when structured around shared real-life experiences rather than fictional scenarios. Static exercises, such as sorting physical cards to simulate phone operations, proved ineffective, reinforcing the necessity for direct, hands-on device interaction.

The qualitative insights gathered across the evaluation process informed specific adjustments within the toolkit and identified directions for future refinement:

- **Module 1 (Ikigai):** While creative and expressive workshops successfully encouraged cognitive and emotional engagement, feedback indicated that the Ikigai concept was being applied through a single universalised model that did not resonate equally across cultural contexts, pointing to the need for deeper, more context-sensitive interpretations in future iterations

- **Module 2 (Digital Transition):** Exercises grounded in practical, real-world utility produced the highest engagement. The final updates focused on multi-level difficulty adaptations and direct device operations (e.g., QR code contact sharing).

- **Module 3 (eHealth):** Feedback highlighted a critical need to move away from deficit-based or competitive educational models. Board games and card decks that penalised health events, were identified as stigmatising, and emotionally inappropriate. The final refinement reoriented health activities toward private self-assessments, peer dialogue, and expert-guided prevention that respect participants' existing knowledge and lived experience.

- **Module 4 (Citizenship):** Where implemented, Module 4 generated broad reflective engagement extending beyond individual ageing to institutional and societal dimensions, underscoring the potential of intergenerational learning formats. However, implementation feasibility was strongly conditioned by local realities. In Poland, facilitators opted not to implement Module 4 due to systemic institutional distrust and low perceived agency among participants, heightened by a major local housing crisis in Łódź resulting from infrastructure construction. This suggested that civic participation exercises need to be directly connected with local realities to be meaningful.

The final version of the toolkit is organised across its four modules. A representative sample of the finalised activities, including facilitation guidebooks, activity dynamics, and participant materials, is provided in Appendix J. The complete toolkit is available on the project's digital platform[2].

Taken together, the iterative refinement process confirmed that the toolkit's perceived acceptability is less dependent on fixed content design than on its capacity to accommodate the heterogeneity of older adult learners. The adjustments made across all four modules suggested that activities grounded in participants' lived experience and immediate practical relevance generated deeper engagement than those relying on abstraction, simulation, or standardised models. These findings informed the final 38-activity version of the toolkit.

[2]All toolkit activities and their associated materials are available at: https://smartagecare.fba.up.pt/tool-kit.

5. Discussion

The increasing digitalisation of healthcare systems has made digital health literacy a condition of access and, therefore, a digital determinant of health (36,96,97). However, the disparity between the digital offer and older adults' capacity to use it, characterised by a marked heterogeneity of skills and motivations, limits the effectiveness of standardised interventions (65,98,99). HCD has been mobilised in response to this challenge, with evidence that interventions developed through this approach demonstrate better usability and acceptability than those conceived through conventional methods, although methodological and quality limitations persist in how these processes are conducted and reported (56,58).

Within this framework, the present study set out to fulfil two objectives. The first was to analyse the development process of the Ikigai Play Toolkit, from the identification of older adults' needs through to the definition of requirements, content, format and other design decisions that guided the prototyping of the intervention. The second was to conduct an exploratory evaluation of the toolkit's pilot implementation in Portugal, Italy and Poland, considering the dimensions of performance, immediate perceived effectiveness, efficiency and usability, as well as the barriers, facilitators, contextual variations and refinements arising from feedback from participants, facilitators and local teams. The discussion that follows is organised around these two axes, interpreting the findings in light of what each reveals about the potential and the tensions of the convergence between Design and Public Health.

Adopting a single case study design informed by guidelines for reporting design-involving research (57), the analytical focus lay in the documentation and critical reflection on this convergence. A preliminary clarification is necessary regarding the extent of end-user participation in the process. Although the development cycle was documented in its entirety, from discovery through to post-pilot refinement, the direct participation of older adults was concentrated at two points, in the discovery phase, through participatory workshops and user characterisation, and in the piloting phase, through the evaluation of activities. The intermediate phases of ideation and prototyping were conducted by the design and research team, informed by the evidence produced during discovery, but without continuous in-person involvement of older adults. This clarification is relevant to accurately situate the degree of effective HCD at each stage of the process.

This pattern is consistent with the third finding of the state of the art review (section 3.3), where the majority of studies concentrated on older adults' participation in the understanding and evaluation phases, with under-representation in the intermediate stages of ideation and development. The SAC project, despite its contributions, did not fully overcome this structural difficulty, which reinforces the need for future interventions to develop strategies for sustaining meaningful participation across the entire HCD cycle.

5.1 HCD applied to the promotion of digital health literacy among older adults

From the identification of needs to design decisions

Regarding the first specific objective, the mobilisation of HCD in the health field has focused predominantly on technology development (10). The SAC case is distinctive in applying the same

methodological repertoire to a different outcome, a ludic-educational intervention for the promotion of digital health literacy, and in having arrived, through this process, at an analogue artefact.

The decision to favour a physical medium stemmed from the evidence produced during the discovery phase. User characterisation revealed a heterogeneous population, proficient in using mobile phones for direct communication but with pronounced barriers in more advanced functionalities, and in which 26% reported a generalised fear of the device. In this context, an exclusively digital intervention risked reproducing, in its very delivery medium, the barrier it set out to overcome.

Additionally, the participatory workshops conducted across the consortium's eight countries during the discovery phase were structured so that the identification of problems and solutions rested with the participants, rather than depending on categories pre-defined *a priori* by the researchers, as typically occurs in public health research (100,101). The results of these workshops, together with the literature review, supported traceability between field-level needs and design decisions. The iterative response enabled the removal of stigmatising mechanics and the restructuring of the eHealth module within weeks, something that a conventional evaluation would have struggled to accommodate without compromising the protocol (102,103).

The distinguishing feature of this process was the combination of HCD methods with learning theories. HCD provides a robust repertoire for investigating needs and iterating solutions, but the definition of the principle that organises the educational response to those needs lies beyond its scope. In the SAC, this articulation was facilitated by the Ikigai philosophy and the Positive Play framework.

This articulation responds to the discovery phase findings, which revealed not only technical barriers but a lack of personal meaning, fear of making mistakes and low intrinsic motivation (69). Rather than the traditional model based exclusively on the technical progression of skills (104), the Ikigai framing anchored learning in a motivational axis, treating digital tools as a means to achieve life purposes identified by the participants. The toolkit's architecture materialises this inversion by including a module dedicated to the identification of sources of purpose.

Exploratory evaluation of the pilot implementation across three national contexts

The transition to the second objective requires a preliminary methodological note. The pilot evaluation collected a total of 318 questionnaires administered immediately after each activity. This figure corresponds to the total volume of responses, not to the number of distinct participants, since the same participant could complete multiple questionnaires across sessions, one per activity undertaken. Furthermore, the implementation coverage differed substantially between countries. A total of 22 activities were evaluated in Italy, 20 in Poland and 13 in Portugal, and Module 4 was not implemented in Poland, by decision of the facilitators. The means per module and per country are therefore based on unequal numbers of evaluated activities and collected responses, which constrains direct comparability and requires that differences between national contexts be interpreted as descriptive and exploratory, rather than as effect estimates.

With this framing established, a consistent pattern was observed across the four evaluated dimensions. Across all three pilot countries, performance recorded the highest overall score and remained the top-rated dimension in every country, indicating that participants were able to carry out the proposed tasks and maintain an active role throughout the sessions. By contrast, usability recorded the lowest aggregate score. Between these extremes lay immediate perceived effectiveness and efficiency, with the former scoring slightly higher. It is important to emphasise that the dimension referred to here as

immediate perceived effectiveness reflects participants' perceptions of the utility and relevance of the activity in the moment immediately following its completion, and not a proven gain in digital health literacy competencies, the measurement of which would have required validated instruments and pre-post evaluation designs that were not implemented in this study.

Taken together, these values suggest that the motivational dimensions, such as the ability to participate, to feel safe and to recognise value in the activity, were rated more favourably than the dimensions relating to the clarity of mechanics and the fluidity of execution. This asymmetry is consistent with the toolkit's conceptual architecture, as the Ikigai and Positive Play framing was oriented primarily towards motivation and the reduction of anxiety associated with error, and it is on this plane that the results are most favourable. The translation of this framing into mechanics, such as rules, materials and task sequences, constitutes the weakest link in the chain, which points back to the first design requirement formulated during the ideation phase, concerning perceived simplicity and intuitiveness.

This interpretation finds support in the distribution by module. Module 1, dedicated to Ikigai, recorded the lowest usability score across all three countries with the minimum value registered in Portugal, whilst simultaneously maintaining high performance scores, which indicates that participants engaged with the reflective and creative activities, but the formalisation of those activities into structured dynamics proved unintuitive. The quantitative finding converges with the qualitative finding for this module, which highlighted the need for more context-sensitive interpretations of Ikigai, avoiding the universalisation of a single model. This is, therefore, an operationalisation difficulty, as the abstraction of a philosophical concept into exercises with clear rules is demanding, and the formulation adopted may not have been adequate for the participants.

Poland constitutes the exception to the described pattern, and the exception is instructive. It was the only country in which usability did not occupy the last position, a result determined by Module 2, which recorded the highest values in the Polish context across all four dimensions, including the highest usability score in the entire series dataset. This module is the one that concentrates practical digital tasks with direct everyday application. In the same country, Module 1 recorded the lowest immediate perceived effectiveness value across all countries and modules. This internal contrast reinforces the reading already suggested by the qualitative data, namely that activities anchored in concrete utility and hands-on device use were better understood and more valued than activities of a reflective or simulated nature.

The finding that utility-anchored activities generated greater participation, whilst theoretical or simulated exercises were perceived as insufficiently stimulating, is consistent with the evidence from Damodaran et al. (105), who identify perceived relevance and applicability to participants' everyday context as central determinants of sustained engagement in digital learning amongst older adults. The same applies to the evidence that activities on digital scams proved more effective when structured around real experiences shared by participants than around fictitious scenarios, which connects to the literature on collaborative and peer learning in adult education contexts (106).

The national profiles diverged as to the highest-rated module (Module 3 in Italy, Module 2 in Poland, Module 4 in Portugal), suggested that perceived relevance was context-dependent. This finding retrospectively supports the decision taken during the prototyping phase to abandon the conception of a single serious game in favour of a modular structure. The case of Module 4 is particularly illustrative. In Portugal, within a residential context of high dependency, it recorded the highest

national scores in performance and immediate perceived effectiveness, whilst in Poland it was never implemented, by decision of the facilitators grounded in institutional distrust and the impact of a local housing crisis. The same content thus achieved the best and the most unviable of results depending on the socio-political context of application.

The efficiency dimension, which occupied an intermediate position in the overall ranking, warrants particular attention. Its intermediate positioning, associated with qualitative observations regarding the role of facilitators, indicates that the fluidity of sessions depended on the facilitators' ability to manage the structural complexity of the activities and the internal heterogeneity of the groups, which ranged from participants with no prior contact with digital technologies to users who already integrated artificial intelligence tools into their routines. The toolkit does not, therefore, function as a self-instructional instrument. This observation has direct implications for scalability, as it shifts the unit of transfer from the artefact in isolation to the combination of the artefact and the pedagogical mediation that accompanies it (107).

The importance of peer and facilitator mediation is also present in the national initiatives identified in the meta-narrative review. Programmes such as Simbioza in Slovenia or Senioru Skola in Latvia are based on intergenerational mentoring and peer learning, sharing with IkigaiPlay the idea that digital competence develops far more through personal relationships than through formal instruction (51). This convergence suggests that the centrality of the facilitator is not a particularity of this toolkit but a common characteristic of digital literacy interventions directed at this population.

Finally, the results must be read in light of the implementation asymmetries already noted. Beyond the differences in the number of activities evaluated per country and the non-implementation of Module 4 in Poland, the recruitment profiles for the pilot evaluation varied substantially, with members of the Ambassador Network in Italy, a combination of ambassadors and externally recruited participants in Poland, and institutionalised residents with no prior connection to the project in Portugal. These recruitment differences, combined with the variation in activity and module coverage, mean that the 318 questionnaires collected reflect structurally distinct application contexts, and comparisons between countries should be understood as descriptive and exploratory exercises.

From pilot evaluation to prototype refinement

Taken together, the quantitative and qualitative results of the pilot evaluation, pertaining to the second objective, converged in a structural revision of the prototype, completing the analytical cycle initiated under the first objective. This revision streamlined the overall toolkit and eliminated the competitive mechanics originally present. The evaluation cycle thus fulfilled the function assigned to it within the HCD process, by identifying friction points and grounding refinement decisions before the final version.

The most distinctive contribution of this study lies in what diverges from current practice. In the literature on gamification in mHealth for older adults, the most commonly used game elements have been oriented towards individual performance, such as progression, challenges and goals, whilst competitive mechanics such as leaderboards and comparison between participants remain under-explored (108). The pilot evaluation results reinforce this trend insofar as competitive mechanics and formats that penalised adverse health events were considered stigmatising and emotionally inappropriate, and were eliminated from the prototype. The subsequent refinement reoriented the eHealth module activities towards self-assessment and peer dialogue.

This divergence is analytically significant for two reasons. The first is that the rejection mechanism is not related to competition as such, but to the object upon which it bears, since penalising a participant for a health event amounts to negatively scoring their own biographical trajectory. The second is that this finding is consistent with what the Positive Play framing already advocated, a ludic design oriented towards human flourishing, agency and emotional well-being, rather than comparative performance. The initial prototype had not fully integrated this principle, and it was the evaluation with users that made it operative. The case thus illustrates a less discussed function of iterative design cycles, transcending the correction of usability failures to reveal inconsistencies between the declared theoretical framing and its material translation.

Lastly, the results concerning the difficulty of simulating digital environments invite a repositioning of the very formulation of the problem. The majority of digital health literacy interventions implicitly assume that the deficit resides in the user's competencies and that the solution lies in empowering them to navigate existing systems (104). The experience of this project suggests that this formulation is incomplete, as the heterogeneity of eHealth solution interfaces across countries, providers and platforms rendered the construction of a transferable simulation unfeasible, thereby shifting part of the responsibility from individual deficit to the design of the systems themselves. This argument brings the study closer to the literature on digital determinants of health, which frames access and usability as structural conditions rather than individual attributes (97,98).

5.2 Strengths and limitations

One of the contributions of this study lies in the documentary traceability of the development process. The chain connecting user characterisation and context to design requirements, from these to prototype activities, and from these to post-pilot refinement decisions is described explicitly, which corresponds precisely to the type of reporting whose absence has been noted in the literature on design applied to health (56). The use of a guideline developed independently of the project, extending beyond a reporting framework to serve as an analytical instrument , reinforces this transparency and reduces reliance on subjective interpretation. Additionally, there is conceptual merit in the use of Ikigai and Positive Play as a learning framework, which favours a motivational approach, modular organisation over a single pathway, and the consideration of analogue support as a legitimate option when the target population presents marked heterogeneity in digital literacy.

These contributions must, however, be read alongside significant methodological constraints. As stated in the methods chapter, the single case study aims at analytical generalisation rather than statistical inference, and the results are not generalisable to populations or contexts external to the SAC. The pilot evaluation measured perceived acceptability and feasibility, not competence gain. The questionnaire was administered immediately after each activity, capturing reaction and use experience, rather than consolidated learning or retention. No pre-post design with validated psychometric instruments, such as the eHEALS scale (35,36) or DHLI (37), nor any longitudinal follow-up was implemented. The four evaluated dimensions, including the one referred to here as immediate perceived effectiveness, should therefore be interpreted within the framework of feasibility and acceptability assessment (109), and not as indicators of effectiveness or of a proven increase in digital health literacy.

The questionnaire itself derived from a selective adaptation of the PLAY heuristics (95), with the design team having excluded the categories specific to digital environments and anchored each item to a heuristic code. Although this adaptation is consistent with the purpose and phase of the study, the

instrument was not submitted to formal psychometric validation, and neither its factorial structure nor the internal consistency of the four dimensions were examined. The analysis was limited to the calculation of arithmetic means on Likert scales, without recourse to inferential statistics, measures of dispersion or between-country difference tests.

A further limitation with broad reach concerns the absence of sociodemographic characterisation. No standardised sociodemographic instrument was applied, either in the formative phase or in the piloting phase. This gap precluded any correlation between social determinants of health, such as education, income, cohabitation status and rural or urban context, and the evaluation indicators, limiting the understanding of the inequalities underlying the observed results and restricting the capacity to interpret differences between countries beyond contextual description. Participants were recruited by convenience and according to criteria that varied between national contexts, and the Ambassador Network's eligibility criteria selected older adults who were active in the community and previously interested in the project's themes, which means that the empirical base that informed the design requirements does not represent the diversity of the final target population.

The characterisation of the development phase relied on documentation produced for project management purposes, not for research. The retrospective reconstruction of design decisions, although systematised through an analytical framework, does not replace prospective recording and carries a risk of *a posteriori* rationalisation. The researcher's integration into the project team ensures privileged access to documentation and tacit knowledge of the process, but required sustained reflexivity to mitigate the risk of confirmatory interpretation, as discussed in the methodological chapter. English served as the pivot language for all materials and instruments, with translation into national languages carried out internally by local partners, without back-translation procedures or semantic equivalence verification. It cannot be excluded that part of the variation observed between countries stems from differences in item wording.

At the operational level, the transnational nature of the project introduced variability in the depth and format of the data produced across contexts, despite the use of standardised protocols and centralised records. This variability constitutes an additional constraint on cross-country comparability. More broadly, the study was conducted under the time constraints of a funded project, whose timeline and contractual indicators were defined before and independently of the research questions formulated here. This subordination explains part of the limitations described, namely the absence of sociodemographic data collection and the selection of activities actually tested, and illustrates a broader tension between intervention production cycles and the requirements of evaluative research.

5.3 Towards a hybrid model of intervention development

The analysis of this case, in light of the two objectives that guided it, suggests that the articulation between HCD and Public Health is not resolved by the subordination of one field to the other, but by the identification of the moments at which each responds more effectively to distinct demands. The proposal that follows is derived from this single case and is intended as a heuristic rather than a prescriptive framework. The tensions identified throughout this study stem from the process having been conducted according to the conventions of one field, without the demands of the other having been incorporated at the points when it was still possible to satisfy them. The absence of sociodemographic characterisation illustrates the foreseeable outcome of a process in which such data collection was never planned, and whose consequence only became visible at the analysis stage, when it was no longer recoverable.

The proposal presented here consists, therefore, of identifying three points of articulation along the development cycle, at each of which the two fields contribute what they are effectively equipped to do.

In the discovery phase, HCD methods enabled a contextual understanding of the needs, fears and priorities of the target population, with a depth that the usual instruments of public health research, such as structured questionnaires and validated scales, do not achieve. The contribution of public health at this point is twofold. It consists, firstly, of applying a standardised sociodemographic instrument to characterise who participates, through the collection of data such as education, income, cohabitation status and residential context, and, secondly, of making recruitment criteria explicit in light of an equity objective. This second contribution responds directly to the limitation identified in this study. It is not a matter of replacing the intentional sampling of design with probability sampling, but of making explicit who is represented and who is not, and of justifying that composition.

In the prototyping and piloting phase, the contribution of HCD remains central, through rapid iteration, the capacity to eliminate or reconfigure components based on evidence of use, and usability evaluation. It was this capacity that enabled, in this project, the identification and removal of competitive and punitive mechanics before the final version. Public health adds the framing of the feasibility evaluation according to the criteria established for complex interventions (109,110), the reapplication of the sociodemographic instrument with pilot participants, and the documentation of implementation fidelity, namely which activities were effectively implemented, under what conditions and with what local adaptations (107,111). This last dimension is the one that would have enabled, in this study, a more robust interpretation of between-country differences, and would likewise have enabled a more rigorous distinction between the number of participants effectively evaluated and the total volume of questionnaires collected.

In the impact evaluation phase, the contribution of public health becomes essential, through the introduction of validated digital health literacy instruments, pre-post designs capable of measuring actual competence gains (as distinct from the immediate perceived effectiveness captured in this study), longitudinal follow-up and linkage with indicators of actual service utilisation. HCD retains here a less obvious but still necessary function, that of ensuring that the intervention continues to be refined in response to the application context, and that local adaptation is not treated as a protocol deviation but as a condition of viability (111).

Finally, it is important to acknowledge the status of this proposal. It is a model derived from a single case, formulated on the basis of the gaps that the analysis made visible, and not an empirically tested framework. Proposals with similar objectives already exist, such as the AHEAD framework (112) and the IDEAS framework (113), from which the present contribution is distinguished by its focus on an educational rather than a technological intervention.

Its utility is heuristic in nature, serving as an initial decision-making grid for similar projects, whose applicability requires empirical validation in different contexts. It is important, however, to avoid the perception that this model constitutes a unidirectional overlay in which public health merely adds procedures to a design process. On the contrary, the strengths of Design, such as its generative potential, iterative cycles and focus on user experience, address frequent gaps in complex intervention research, making its integration indispensable to the model and not a mere concession.

6. Conclusion

This dissertation set out to analyse how Human-Centred Design guided the development, pilot implementation, and refinement of the Ikigai Play Toolkit, a ludic-educational intervention for promoting digital health literacy among older adults. The solution that emerged from this process was a predominantly analogue, modular toolkit anchored in the Ikigai philosophy and the Positive Play framework, an outcome that was not predetermined but arrived at through the evidence produced during the HCD cycle. This result can be considered positive in that it illustrates the capacity of HCD methods to generate interventions that respond to the actual conditions of the target population rather than to assumptions about what a digital health literacy intervention should look like. Its broader implication is that promoting digital competencies does not necessarily require a digital medium, particularly when the population in question presents marked heterogeneity in skills, motivation, and access.

The findings fulfilled the first specific objective by documenting the progression from the identification of older adults' needs, through participatory workshops, a technology use questionnaire, and a meta-narrative literature review, to the formulation of personas, scenarios, and seven design requirements that guided the prototyping of 43 activities across four modules. The traceability between field-level needs and design decisions was maintained throughout, showing how the evidence of a utilitarian relationship with technology, a generalised fear of the device reported by 26% of participants, and low intrinsic motivation converged in the decision to prioritise an accessible, adaptable, and purpose-driven format.

The second specific objective was fulfilled on an exploratory basis. The pilot evaluation in Portugal, Italy, and Poland indicated favourable performance and recognition of the immediate usefulness of the activities, while revealing that usability and facilitator dependence constituted the weakest dimensions. The variation in highest-rated modules across countries, with Module 3 in Italy, Module 2 in Poland, and Module 4 in Portugal, suggested that perceived relevance was context-dependent. This feedback cycle drove the final refinement of the toolkit, resulting in the elimination of competitive mechanics and a more streamlined, consolidated set of activities. These results represent immediate perceptions of the implementation and do not demonstrate long-term effects on digital health literacy.

The main limitations of this study stem from the constraints of a funded project whose timeline and deliverables were defined independently of the research questions formulated here. Ideally, the pilot evaluation would have included validated digital health literacy instruments applied in a pre-post design, a standardised sociodemographic questionnaire enabling the analysis of social determinants underlying the observed results, and a larger and more homogeneous sample across countries. What was achieved instead was a feasibility and acceptability assessment based on 318 questionnaires and qualitative documentary data, which, while sufficient to inform the iterative refinement of the toolkit, does not permit conclusions about actual competence gains or long-term impact. The absence of sociodemographic data is the limitation with the broadest reach, as it restricts the capacity to interpret differences between countries beyond contextual description.

Future research should address these gaps by applying validated instruments for assessing DHL such as the eHEALS scale, the DHLI or other psychometrically robust scales, within pre-post and longitudinal designs, collecting sociodemographic data from the outset, and documenting implementation fidelity across sites. The centrality of facilitator mediation, confirmed across all three national contexts, further suggests that the unit of transfer in scaling interventions of this nature is not

the artefact alone but the combination of the artefact and the pedagogical support that accompanies it, a dimension that warrants dedicated investigation.

Taken together, the evidence produced across this study suggests that Human-Centred Design, when applied with methodological consistency and openness to emergent outcomes, can generate health promotion interventions that are simultaneously grounded in evidence and responsive to the lived realities of their intended users. The Ikigai Play Toolkit illustrates this by arriving at a predominantly analogue solution to a nominally digital challenge, an outcome that only became legible through sustained engagement with the needs, capacities, and motivations of older adults in diverse European contexts. More broadly, this work contributes to an understanding of digital health literacy promotion not as a matter of technology transfer, but as a situated, relational, and pedagogically mediated process in which the design of the intervention and the conditions of its facilitation proved closely interdependent. These propositions, however, are derived from a single case and carry heuristic rather than confirmatory value. Their applicability to other populations, intervention types, and implementation contexts remains an open empirical question.

References

1. European Commission. Statistical Office of the European Union. Ageing Europe: looking at the lives of older people in the EU : 2020 edition. [Internet]. LU: Publications Office; 2020 [cited 2026 Aug 26]. Available from: https://data.europa.eu/doi/10.2785/628105

2. Christensen K, Doblhammer G, Rau R, Vaupel JW. Ageing populations: the challenges ahead. The Lancet. 2009 Oct 3;374(9696):1196–208. doi:10.1016/S0140-6736(09)61460-4

3. Khan HTA, Addo KM, Findlay H. Public Health Challenges and Responses to the Growing Ageing Populations. Public Health Chall. 2024 Jul 21;3(3):e213. doi:10.1002/puh2.213

4. World Health Organization. World Health Organization [Internet]. 2022 [cited 2026 Aug 26]. Ageing and health. Available from: https://www.who.int/news-room/fact-sheets/detail/ageing-and-health

5. United Nations, Department of Economic and Social Affairs, Population Division. World Population Prospects 2024: Summary of Results [Internet]. New York: United Nations; 2024 [cited 2026 Aug 26]. Available from: https://population.un.org/wpp/assets/Files/WPP2024_Summary-of-Results.pdf

6. World Health Organization. World report on ageing and health. World Health Organization; 2015.

7. Eurostat. Eurostat Statistics Explained [Internet]. Eurostat; 2026 [cited 2026 Aug 26]. Population structure and ageing. Available from: https://ec.europa.eu/eurostat/statistics-explained/index.php?title=Population_structure_and_ageing

8. Eurostat. Eurostat Statistics Explained [Internet]. 2026 [cited 2026 Aug 26]. Mortality and life expectancy statistics. Available from: https://ec.europa.eu/eurostat/statistics-explained/index.php?title=Mortality_and_life_expectancy_statistics

9. OECD, European Commission. Health at a Glance: Europe 2024: State of Health in the EU Cycle [Internet]. OECD Publishing; 2024 [cited 2026 Aug 26]. (Health at a Glance: Europe). Available from: https://www.oecd.org/en/publications/health-at-a-glance-europe-2024_b3704e14-en.html doi:10.1787/b3704e14-en

10. Eurostat. Eurostat Statistics Explained [Internet]. 2025 [cited 2026 Aug 26]. Healthy life years statistics. Available from: https://ec.europa.eu/eurostat/statistics-explained/index.php?title=Healthy_life_years_statistics

11. Liotta G, Canhao H, Cenko F, Cutini R, Vellone E, Illario M, et al. Active Ageing in Europe: Adding Healthy Life to Years. Front Med. 2018 Apr 30;5:123. doi:10.3389/fmed.2018.00123

12. van den Akker M, Buntinx F, Knottnerus JA. Comorbidity or multimorbidity: what's in a name? A review of literature. Eur J Gen Pract. 1996 Jan 1;2(2):65–70. doi:10.3109/13814789609162146

13. Wilk P, Ruiz-Castell M, Stranges S, Bohn T, Fagherazzi G, Nicholson K, et al. Relationship between multimorbidity, functional limitation, and quality of life among middle-aged and older adults: findings from the longitudinal analysis of the 2013–2020 Survey of Health, Ageing, and

Retirement in Europe (SHARE). Qual Life Res. 2024 Jan 1;33(1):169–81. doi:10.1007/s11136-023-03508-9

14. Jindai K, Nielson CM, Vorderstrasse BA, Quiñones AR. Multimorbidity and Functional Limitations Among Adults 65 or Older, NHANES 2005–2012. Prev Chronic Dis. 2016 Nov 3;13:E151. doi:10.5888/pcd13.160174

15. Cantarero-Prieto D, Pascual-Sáez M, Blázquez-Fernández C. Social isolation and multiple chronic diseases after age 50: A European macro-regional analysis. PLOS ONE. 2018 Oct 24;13(10):e0205062. doi:10.1371/journal.pone.0205062

16. Gomes Dantas AA, Wingerter Barros AP, Da Câmara Melo Freire G, Carlos De Amorim Santos M, Jerez-Roig J, Bezerra De Souza DL. Multimorbidity Among Adults Aged 50 and Over in Europe and Israel: Prevalence and Associated Factors From SHARE Wave 9. J Am Med Dir Assoc. 2026 May;27(5):106138. doi:10.1016/j.jamda.2026.106138

17. Wu Y, Pang J, Xu S, Lett AM. Digital exclusion and health in older adults: a systematic review. Npj Digit Med. 2026 Aug 18. doi:10.1038/s41746-026-03091-6

18. Global Strategy on Digital Health 2020-2025. 1st ed. Geneva: World Health Organization; 2021. 60 p.

19. COMMUNICATION FROM THE COMMISSION TO THE EUROPEAN PARLIAMENT, THE COUNCIL, THE EUROPEAN ECONOMIC AND SOCIAL COMMITTEE AND THE COMMITTEE OF THE REGIONS on enabling the digital transformation of health and care in the Digital Single Market; empowering citizens and building a healthier society [Internet]. 2018 [cited 2026 Aug 25]. Available from: https://eur-lex.europa.eu/legal-content/EN/TXT/?uri=COM:2018:233:FIN

20. Eysenbach G. What is e-health? J Med Internet Res. 2001 Jun 18;3(2):e20. doi:10.2196/jmir.3.2.e20

21. World Health Organization. mHealth: Second Global Survey on eHealth. Geneva: World Health Organization; 2011. 111 p. (Global observatory for eHealth series; Volume 3).

22. World Health Organization. Telemedicine: Opportunities and Developments in Member States. Report on the Second Global Survey on eHealth 2009. Geneva: World Health Organization; 2010. 96 p. (Global Observatory for Ehealth).

23. Proposal for a REGULATION OF THE EUROPEAN PARLIAMENT AND OF THE COUNCIL on the European Health Data Space [Internet]. 2022 [cited 2026 Aug 25]. Available from: https://eur-lex.europa.eu/legal-content/EN/TXT/?uri=celex:52022PC0197

24. Evroux CT. European health data space [Internet]. Brussels: European Parliamentary Research Service (EPRS); 2022 [cited 2026 Aug 26]. Report EPRS_BRI(2022)733646. Available from: https://www.europarl.europa.eu/thinktank/en/document/EPRS_BRI(2022)733646

25. Regulation (EU) 2025/327 of the European Parliament and of the Council of 11 February 2025 on the European Health Data Space and amending Directive 2011/24/EU and Regulation (EU) 2024/2847 (Text with EEA relevance) [Internet]. 2025 [cited 2026 Aug 27]. Available from: http://data.europa.eu/eli/reg/2025/327/oj

26. Cunha AS, Pedro AR, Cordeiro JV. Facilitators of and Barriers to Accessing Hospital Medical Specialty Telemedicine Consultations During the COVID-19 Pandemic: Systematic Review. J Med Internet Res. 2023 Jul 10;25:e44188. doi:10.2196/44188

27. Kruse C, Heinemann K. Facilitators and Barriers to the Adoption of Telemedicine During the First Year of COVID-19: Systematic Review. J Med Internet Res. 2022 Jan 4;24(1):e31752. doi:10.2196/31752

28. Ftouni R, AlJardali B, Hamdanieh M, Ftouni L, Salem N. Challenges of Telemedicine during the COVID-19 pandemic: a systematic review. BMC Med Inform Decis Mak. 2022 Aug 3;22(1):207. doi:10.1186/s12911-022-01952-0

29. Eurostat. Individuals using the internet for seeking health-related information [Internet]. Eurostat; 2026 [cited 2026 Aug 25]. Available from: https://ec.europa.eu/eurostat/databrowser/product/page/TIN00101 doi:10.2908/TIN00101

30. van Dijk JAGM. The Digital Divide. Cambridge: Polity Press; 2020. 208 p.

31. Nutbeam D. Health literacy as a public health goal: a challenge for contemporary health education and communication strategies into the 21st century. Health Promot Int. 2000;15(3):259–67.

32. Sørensen K, Van den Broucke S, Fullam J, Doyle G, Pelikan J, Slonska Z, et al. Health literacy and public health: a systematic review and integration of definitions and models. BMC Public Health. 2012;12(1):80.

33. Norman CD, Skinner HA. eHealth Literacy: Essential Skills for Consumer Health in a Networked World. J Med Internet Res. 2006 Jun 16;8(2):e9. doi:10.2196/jmir.8.2.e9

34. Norman C. eHealth literacy 2.0: problems and opportunities with an evolving concept. J Med Internet Res. 2011;13(4):e125. doi:10.2196/jmir.2035

35. Milanti A, Norman C, Chan DNS, So WKW, Skinner H. eHealth Literacy 3.0: Updating the Norman and Skinner 2006 Model. J Med Internet Res. 2025 Mar 11;27(1):e70112. doi:10.2196/70112

36. Norman CD, Skinner HA. eHEALS: The eHealth Literacy Scale. J Med Internet Res. 2006 Nov 14;8(4):e27. doi:10.2196/jmir.8.4.e27

37. Van Der Vaart R, Drossaert C. Development of the digital health literacy instrument: measuring a broad spectrum of health 1.0 and health 2.0 skills. J Med Internet Res. 2017;19(1):e27.

38. Van Kessel R, Wong BLH, Clemens T, Brand H. Digital health literacy as a super determinant of health: more than simply the sum of its parts. Internet Interv. 2022;27:100500.

39. Chidambaram S, Jain B, Jain U, Mwavu R, Baru R, Thomas B, et al. An introduction to digital determinants of health. Kalla M, editor. PLOS Digit Health. 2024 Jan 4;3(1):e0000346. doi:10.1371/journal.pdig.0000346

40. Petretto DR, Carrogu GP, Gaviano L, Berti R, Pinna M, Petretto AD, et al. Digital determinants of health as a way to address multilevel complex causal model in the promotion of Digital health equity and the prevention of digital health inequities: A scoping review. J Public Health Res. 2024 Jan 17;13(1):22799036231220352. doi:10.1177/22799036231220352

41. Arias López M del P, Ong BA, Borrat Frigola X, Fernández AL, Hicklent RS, Obeles AJ, et al. Digital literacy as a new determinant of health: a scoping review. PLOS Digit Health. 2023;2(10):e0000279.

42. Jiang X, Wang L, Leng Y, Xie R, Li C, Nie Z, et al. The level of electronic health literacy among older adults: a systematic review and meta-analysis. Arch Public Health. 2024;82(1):204.

43. Xie L, Zhang S, Xin M, Zhu M, Lu W, Mo PKH. Electronic health literacy and health-related outcomes among older adults: a systematic review. Prev Med. 2022;157:106997.

44. Shi Z, Du X, Li J, Hou R, Sun J, Marohabutr T. Factors influencing digital health literacy among older adults: a scoping review. Front Public Health. 2024;12:1447747.

45. Wang X, Luan W. Research progress on digital health literacy of older adults: a scoping review. Front Public Health. 2022;10:906089.

46. Hepburn J, Williams L, McCann L. Barriers to and facilitators of digital health technology adoption among older adults with chronic diseases: updated systematic review. JMIR Aging. 2025;8:e80000.

47. Birati Y, Tzemah-Shahar R. Barriers to digital health adoption in older adults: scoping review informed by innovation resistance theory. J Med Internet Res. 2026;28:e75591.

48. Bertolazzi A, Quaglia V, Bongelli R. Barriers and facilitators to health technology adoption by older adults with chronic diseases: an integrative systematic review. BMC Public Health. 2024;24(1):506.

49. Dong Q, Liu T, Liu R, Yang H, Liu C. Effectiveness of digital health literacy interventions in older adults: single-arm meta-analysis. J Med Internet Res. 2023;25:e48166.

50. Yang Y, Yao X, Lu D, Wang Y, Gan Y, Bao X, et al. Improving the eHealth literacy of older adults: a scoping review. Geriatr Nur (Lond). 2024;60:128–36.

51. Giesteira B, Souza T, Sousa A, Rodrigues L, Maior GV. Ikigai Play: Towards an Ikigai Paradigm of Healthy and Active Ageing in Europe. In: Costa SR, Remondes J, editors. Reshaping Health Promotion and Disease Prevention Through Digital Innovation [Internet]. IGI Global Scientific Publishing; 2026 [cited 2026 Apr 8]. p. 217–54. Available from: https://services.igi-global.com/resolvedoi/resolve.aspx?doi=10.4018/979-8-3373-3531-5.ch008 doi:10.4018/979-8-3373-3531-5.ch008

52. Sinanan R, Van Doorn G, Browning C, Klein B, Foale C. Evaluating digital health literacy interventions for adults 45+ years: a scoping review. Health Promot Int. 2026;41(3):daag080.

53. Rooper IR, Lewis-Thames MW, Graham AK. Beyond usability: Designing digital health interventions for implementation with older adults. J Am Geriatr Soc. 2025;73(5):1648.

54. Wilson J, Heinsch M, Betts D, Booth D, Kay-Lambkin F. Barriers and facilitators to the use of e-health by older adults: a scoping review. BMC Public Health. 2021 Aug 17;21(1):1556. doi:10.1186/s12889-021-11623-w

55. ISO 9241-210:2019, Ergonomics of human-system interaction - Part 210: Human-centred design for interactive systems. [Internet]. [cited 2026 Aug 27]. Available from: https://www.iso.org/obp/ui/#iso:std:iso:9241:-210:ed-2:v1:en

56. Bazzano AN, Martin J, Hicks E, Faughnan M, Murphy L. Human-centred design in global health: A scoping review of applications and contexts. PLOS ONE. 2017 Nov 1;12(11):e0186744. doi:10.1371/journal.pone.0186744

57. Bazzano AN, Yan SD, Martin J, Mulhern E, Brown E, LaFond A, et al. Improving the reporting of health research involving design: a proposed guideline. BMJ Glob Health. 2020 Feb;5(2):e002248. doi:10.1136/bmjgh-2019-002248

58. Altman M, Huang TTK, Breland JY. Design Thinking in Health Care. Prev Chronic Dis. 2018 Sep 27;15:E117. doi:10.5888/pcd15.180128

59. Brown T. Change by Design: How Design Thinking Transforms Organizations and Inspires Innovation. Harper Collins; 2009. 278 p.

60. Schuler D, Namioka A. Participatory design: Principles and practices. CRC press; 1993.

61. Sanders EBN, Stappers PJ. Co-creation and the new landscapes of design. Co-Des. 2008;4(1):5–18.

62. Backåberg S, Strandberg S, Freeman G, Katz L, Rafiei Milajerdi H, Wylant B, et al. Facilitating co-design among older adults in a digital setting: methodological challenges and opportunities. CoDesign. 2025;21(1):118–35.

63. Tzimourta KD. Human-centered design and development in digital health: approaches, challenges, and emerging trends. Cureus. 2025;17(6).

64. García H, Miralles F. Ikigai: The Japanese secret to a long and happy life. Penguin; 2017.

65. Kebede AS, Ozolins LL, Holst H, Galvin K. Digital Engagement of Older Adults: Scoping Review. J Med Internet Res. 2022 Dec 7;24(12):e40192. doi:10.2196/40192

66. Ijeaku I, Zare A, Egu O, Chukwueke I, Onwuzulike O. Exploring the Effects of Ikigai on Mental, Physical, and Social Health: A Scoping Review. Lifestyle Med. 2025 Apr;6(2):e70018. doi:10.1002/lim2.70018

67. Song IY, Song M, Timakum T, Ryu SR, Lee H. The landscape of smart aging: Topics, applications, and agenda. Data Knowl Eng. 2018 May;115:68–79. doi:10.1016/j.datak.2018.02.003

68. Su Z, Zhang R, McDonnell D, Bentley BL, Adobor YK, Jiang J, et al. Smart ageing with sway: Opportunities and challenges. Arch Gerontol Geriatr Plus. 2024 Dec;1(4):100079. doi:10.1016/j.aggp.2024.100079

69. Giesteira B, Souza T. IKIGAI PLAY: Requirements for the Development of a Lúdic Toolkit Oriented to Smart Ageing Through a Human-Centered Design Approach. In: Brooks AL, editor. ArtsIT, Interactivity and Game Creation [Internet]. Cham: Springer Nature Switzerland; 2026 [cited 2026 Jul 8]. p. 230–9. (Lecture Notes of the Institute for Computer Sciences, Social Informatics and Telecommunications Engineering). Available from: https://link.springer.com/10.1007/978-3-032-26999-7_16 doi:10.1007/978-3-032-26999-7_16

70. Csikszentmihalyi M, Csikzentmihaly M. Flow: The psychology of optimal experience. Vol. 1990. Harper & Row New York; 1990.

71. Giesteira B, Berge G, Peçaibes V. Positive Play: Designing Ludic Tools for Health. Septentrio Rep. 2024 Jul 8;(1). doi:10.7557/7.7582

72. Cardoso P, Peçaibes V, Giesteira B, Castro LCD. Positive Play: Games for Human Potential and the Yet Unexplored Case of Anorexia Nervosa. In: Advances in Medical Technologies and Clinical Practice [Internet]. IGI Global; 2021 [cited 2025 Jul 7]. p. 154–85. Available from:

http://services.igi-global.com/resolvedoi/resolve.aspx?doi=10.4018/978-1-7998-7472-0.ch010 doi:10.4018/978-1-7998-7472-0.ch010

73. Yin RK. Case study research and applications. Vol. 6. Sage Thousand Oaks, CA; 2018.

74. Mercer J. The challenges of insider research in educational institutions: Wielding a double-edged sword and resolving delicate dilemmas. Oxf Rev Educ. 2007;33(1):1–17.

75. Page MJ, McKenzie JE, Bossuyt PM, Boutron I, Hoffmann TC, Mulrow CD, et al. The PRISMA 2020 statement: an updated guideline for reporting systematic reviews. bmj. 2021;372.

76. LaMonica HM, Davenport TA, Roberts AE, Hickie IB. Understanding Technology Preferences and Requirements for Health Information Technologies Designed to Improve and Maintain the Mental Health and Well-Being of Older Adults: Participatory Design Study. Jmir Aging. 2021 Mar;4(1):e21461. doi:10.2196/21461

77. Dias I, Costae E, Mealha O. Involving older adults in the design process: a humancentric Design Thinking approach. Interact Des Archit. 2022 FAL;(54):85–110.

78. Darley A, Carroll A. Conducting Co-Design with Older People in a Digital Setting: Methodological Reflections and Recommendations. Int J Integr Care. 2022 Dec;22(4):18. doi:10.5334/ijic.6546

79. Sheahan J, Hjorth L, Figueiredo B, Martin DM, Reid M, Aleti T, et al. Co-Creating ICT Risk Strategies with Older Australians: A Workshop Model. Int J Environ Res Public Health. 2023 Jan;20(1):52. doi:10.3390/ijerph20010052

80. Paluch R, Cerna K, Kirschsieper D, Mueller C. Practices of Care in Participatory Design With Older Adults During the COVID-19 Pandemic: Digitally Mediated Study. J Med Internet Res. 2023 Jul 17;25:e45750. doi:10.2196/45750

81. Teh PL, Kwok AOJ, Cheong WL, Lee S. Insights Into the Use of a Digital Healthy Aging Coach (AGATHA) for Older Adults From Malaysia: App Engagement, Usability, and Impact Study. Jmir Form Res. 2024;8:e54101. doi:10.2196/54101

82. Ahmed M, Marín M, Gangas P, Bentlage E, Louro C, Brach M. Improving the Acceptability and Implementation of Information and Communication Technology–Based Health Care Platforms for Older People With Dementia or Parkinson Disease: Qualitative Study Results of Key Stakeholders. JMIR Form Res. 2024;8. doi:10.2196/58501

83. Spencer RA, Shariff Z, Dale J. Promoting health literacy of older post-discharge patients in general practice - Creation of the GP-MATE communication tool through co-design. Patient Educ Couns. 2025 Jan;130:108474. doi:10.1016/j.pec.2024.108474

84. Zonneveld MBG, Pol MC, Achterberg WP, van Isselt EF van D. Identifying Stakeholder Values for an eHealth Intervention to Facilitate Home-Based Geriatric Rehabilitation: A Qualitative Multi-Method Approach. Inq- J Health Care Organ Provis Financ. 2025;62:00469580251347139. doi:10.1177/00469580251347139

85. Kastl A. Empathy mapping and hybrid persona creation: Understanding older adults' needs in technology design for ageing in place. Comput Struct Biotechnol J. 2025;28:552–63. doi:10.1016/j.csbj.2025.11.044

86. Saragosa M, Abejirinde IOO, MacEachern E, Nelson MLA, Kokorelias KM, Bharmal S, et al. Exploring Technology Supporting Aging-in-Place Using an Equity Lens Through Focus Groups

and World Café–Informed Research Agenda: Qualitative Study. JMIR Aging. 2025;8. doi:10.2196/71093

87. Chung S, Lee H, Jung J. Design and Evaluation of a Mobile App for Intergenerational Communication: User-Centered Participatory Design and Experimental Mixed Methods Study. Jmir Aging. 2025;8:e75950. doi:10.2196/75950

88. Gonzalez-Gonzalez C, Violant-Holz V, Colombo-Ruano L, Rodriguez-Silva C. Designing ethical and inclusive voice assistants through co-creation with older adults. Behav Inf Technol. 2026 Jan 20;45(2):237–59. doi:10.1080/0144929X.2025.2514245

89. Piera-Jiménez J, Creus NV, Costa AM, Michelena X, Fageda AC, Farré A, et al. Cocreating Principles for Digital Health Equity: Cross-Sectional, Qualitative Study for Participatory Human-Centered Design in Catalonia. J Med Internet Res. 2026;28. doi:10.2196/84129

90. Philpot LM, Ramar P, Canning RE, DeZutter MA, Dulohery Scrodin MM, Johnson MG, et al. From Barriers to Solutions: A Design Synthesis to Improve Video Visit Experience for Older Adults. J Patient Exp. 2026;13:23743735261416449. doi:10.1177/23743735261416449

91. Amouzadeh E, Dianat I, Faradmal J, Babamiri M. Optimizing mobile app design for older adults: systematic review of age-friendly design. Aging Clin Exp Res. 2025 Aug 14;37(1):248. doi:10.1007/s40520-025-03157-7

92. Arslan STA, O'Connor S, Karki B, French C, Stanmore E. Human-centred design of digital health dashboards in care of older adults: a scoping review. BMJ Open. 2026 Jul 17;16(7):e113525. doi:10.1136/bmjopen-2025-113525

93. Hanington BM, Martin B. Universal methods of design: 100 ways to research complex problems, develop innovative ideas, and design effective solutions. Beverly, MA: Rockport Publishers; 2012. 208 p.

94. Goodwin K. Designing for the Digital Age: How to Create Human-Centered Products and Services. Chichester: John Wiley & Sons; 2011. 1485 p.

95. Desurvire H, Wiberg C. Game Usability Heuristics (PLAY) for Evaluating and Designing Better Games: The Next Iteration. In: Ozok AA, Zaphiris P, editors. Online Communities and Social Computing [Internet]. Berlin, Heidelberg: Springer Berlin Heidelberg; 2009 [cited 2026 Apr 9]. p. 557–66. (Lecture Notes in Computer Science). Available from: http://link.springer.com/10.1007/978-3-642-02774-1_60 doi:10.1007/978-3-642-02774-1_60

96. Wamala-Andersson S, Uitto M, Diop-Christensen A, Hidalgo IR, Thorup CB, Heß F, et al. Understanding digital health literacy as a structural determinant of health and public health capability. BMC Glob Public Health. 2026 Jan 14;4(1):7. doi:10.1186/s44263-025-00236-9

97. Duric P, Rajcevic S, Djekic Malbasa J, Mulic D. What do we talk about when we talk about digital determinants of health? – A systematic review. Digit Health. 2026 Apr 13;12:20552076261443121. doi:10.1177/20552076261443121

98. Wildenbos GA, Peute L, Jaspers M. Aging barriers influencing mobile health usability for older adults: A literature based framework (MOLD-US). Int J Med Inf. 2018 Jun;114:66–75. doi:10.1016/j.ijmedinf.2018.03.012

99. Monasterio G, Fernández-López MJ, Valero E, Martin U, Ayala-García A. Digital Inequalities in the Use of eHealth Services in European Public Health Care Systems: Systematic Review of Observational Studies. J Med Internet Res. 2026 Feb 9;28:e81841. doi:10.2196/81841

100. Cornwall A, Jewkes R. What is participatory research? Soc Sci Med. 1995 Dec 1;41(12):1667–76. doi:10.1016/0277-9536(95)00127-S

101. Vaughn LM, Jacquez F. Participatory Research Methods – Choice Points in the Research Process. J Particip Res Methods. 2020 Jul 21;1(1). doi:10.35844/001c.13244

102. Mohr DC, Schueller SM, Riley WT, Brown CH, Cuijpers P, Duan N, et al. Trials of Intervention Principles: Evaluation Methods for Evolving Behavioral Intervention Technologies. J Med Internet Res. 2015 Jul 8;17(7):e4391. doi:10.2196/jmir.4391

103. Pham Q, Wiljer D, Cafazzo JA. Beyond the Randomized Controlled Trial: A Review of Alternatives in mHealth Clinical Trial Methods. JMIR MHealth UHealth. 2016 Sep 9;4(3):e107. doi:10.2196/mhealth.5720

104. Xu L, Ng DTK, Lee CSY, Peng P, Chu SKW. A systematic review of digital literacy in lifelong learning for older adults: challenges, strategies, and learning outcomes. Educ Technol Res Dev. 2025 Dec 1;73(6):3627–74. doi:10.1007/s11423-025-10530-w

105. Damodaran L, Olphert CW, Sandhu J. Falling off the bandwagon? Exploring the challenges to sustained digital engagement by older people. Gerontology. 2014;60(2):163–73. doi:10.1159/000357431

106. Lave J, Wenger E. Situated Learning: Legitimate Peripheral Participation. Cambridge University Press; 1991. 144 p.

107. Moore GF, Audrey S, Barker M, Bond L, Bonell C, Hardeman W, et al. Process evaluation of complex interventions: Medical Research Council guidance. BMJ. 2015 Mar 19;350:h1258. doi:10.1136/bmj.h1258

108. Chen X, Zhu Y, Jiang D, Huang J, Xie Q, Chen Y, et al. mHealth-Based Gamification Interventions to Promote Health Among Older Adults: Scoping Review. JMIR MHealth UHealth. 2026 May 4;14(1):e82368. doi:10.2196/82368

109. Bowen DJ, Kreuter M, Spring B, Cofta-Woerpel L, Linnan L, Weiner D, et al. How we design feasibility studies. Am J Prev Med. 2009 May;36(5):452–7. doi:10.1016/j.amepre.2009.02.002

110. Skivington K, Matthews L, Simpson SA, Craig P, Baird J, Blazeby JM, et al. A new framework for developing and evaluating complex interventions: update of Medical Research Council guidance. BMJ. 2021 Sep 30;374:n2061. doi:10.1136/bmj.n2061

111. Carroll C, Patterson M, Wood S, Booth A, Rick J, Balain S. A conceptual framework for implementation fidelity. Implement Sci IS. 2007 Nov 30;2:40. doi:10.1186/1748-5908-2-40

112. Fischer M, Safaeinili N, Haverfield MC, Brown-Johnson CG, Zionts D, Zulman DM. Approach to Human-Centered, Evidence-Driven Adaptive Design (AHEAD) for Health Care Interventions: a Proposed Framework. J Gen Intern Med. 2021 Apr 1;36(4):1041–8. doi:10.1007/s11606-020-06451-4

113. Mummah SA, Robinson TN, King AC, Gardner CD, Sutton S. IDEAS (Integrate, Design, Assess, and Share): A Framework and Toolkit of Strategies for the Development of More Effective Digital Interventions to Change Health Behavior. J Med Internet Res. 2016 Dec 16;18(12):e317. doi:10.2196/jmir.5927

Appendix A. Checklist for Reporting Health Research Involving Design

Adapted from Bazzano AN, Yan SD, Martin J, et al. Improving the Reporting of Health Research Involving Design: A Proposed Guideline. BMJ Global Health. 2020; 5(2). doi:10.1136/bmjgh-2019-002248.

Section	Description	Reported?
Title and Abstract	Title: Title should indicate that the study included a design approach.	Yes
	Abstract: Summarises the salient components, including background, statement of the problem, approach/methods, findings, results and conclusion.	Yes
Introduction / Background	Available Knowledge: Summary of what is known about the topic and any gaps.	Yes
	Rationale for Design: Explanation of design as appropriate to address the topic.	Yes
	Description of design challenge for health: Description of the main research question or health problem that the design-based work aimed to address.	Yes
	Research Aims: Defines overall project aims and specific objectives.	Yes
Methods / Approach	Theory: Underlying theories informing the work (if any).	Yes
	Process and Timeline: Processes or steps and timeline for the research.	Yes
	Research Team and Reflexivity: Individuals involved in the research team and characteristics of these. Ways that reflectivity was addressed.	Yes
	Site Selection: Description of study sites selected.	Yes
	Participant Selection and Engagement: Process to select participants, description of the participants and explanation of how they were involved in design.	Yes
	Ethical Considerations: Ethical precautions taken to protect participants, communities, and personal information.	Yes
	Language: Description of any language considerations.	Yes
	Data Collection Tools and Techniques: Techniques or tools used during the research process.	Yes
	Documentation: Documentation of work undertaken in research.	Yes
	Data Synthesis and Analysis: Description of techniques used to synthesise insights, iterate, and analyse data.	Yes
	Validation Approaches: Process of checking that insights, prototypes or other products were validated.	Yes
Results / Findings	Design Research Phases: Summary of major insights or reflection from design activities.	Yes

Section	Description	Reported?
	Decision Points: Description of decisions made during the design process.	Yes
	Evidence of Change or Impact: Summary of any evidence of change or impact to health or other facets of the situation.	Partial
Discussion	Design-Specific Reflections: Discusses unique contribution or transferability of design process/outcomes.	Yes
Conclusion	Implications of this work for the larger field and next steps.	Yes
Other Information	Acknowledgements and Funding: Discloses support, funding, conflicts of interest.	Yes
	Glossary: Definition of key terms.	Yes

Source: Bazzano AN, Yan SD, Martin J, et al. Improving the Reporting of Health Research Involving Design: A Proposed Guideline. BMJ Global Health. 2020; 5(2). doi:10.1136/bmjgh-2019-002248.

Appendix B. Complete Search Strings

The bibliographic search was conducted in three indexed databases. Three Boolean axes were combined with AND: Population (older adults), Digital health literacy, and Human-centred design approaches. Each axis used OR to join synonyms and variant spellings. The search was run in two rounds; the second expanded the vocabulary in all three axes. MeSH descriptors were applied in PubMed only.

PubMed

1st round: 3 records, 2 selected

> (("older adult*"[Title/Abstract] OR elderly[Title/Abstract] OR senior*[Title/Abstract] OR aging[Title/Abstract] OR ageing[Title/Abstract]) AND ("digital health literacy"[Title/Abstract] OR "eHealth literacy"[Title/Abstract] OR "electronic health literacy"[Title/Abstract] OR eHEALS[Title/Abstract]) AND ("human-centered design"[Title/Abstract] OR "human-centred design"[Title/Abstract] OR "user-centered design"[Title/Abstract] OR "user-centred design"[Title/Abstract] OR "participatory design"[Title/Abstract] OR co-design[Title/Abstract]))

2nd round: 126 records, 11 selected

> (("older adult*"[Title/Abstract] OR elderly[Title/Abstract] OR senior*[Title/Abstract] OR aging[Title/Abstract] OR ageing[Title/Abstract] OR "older people"[Title/Abstract] OR "older person*"[Title/Abstract] OR geriatric*[Title/Abstract] OR aged[Title/Abstract] OR "older population*"[Title/Abstract] OR Aged[MeSH]) AND ("digital health literacy"[Title/Abstract] OR "eHealth literacy"[Title/Abstract] OR "electronic health literacy"[Title/Abstract] OR eHEALS[Title/Abstract] OR "digital literacy"[Title/Abstract] OR "digital competence*"[Title/Abstract] OR "mHealth literacy"[Title/Abstract] OR "online health literacy"[Title/Abstract] OR "internet health literacy"[Title/Abstract] OR "digital skills"[Title/Abstract] OR "digital health competence*"[Title/Abstract] OR "technology literacy"[Title/Abstract] OR Health Literacy[MeSH]) AND ("human-centered design"[Title/Abstract] OR "human-centred design"[Title/Abstract] OR "user-centered design"[Title/Abstract] OR "user-centred design"[Title/Abstract] OR "participatory design"[Title/Abstract] OR co-design[Title/Abstract] OR codesign[Title/Abstract] OR "co-creation"[Title/Abstract] OR cocreation[Title/Abstract] OR "design thinking"[Title/Abstract] OR "inclusive design"[Title/Abstract] OR "person-centred design"[Title/Abstract] OR "person-centered design"[Title/Abstract] OR "experience-based design"[Title/Abstract] OR "participatory research"[Title/Abstract] OR "user involvement"[Title/Abstract]))

Web of Science

1st round: 36 records, 1 selected

> TS=(("older adult*" OR elderly OR senior* OR aging OR ageing) AND ("digital health literacy" OR "eHealth literacy" OR "electronic health literacy" OR eHEALS) AND ("human-centered design" OR "human-centred design" OR "user-centered design" OR "user-centred design" OR "participatory design" OR co-design))

2nd round: 272 records, 28 selected

TS=(("older adult*" OR elderly OR senior* OR aging OR ageing OR "older people" OR "older person*" OR geriatric* OR aged OR "older population*") AND ("digital health literacy" OR "eHealth literacy" OR "electronic health literacy" OR eHEALS OR "digital literacy" OR "digital competenc*" OR "mHealth literacy" OR "online health literacy" OR "internet health literacy" OR "digital skills" OR "digital health competenc*" OR "technology literacy") AND ("human-centered design" OR "human-centred design" OR "user-centered design" OR "user-centred design" OR "participatory design" OR co-design OR codesign OR "co-creation" OR cocreation OR "design thinking" OR "inclusive design" OR "person-centred design" OR "person-centered design" OR "experience-based design" OR "participatory research" OR "user involvement"))

Scopus

1st round: 11 records, 1 selected

TITLE-ABS-KEY(("older adult*" OR elderly OR senior* OR aging OR ageing) AND ("digital health literacy" OR "eHealth literacy" OR "electronic health literacy" OR eHEALS) AND ("human-centered design" OR "human-centred design" OR "user-centered design" OR "user-centred design" OR "participatory design" OR co-design))

2nd round: 227 records, 24 selected

TITLE-ABS-KEY(("older adult*" OR elderly OR senior* OR aging OR ageing OR "older people" OR "older person*" OR geriatric* OR aged OR "older population*") AND ("digital health literacy" OR "eHealth literacy" OR "electronic health literacy" OR eHEALS OR "digital literacy" OR "digital competenc*" OR "mHealth literacy" OR "online health literacy" OR "internet health literacy" OR "digital skills" OR "digital health competenc*" OR "technology literacy") AND ("human-centered design" OR "human-centred design" OR "user-centered design" OR "user-centred design" OR "participatory design" OR co-design OR codesign OR "co-creation" OR cocreation OR "design thinking" OR "inclusive design" OR "person-centred design" OR "person-centered design" OR "experience-based design" OR "participatory research" OR "user involvement"))

Appendix C. Technology use questionnaire

This instrument represents the text and structure of the baseline technology usage questionnaire administered digitally to participants via Google Forms.

Note: *This document was developed as part of the ERASMUS+ SMARTageCARE project in collaboration with the design team.*

What is your country?

☐ Belgium ☐ Cyprus ☐ Germany ☐ Italy
☐ Latvia ☐ Poland ☐ Portugal ☐ Slovenia

Computer Use

1. Do you frequently use the computer?

☐ Yes ☐ No

2. How frequently do you use the computer?

☐ Never
☐ Rarely
☐ Sometimes a week
☐ Once a day
☐ Several times a day

Smartphone Use

3. Do you frequently use a smartphone?

☐ Yes ☐ No

4. How frequently do you use a smartphone?

☐ Never
☐ Rarely
☐ Sometimes a week
☐ Once a day
☐ Several times a day

5. For how long have you been using a smartphone?

(Open-ended response)

6. Do you struggle to use a smartphone?

☐ Yes ☐ No

7. If you said "Yes", what are some of your main struggles?

(Open-ended response)

8. What do you use a smartphone for?

(Select all that apply)

☐ Phone calls
☐ Send texts
☐ Use the internet

□ Social Media
□ Listening to music
□ Take photos
□ Other: _____

Perceived Difficulty

9. On a scale of 1 to 10, how difficult is it for you to make a phone call?

1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**
○	○	○	○	○	○	○	○	○	○

1 — Very easy *10 — Very difficult*

10. On a scale of 1 to 10, how difficult is it for you to send a text message?

1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**
○	○	○	○	○	○	○	○	○	○

1 — Very easy *10 — Very difficult*

Attitudes and Security Concerns

11. Are you afraid of using the smartphone in general?
□ Yes □ No

12. When it comes to security when using the smartphone, what worries you the most?
(Open-ended response)

Digital Engagement and App Recognition

13. Do you usually use smartphones for entertainment?
□ Yes □ No

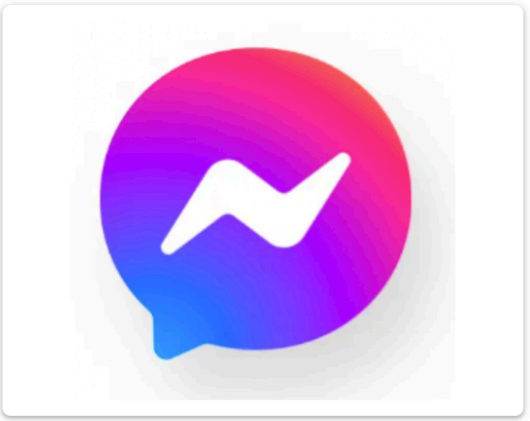
14. Do you use Social Media?
□ Yes □ No

15. Do you know what a smartphone application is?
□ Yes □ No

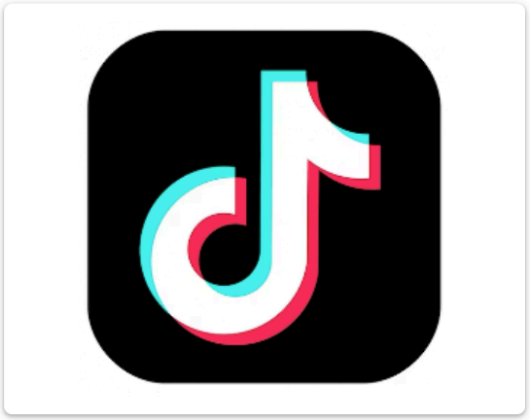
16. Select only the applications you recognise from the list below.



☐ 1



☐ 2



☐ 3



☐ 4



☐ 5



☐ 6



☐ 7



☐ 8



☐ 9



☐ 10

Appendix D. Pilot assessment questionnaire applied to the older adults.

Note: *This document was developed as part of the ERASMUS+ SMARTageCARE project in collaboration with the design team.*

Em que medida concorda com as seguintes frases?	Discordo totalmente	Discordo	Neutro	Concordo	Concordo totalmente
Diverti-me com esta atividade.					
Faria essa atividade novamente.					
O que aprendi nesta atividade é útil no meu dia a dia.					
Esta atividade ofereceu algo diferente das atividades que eu já fiz antes.					
Esta atividade manteve o meu interesse.					
O facilitador forneceu orientações úteis.					
O ritmo da atividade foi adequado.					
Precisei de ajuda para concluir esta atividade.					
Gostei do design e dos materiais utilizados nesta atividade.					
Participei ativamente na atividade.					
Interagi com os outros participantes durante a atividade.					
Eu senti-me confortável e em segurança durante a atividade.					
Consegui seguir todas as instruções necessárias durante toda a atividade.					
Tive dificuldades com essa atividade.					
O tamanho e a legibilidade do texto eram adequados.					
As instruções fornecidas pelo facilitador para a atividade foram claras e fáceis de entender.					

Appendix E. Consortium Synthesis Report on Toolkit Structural Limitations and Module Development.

Note: *This document was developed as part of the ERASMUS+ SMARTageCARE project in collaboration with the design team.*

MODULE A

This first module introduces Ikigai, a Japanese philosophy that focuses on finding purpose and meaning in everyday life.

Through a range of activities such as reflection cards, creative workshops (including air drying clay modelling, flower arranging, and painting), as well as social and expressive sessions such as karaoke and dance, participants are encouraged to reconnect with their personal interests, passions, and life experiences in an active and engaging way.

The main objective with this module is to support older adults in reflecting on what brings them joy, motivation, and a sense of purpose, while fostering creativity, emotional wellbeing, and social interaction.

Activities are designed to stimulate both cognitive and creative engagement, as well as a touch of physical and motor skills in action, where appropriate. All materials and activity dynamics can be adapted to suit the needs, abilities, and preferences of different groups of older adults.

MODULE B

This module focuses on digital transition, supporting older adults in developing confidence, autonomy, and comfort in the use of digital technologies.

Through interactive activities such as app recognition games, scam awareness exercises, and online safety scenarios, participants are encouraged to develop practical digital skills while engaging with real-life situations in a safe and guided environment.

The main goal of this module is to strengthen digital confidence and independence, enabling older adults to navigate an increasingly digital world with more awareness and security.

The module includes a variety of activities based on card decks, mobile device interaction, and structured training sheets. The pace and delivery of each activity should be adapted by the facilitator according to the specific needs, abilities, and dynamics of each group.

MODULE C

The third module focuses on health, wellbeing, and the use of digital health tools.

Through activities exploring healthy lifestyle practices, role-playing healthcare interactions, health-related misinformation activities, and learning about wearable health technologies, participants are introduced to ways in which digital solutions can support personal health

management. The module also encourages reflection and discussion on topics such as healthy ageing, nutrition, misinformation, and active lifestyles.

The main objective is to empower older adults to take an active role in managing their own wellbeing, while increasing their confidence and familiarity with digital health services and tools.

MODULE D

The fourth module focuses on citizenship, participation, and social awareness.

Through activities such as community mapping, storytelling, and discussions on identity, gender, ageism, and social perspectives, participants are encouraged to reflect on their role within society and the value of their lived experiences.

This module promotes dialogue, critical thinking, and active engagement, supporting older adults in recognising themselves as active contributors who can share knowledge, express opinions, and continue shaping their communities.

Activities are designed to engage cognitive, ethical, and creative dimensions, fostering a broader understanding of community dynamics and encouraging reflection on diverse perspectives, relationships, and social challenges within society.

Limitations

This first edition of the SMARTageCARE Toolkit reflects an initial phase of research, design, and testing, and therefore presents a series of inherent limitations that should be acknowledged for future development. One of the most relevant constraints is the high diversity of digital literacy among older adults. Participants ranged from individuals with very limited or no experience with digital technologies to highly experienced users who already integrate advanced digital tools, including artificial intelligence, into their daily routines. This wide spectrum makes it difficult for a single level of activity complexity to fully address all needs within the same group.

In addition, the toolkit was originally designed as a physical, gamified resource, which introduced certain structural limitations. While gamification elements were effective in some contexts, competitive mechanics were not always well received, and some activities were perceived as too simple or not sufficiently engaging for more experienced participants. Furthermore, activities relying on specific digital interfaces or applications are subject to rapid technological change, which can affect their long-term relevance.

Finally, the effectiveness of the toolkit is highly dependent on the role of the facilitator. Different contexts, group sizes, and participant profiles require continuous adaptation, meaning that successful implementation relies on facilitator experience, flexibility, and sometimes specific thematic knowledge.

Findings from the Testing Phase

The testing phase confirmed a strong contrast among older adult participants in terms of skills, motivation, and learning preferences. Some participants demonstrated high levels of enthusiasm and actively engaged with challenges, while others preferred more passive roles, focusing on observation and listening rather than interacting.

Engagement levels varied significantly depending on the type of activity. Practical and context-relevant exercises generally produced higher levels of participation, while some content was perceived as overly basic by more advanced users. At the same time, certain activity mechanics did not fully support hands-on interaction with digital devices, limiting their effectiveness in achieving practical learning outcomes.

Participants also showed different preferences in learning styles, ranging from structured, step-by-step guidance to more autonomous and exploratory approaches. The Citizenship module, in particular, generated broader reflections that extended beyond the individual experience of ageing, touching on institutional and societal dimensions. This also highlighted the potential value of intergenerational learning formats. In parallel, feedback indicated that the Health and Wellbeing module could be further deepened, considering the high level of existing knowledge and lived experience among participants.

Future Development

Future iterations of the SmartAgeCare Toolkit should aim to better address the diversity of older adult profiles through differentiated levels of difficulty and more personalised learning pathways. This would allow participants with varying levels of digital literacy to engage meaningfully within the same activity framework, either through adaptive content or parallel difficulty options.

Greater emphasis should be placed on personalisation and flexibility, particularly through the digital platform, enabling facilitators to adapt content to local contexts, cultural realities, and participant needs. A future version should also prioritise practical, hands-on learning experiences that involve direct interaction with real technologies, moving beyond predominantly theoretical or printed-based approaches.

The activities dynamics should evolve towards less competitive and more collaborative and reflective approaches, strengthening dialogue, shared learning, and knowledge exchange among participants. Where appropriate, intergenerational formats could further enrich the

learning experience and dynamic. Broader field research, content, activity dynamics and mechanisms with more extensive validation across the different European contexts would further strengthen the relevance, robustness, inclusivity, and scalability of the toolkit.

Future development should also include regularly updated content aligned with the rapid evolution of digital transition, health and wellbeing, and citizenship practices.

At module level, further refinement is recommended. The IKIGAI module (Module A) would benefit from deeper and more context-sensitive research, allowing for multiple interpretations and applications of IKIGAI across different countries and communities, rather than a single universal model. The Digital Transition module (Module B) should integrate multiple levels of difficulty per activity, enabling the participation of different skilled participants within the same group and ensuring accessibility across a wide range of digital skills.

The E-Health and Wellbeing module (Module C) should be further developed through stronger cross-country collaboration, incorporating locally relevant digital health systems, applications, and practices, as well as dynamics tailored to national contexts and user needs. The Citizenship module (Module D) should move beyond reflective discussions of community issues, focusing on more direct engagement with public institutions, policies, and real governmental actors, ensuring a more concrete connection between learning and civic participation.

Importantly, the structure, definitions, and scope of each module should be further refined and clearly delineated to avoid overlap, ambiguity, or confusion. A clearer conceptual separation of themes and objectives would strengthen the identity of each module and ensure that facilitators and participants have a precise understanding of what each area focuses on and aims to achieve.

Finally, future iterations should strengthen collaboration with educators, gerontologists, and professionals actively working with older adults, ensuring that facilitators are properly supported for their role. Facilitation should be recognised as a critical responsibility, requiring not only adherence to activity scripts but also the ability to adapt, extend, and guide activities dynamically according to group needs without disrupting learning flow.

Overall, each module could evolve into a more specialised and in-depth toolkit, potentially developed through dedicated expertise, allowing for greater depth, precision, and contextual relevance across all thematic areas.

Appendix F. A qualitative observational synthesis from a transnational feedback meeting

Served as a complementary source of evaluative input for activities not directly evaluated with participants. Note: *This document was developed as part of the ERASMUS+ SMARTageCARE project in collaboration with the design team.*

Meeting Summary (English)

The participants reviewed and discussed workshop activities, focusing on how well they matched the needs and abilities of their group (mainly older adults).

General observations

- The group strongly preferred practical, real-life tasks over games, role-play, or hypothetical scenarios.
- Participants were solution-oriented and wanted immediately useful outcomes rather than abstract exercises.
- The group showed a clear preference for collaboration and discussion, rather than individual work or competition.
- Many proposed activities were seen as too simplistic, childish, or not adapted to the group's competence level.

Key insights from specific activities

1. Vacation planning

- Participants ignored step-by-step instructions and instead used tools like AI (e.g., Gemini) to find real travel options.
- They focused on concrete needs (budget, location, number of people).

2. Email scams

- Participants preferred sharing their own real experiences rather than discussing fictional examples.
- Group discussion was more valuable than individual tasks.

3. Detecting fake profiles

- The task was considered too easy and basic.
- Participants demonstrated higher knowledge than expected.

4. Phone/contact exercises

- Card-based, theoretical exercises were ineffective.
- Participants need hands-on practice on actual devices, not simulations.

5. Health-related activities

- Many exercises (especially games) were seen as:
    - Infantilizing
    - Unrealistic or irrelevant
    - Potentially harmful or stigmatizing (e.g., illness framed as punishment)
- Sensitive topics (illness, aging) should not be gamified.

6. Preferred formats

- Self-assessment tools (private, individual reflection) were well received.
- Activities should respect privacy and sensitivity.

7. Physical exercises (e.g., movement games)

- Considered unsafe, uncomfortable, or inappropriate for older adults.

8. Nutrition activities

- Competitive quizzes were ineffective.
- Better approach: open discussion based on personal experiences, not “correct answers.”

9. Digital health literacy

- Important but currently too complex and under-supported.
- Participants lack reliable tools to verify online health information.

Overall conclusion

- The materials need significant adaptation.
- Activities should be:
    - Practical and immediately useful
    - Respectful of participants’ experience and dignity
    - Based on real-life situations
    - Collaborative rather than competitive
- Gamification and overly theoretical approaches are largely ineffective for this group.

Appendix G. Feedback report documenting facilitator observations across the Polish pilot implementation sessions.

Note: *This document was developed as part of the ERASMUS+ SMARTageCARE project in collaboration with the design team.*

Several proposals were criticized – especially the card and board game about health – for inadequate content, emotional blackmail, stigmatization and infantile movement elements (comments from participants and own observations)

The health self-assessment module was positively assessed for privacy reasons, and practical exercises on devices (e.g. saving contacts, using QR codes) were indicated as valuable.

The difficulties in verifying health information by individuals without specialized knowledge were also discussed. The increasing prevalence of other tools specialized in "AI assistance in health and medicine" also requires further clarification. These tools are becoming increasingly popular, widely used, and are not clearly "ineffective or misleading."

The WHO recommendation on the development of digital health literacy, self-care and self-medication should be mentioned as a challenge due to lack of resources and the growing staffing gap in healthcare.

Detailed notes:

Activities related to devices and instruction cards

The merits of using instructional cards for finding and writing down numbers were discussed, as was the advantage of hands-on exercises on smartphones. It was pointed out that arranging cards does not translate into the ability to perform operations on the device.

Practical exercises on devices (e.g. saving contacts, QR) proved to be more useful than theoretical exercises with cards

Health module and board game critique

A health-related board game was analyzed and found to be out of touch with reality, stigmatizing, and uneducational; it was suggested that elements of

prevention and support be incorporated into the game design instead of punishing illness.

The scenarios and games proposed in the health module were considered infantile and stigmatizing by the presenters.

Reactions and first comments on the game's content

Participants immediately expressed reservations about the tone and content of the cards, commenting on the inappropriate humor and examples (e.g., falling after drinking wine, emergency care) and pointing out a lack of identification with the presented role models. Criticism was also expressed about the emotional impact and potential blackmail in the message.

There were concerns that the game presented old age as a pathology, which was misleading and stigmatizing.

The participants proposed an educational format based on a moderated conversation and explanation of the physiological changes associated with aging, which, like most content and topics, requires the expertise and participation of experts in the given topics as moderators.

In general, older people have the right to have all topics and activities carried out with the participation of specialists who can verify individual activities and content.

Also in activities such as singing, pottery, painting, or similar, it is advisable, in accordance with the knowledge and recommendations of geragogy, to engage with elements of art, knowledge about art, expert advice, and strive to realize one's work in an aesthetic and conscious manner (geragogy of culture, geragogy of art, etc.).

Evaluation of individual modules and practical suggestions

The modules were analyzed: the health self-assessments were rated positively for their privacy, while the exercise games and quizzes were deemed childish, potentially dangerous, or poorly worded. It was suggested that the competition be replaced with a moderated discussion and that the questions be better tailored to the actual needs of the audience.

Some positive elements, such as health self-assessments, were rated well due to the intimacy and privacy of participants.

Movement elements (melodic steps, jumping on letters) were considered dangerous or inappropriate for older people with hearing or balance deficits (feedback from participants)

Nutrition quiz questions are poorly worded and don't take into account the diversity of diets and individual limitations, habits, and preferences, which aren't always bad. Personalization and individualization are key here.

It's also worth considering the knowledge and life experience of seniors themselves 1), as well as their understanding of their own bodies. They're not children, and they have a wealth of knowledge.

The concept of "digital health detectives" and their competencies

Participants introduced the idea of "digital health detectives" as a learning exercise and emphasized the need to develop digital health literacy. They highlighted the complexity of analyzing health news and the need for tools and checklists to assess the credibility of information.

Participants reported that verifying health messages is difficult without competencies and tools, which increases the risk of misinformation.

Problems with information verification and medical consultations

The discussion focused on the difficulties of non-specialists independently verifying health information and the limited access to healthcare, which leads people to seek alternative sources. The recommendation that patients should come to a doctor with basic knowledge prepared in advance was also raised.

The aim of the materials is to encourage consultation with a doctor rather than just self-diagnosis online.

T**raining materials, cards and educational content**

The content of the cards on truth and lies about aging and the content for group discussion were discussed. Participants questioned some of the formulations and found the materials useful as a starting point for discussion, but somewhat controversial. Here, too, it will be helpful to approach the cards

as a source of discussion rather than as a way to impose correct or incorrect answers.

Examples of wearable device types (smartwatch, ring, VitalPatch, smart socks) and concerns about their availability in local practice were discussed. Discussing potential offerings, whether or not they will be available in the future, is of little use.

It seems better to gather available devices and present them live, or to enrich the game formula with such an element. Of course, taking into account local conditions.

Examples:

Module 2 – overall, different activities

The main thing was that when they (participants/seniors) read this task, they didn't follow the pattern given there at all, they just opened Gemini, entered it to check travel agencies that they trusted and based on the criteria they entered, it would find them some holiday trips.

How to do it step by step was completely out of sync with how the state operates. And they immediately looked for specifics. They didn't engage in the fun that was being proposed here, but instead sought specific proposals. They knew how to do it, how to make it happen, how to compare, where to look for it, and above all, specifics: I want to go to a seaside resort, I have this amount of cash, five people are going, look for it.

It's as if the examples or stories proposed there weren't useful, but they preferred to immediately think about what their needs were related to their vacation and simply look for it.

Everyone also related it to specific emails they received, and what happened to them. And they also seemed to share what happened to them, and not necessarily this story, which again wasn't meant to be an inspiration. Of course, it can be an inspiration, but basically, the group we worked with has its own experiences and simply doesn't need made-up stories; they just share whatever they might have.

Participants treat this suggestion as inspiration for own work, own reflections, recalling your own stories, cases, or friends, and discussing them together. Each

time—and that's what was missing here—they didn't engage in individual work, but rather in shared work. It was always a shared conversation, shared problem-solving, shared recollection—someone said, "I had a similar case," another said, "What did you do?" "I would do this," and they approached solutions together, not individually. Here, in the comments, we'll note that our group is very collaborative, focused on working together, not individually. Or perhaps a game where we identify who did it best and who did it worst.

These cards presented a step-by-step process of how to do this, **how to find a phone number and write it down.** Your task is to arrange these scattered cards in order, that is, create a sequence of actions on the cards. My point is this: this doesn't make sense, because you need to practice, not just arrange the cards. Even if you theoretically know and arrange the cards, you'll pick up the phone and have absolutely no idea how to do it. The most important thing is that each time, this exercise has a theoretical preparation character. This practice is theoretical, and we don't practice immediately. And we have concrete results. And this is a reminder to everyone that you care about a specific exercise; they need to see that it's useful and be able to do it.

Saving a contact requires adding a first and last name so that it can be recognized later. – no more useful.

And just yesterday, we did exactly that. Using a QR code, you immediately share your contacts with each other, and the contacts were saved automatically.

Module 3

In my opinion, this game is also very stigmatizing, in the sense that, for example, I'm reading now, you climb onto a table to change a light bulb and you fall, breaking your hip, you end up in the hospital for a long stay, and because of that, you have to pay about 4 points. So, not only is someone hurt, but they also get punished in this game for having that light bulb there and broken their hip, right? So I don't know if it should be like that.

So, threatening to say that if something happens to you, instead of playing strategically, which would show me certain behaviors and encourage prevention, but also mutual support, it should be like this: someone has fallen, the other players have to do something to, for example, get him out. How can I help them?

If this game is called a healthy lifestyle, then it should be structured differently. It should teach preventative behaviors, safe behaviors, show what can happen to you or what has already happened to you, and then add a penalty in the form of losing points or removing the participant from the game. It should probably be something like, "You need to change a light bulb, you're home alone, there's a risk of falling," and so on. What should you do?

What factors in real life help protect our health as we age, for example?

Well, there are the obvious ones, like regular walks, healthy eating, and social interactions. What factors pose a risk, like forgetting to take medication, drinking too much alcohol, avoiding activity, and not climbing on a table, for example.

I'm paying attention here, I understand that this is a game and gamification, that it shows me how to take care of myself. I'm not immersed in any kind of supportive community at all. It doesn't show me, listen, just look around, there's no one weaker. Well, after a fall, and you do something together, help, and recover together, there's no element of joint prevention. There's constant self-focus. I think that's not good either.

And the overall confusion of the target audience for this whole game. On the one hand, it's childish, because of suggestion you choose fruit instead of sweets—typically childish behavior. On the other hand, old person and using a stick and going to work as the third category.

From a card: Your daughter tells you you're no longer able to lift you into bed or the bathtub, insisting you have to move into a nursing home unless you start exercising and gain the strength to become more independent. That means blackmail. Yes, listen, on a psychological level, this is so unethical that I wouldn't even consider giving it to people, especially people who have had this experience.

The reference is to the job market. You lose your job, you can't work. That's not appropriate either. I've opened up loneliness to myself yet.

On the other hand, if young people were doing this, let's say it's a game that prepares them for certain behaviors, they'd be scared. There are some things like, you can't stand up, you can barely walk, your body is failing.

(We considered the whole set and some of the activities as an inspiration to the intergenerational workshop but these approach should be also adjusted in the content and intension)

Besides, unfortunately, as a person ages and becomes much older, they become weakened and lose their mobility. This is natural, and it should rather be directed in this direction: of course, we should do everything we can to keep our body in good working order, but again, we shouldn't approach old age as some terrible disease that kills us. Old age is a disease according to this game. You have to do everything to avoid getting sick, to avoid growing old.

Or if you're in a social welfare home, if the social welfare home is presented there as some kind of punishment, and yet millions of people are in these social welfare homes, how can you not think about the consequences when it comes to thinking about the various deficits that appear and the person stops being independent.

So let's not make a game, but rather discuss together based on some of the things we've prepared here. But we're not playing against each other to see who knows it better, or who's more likely to get the right answers. We're discussing together what it means. And why it might be important, or difficult, or easy, and how we deal with it. I'm generally opposed to gamification because you get drawn into the game and start emphasizing that you're better, competing, and then you stop looking at anyone else.

Digital health competencies/literacy

On the one hand, childish, completely infantile games and questions, and on the other, analyzing health news. Analyzing health news requires some level of competence. It's not like everyone can do it on their own—it's not even clear

how, where, or with what tools—to investigate before deciding whether a message is credible, questionable, or likely—it's probably disinforming.

Of course, it should be done, but in these times, we're simply flooded with unreliable news. Now, I personally don't know, I don't feel like someone without knowledge could do it, could verify it, unless they submit it to the municipality and ask, but that wouldn't be credible either. Should I consult a specialist? But that's not entirely clear, because specialists also have their own ideologies sometimes..... And we still have own intuition and experience, especially older adults...

Regarding the **citizenship module**, it is going to be very difficult. We haven't implemented it yet, but we have already held discussions with our ambassadors. Both our national organization and our local branch in this city have completed numerous projects concerning citizenship over the last 10 to 15 years, particularly those dedicated to the elderly.

Unfortunately, cooperation with the city authorities—and with various levels of government in general—is not satisfactory. To put it bluntly, **not a single model of participation is working**, and the situation is only getting worse. When it comes to listening to residents' voices, responding to their needs, or engaging in any form of dialogue, it is virtually non-existent.

Because of this, it will be hard to convince anyone to get involved in planning or local research. These types of exercises might be useful when working with children, youth, or perhaps in intergenerational activities. However, as I mentioned, based on our experience in this specific location and context, it is **completely pointless**. People simply lack trust; they don't believe in their own agency or that their roles will be valued. In the face of the current administration's ignorance, they see no real way to exercise their rights.

Example of two our Ambassadors – how our city respects the rights of citizens: almost 2 years "homeless" because of the incompetence of city authorities.

The "Łódź Crater" Crisis: Displacement in the Heart of the City

In Łódź, the ambitious project to connect the **Łódź Fabryczna** and **Łódź Kaliska** stations via an underground tunnel has turned into a tragedy for residents of the historic city center, particularly those living on streets like **1 Maja** and **Próchnika**.

The "Katarzyna" Impact

As the massive Tunnel Boring Machine (TBM), nicknamed **Katarzyna**, made its way through the dense, unstable soil of central Łódź, the fragile foundations of old, unrenovated tenements began to fail.

- **Structural Collapse:** Unlike a planned relocation, many residents were forced out after actual **structural collapses** occurred, with floors sinking and walls crumbling as the machine passed directly underneath.
- **The Evacuation:** Hundreds of Łódź residents were moved to hotels. While initially intended as a stay of a few days, it has stretched into months of uncertainty.

For the inhabitants of the collapsed or "at-risk" buildings, the situation has shifted from a temporary inconvenience to a permanent loss of stability.

The Legal and Emotional Void

The residents face a complex bureaucratic battle. The railway investor (PKP PLK) and the contractors often point fingers at the technical condition of the buildings prior to drilling.

"Łódź was built on textiles and history," says one displaced tenant. "Now, that history is being swallowed by a hole in the ground. We are told we are part of progress, but we are actually just homeless in our own city."

Key Issues in Łódź

- **The "Secret" Condition of Tenements:** Many buildings were already in poor repair, making the TBM's vibration a "death sentence" for the structures.
- **Compensation Delays:** Many families are still waiting for clear answers on whether their homes will be demolished entirely or if they will ever receive enough compensation to buy a new apartment in the current market.

This isn't just an engineering challenge; it is a **humanitarian crisis** unfolding in the center of Poland's third-largest city.

This is the reality of daily life, and I don't think we should be creating projects or various activities in isolation from these contexts. The truth is that in many places, the social and economic situation is unstable and far from good.

These problems affect a great number of people, and the fundamental challenge is to actually solve them.

That is why we believe that an educational approach based on play and inventing artificial problems—challenges that have no basis in the real world or the local context—misses the mark.

The reality today is that older people face a multitude of genuine difficulties and challenges that we should be striving to address.

When it comes to participation, engagement, and active citizenship, trust is the primary requirement. It requires believing that what I do matters—believing in the purpose of my actions and my involvement. At the moment, within our community, that sense of purpose is certainly missing, and trust is very, very low.

Appendix H. Affinity Mapping Results.

The following figures present the six affinity maps generated from the Ambassadors' Challenges workshops, which map pain points and proposed solutions across three thematic axes (Digital Transition, eHealth, and Citizenship). For each axis, the findings are detailed through summary tables and explanatory texts that outline the identified pain points and proposed solutions. These descriptions are visually supported by the six affinity maps themselves. Because the original maps' size and complexity may limit legibility, full overviews are presented first, followed by enlarged views of selected clusters. These close-ups facilitate interpretation and highlight the main findings discussed in the Results section. Additionally, a digital version of the project outputs is available on the SMARTageCARE project website: https://smartagecare.fba.up.pt/workPackages/wp3.

Note: *This document was developed as part of the ERASMUS+ SMARTageCARE project in collaboration with the design team.*

Digital Transition

The main pain points and solutions identified in this area are summarized in the table below.

Table H.1. Key pain points and solutions for digital inclusion.

Pain Points	**Solutions**
Fear of digital risks (fraud, manipulation, security)	Computer, smartphone and table lessons
Skills and lack of knowledge	Support Materials (Illustrations, Free access)
Digital Illiteracy (Icons, Terms, Tools)	Individualized and practical training
Dependence on assistance	Cybersecurity education
Complex user interfaces	User-friendly, senior-centric design
Senior-unfriendly digital devices	Generational support and group education
Language and accessibility barriers	Accessibility
Outdated or incompatible technology	

Pain Points

With regard to digital inclusion, the data reveal a set of structural and experiential barriers shared among the participating countries. From a structural perspective, the high cost of equipment and internet connectivity, insufficient connectivity infrastructure, and the incompatibility of obsolete devices with the requirements of contemporary digital platforms stand out. From an experiential perspective, participants identified difficulties in understanding digital interfaces, namely icons, applications, and registration processes, reliance on others to perform basic tasks, language barriers in accessing digital services and resources, and exposure to cybersecurity risks, including misinformation and online fraud schemes. Local specificities were also highlighted: in Germany, the limited dissemination of information about activities aimed at older adults; in Cyprus, the excessive complexity of available devices; and in Slovenia, technological compatibility issues.

Figure H.1. Digital transition - Pain points

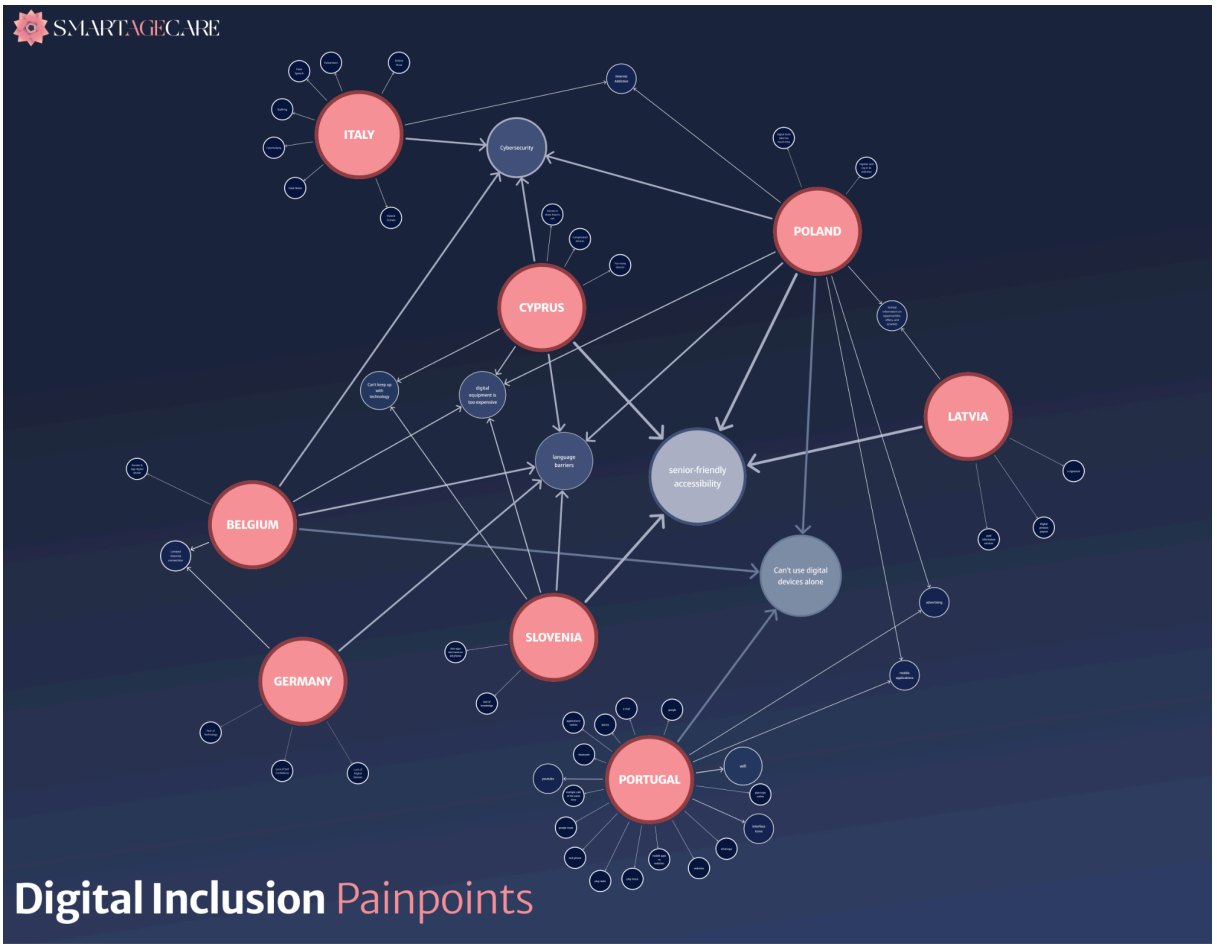
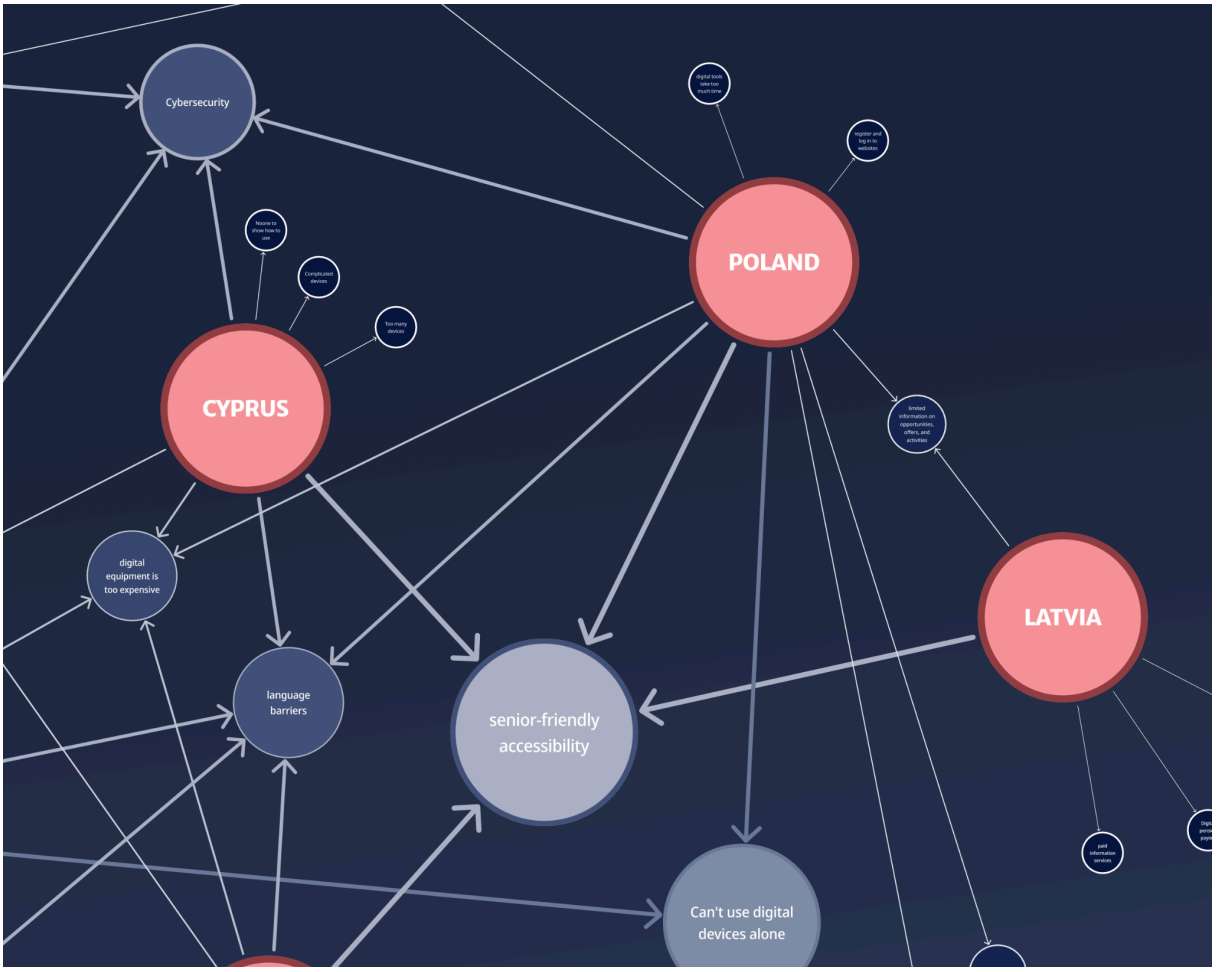


Figure H.2. Zoom In: Key Digital transition pain points



Proposed Solutions

In response to these challenges, the proposed strategies centered on accessible and context-specific digital education. Suggestions included creating individualized and group-based learning paths focused on practical skills, developing peer-learning networks, providing language support in participants' native languages, incorporating digital mediators into public services, and simplifying tools and procedures. Cybersecurity training, the involvement of older adults in the design of technological solutions, and the development of intergenerational support initiatives were also highlighted.

Figure H.3. Digital transition - Solutions

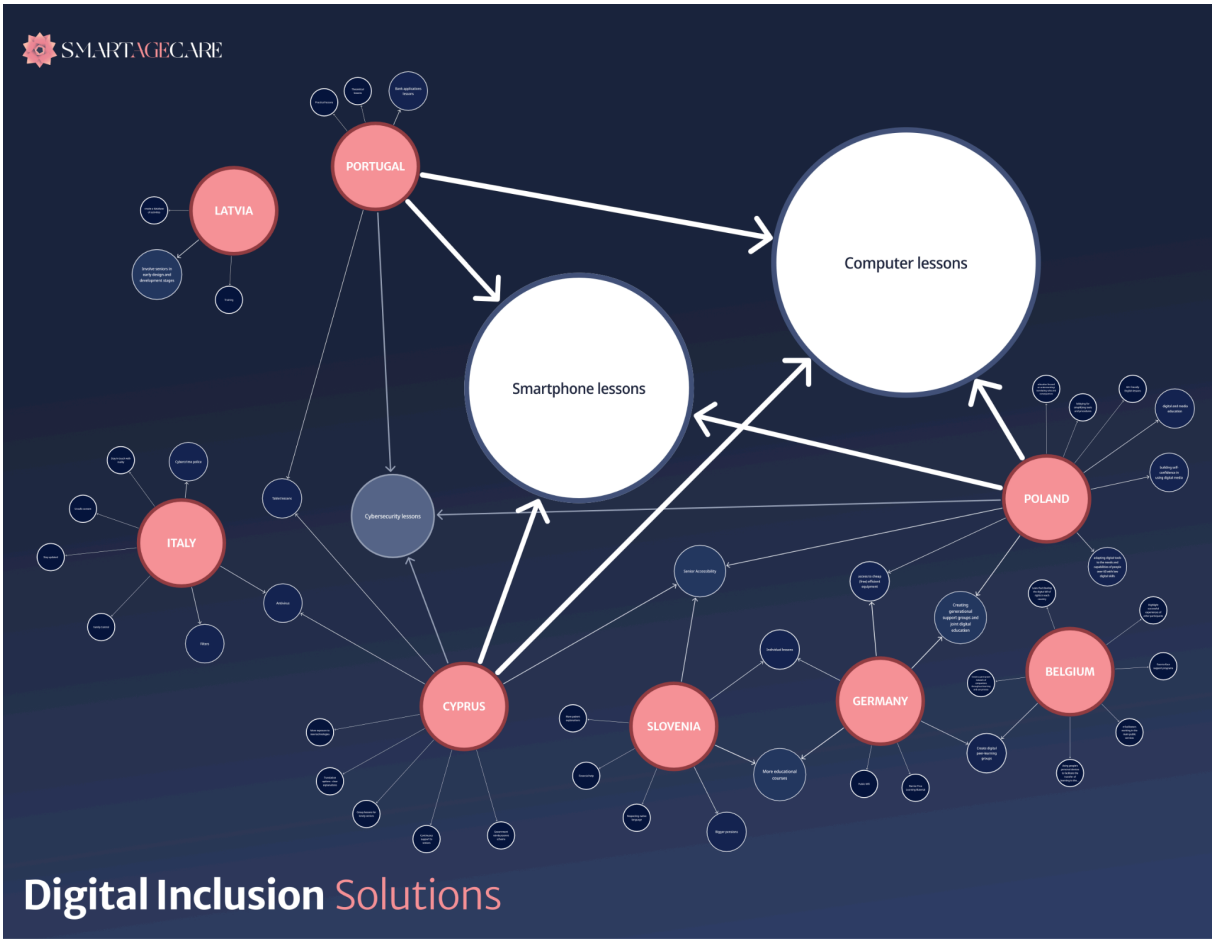
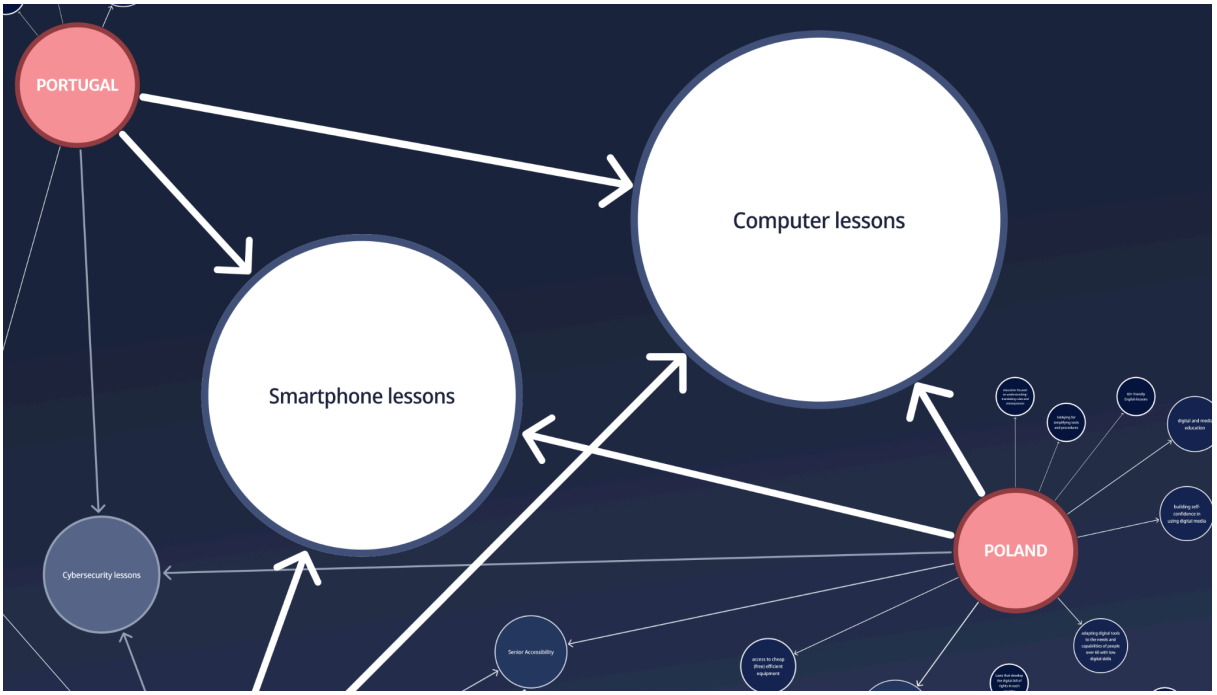


Figure H.4. Zoom In: Key Digital transition solutions



eHealth

The main pain points and solutions identified in this area are summarized in the table below.

Table H.2. Key pain points and solutions for eHealth.

Pain Points	Solution
Fear of Digital Risks (Scams, Data Privacy)	Digital Training
Preference for In-Person and Paper-Based Services	eHealth Awareness and Education
Limited Training and Knowledge	In-Person Assistance
Device Limitations	Family and Doctor Contact for Support
Digital Health Exclusion and Inflexibility	Integrated eHealthPlatform
Need for Integrated eHealth Systems	Expanded and Updated eHealth Services
Limited eHealth Services Accessibility	

Pain Points

In the field of digital health, participants identified barriers related to both digital literacy and trust in institutions. Among the most frequently cited challenges are a lack of familiarity with the technical vocabulary associated with digital health platforms, insufficient promotion of existing tools, low digital trust, and a lack of specific training on how to use them. The inflexibility of some platforms, combined with an insufficient number of available services, compromises usability for users with lower digital skills. Added to these barriers are concerns regarding the privacy of clinical data, the credibility of online information, and the risk of exposure to fraudulent content. Other issues mentioned included difficulties navigating the systems independently, memory problems, long wait times, and the perception that healthcare professionals lack sufficient knowledge about the available eHealth tools.

Figure H.5. eHealth - Pain points

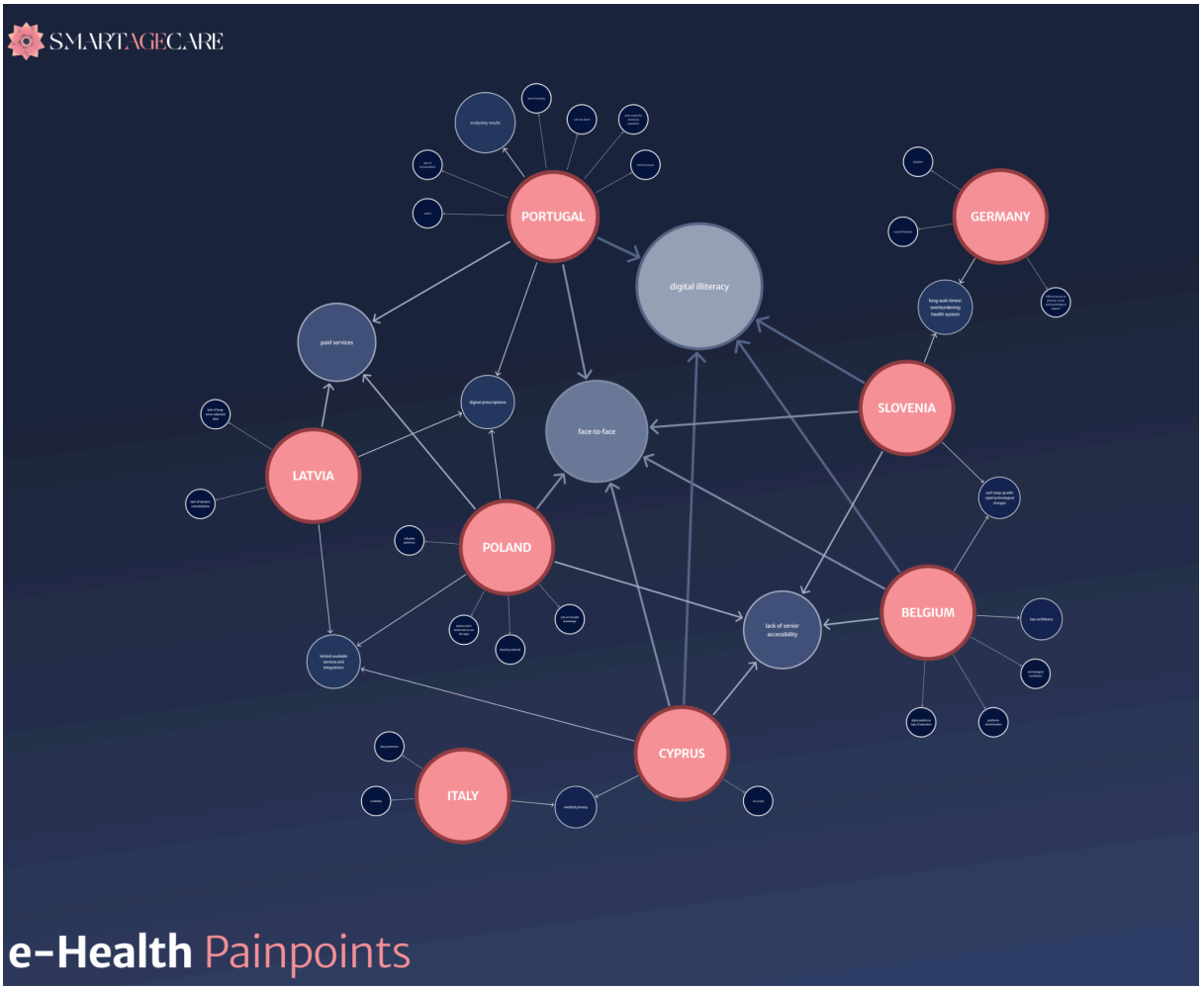
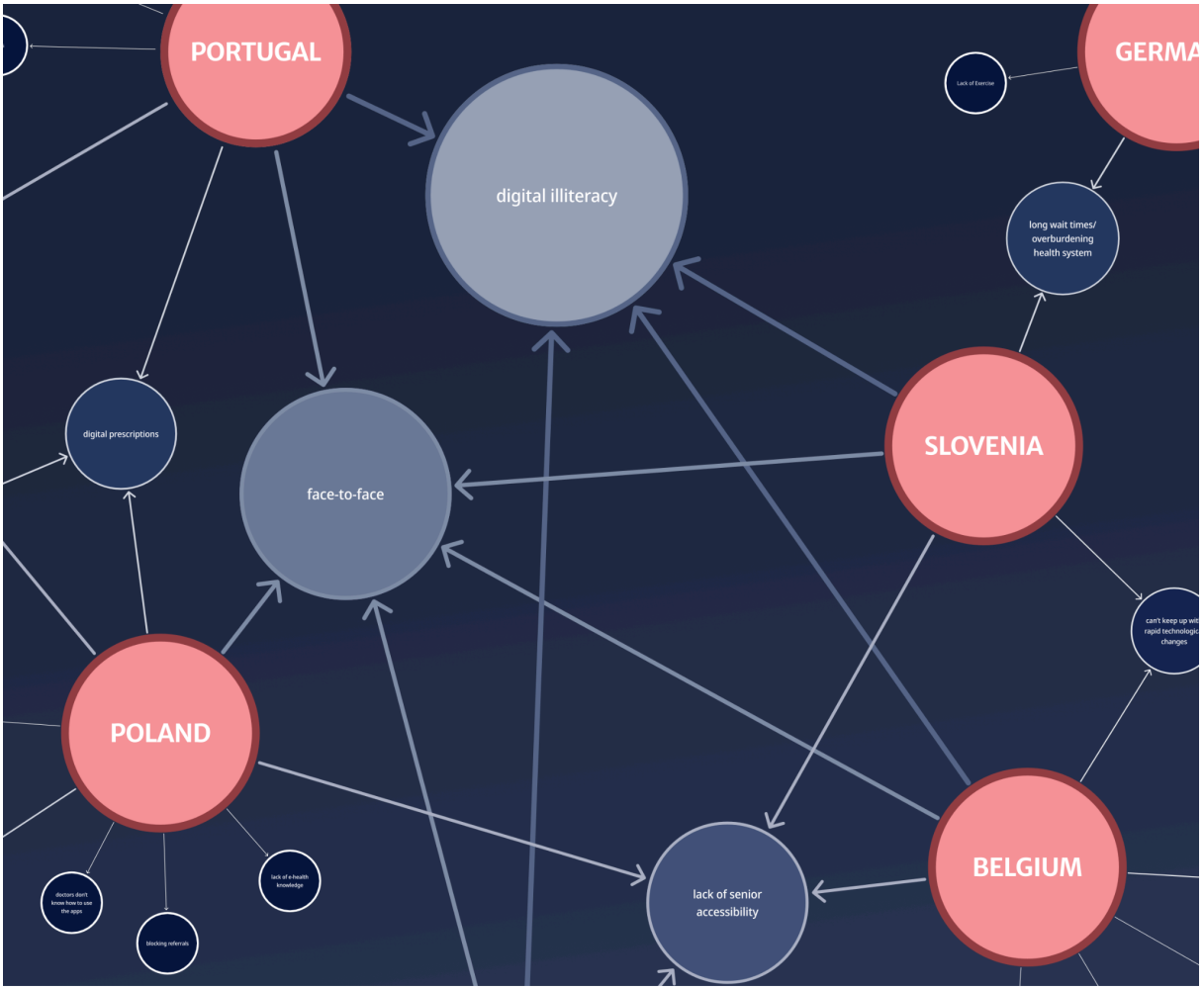


Figure H.6. Zoom In: Key eHealth pain points



Proposed Solutions

The proposed solutions prioritized participatory and community-based approaches: the co-design of digital health tools with the active participation of older adults, the implementation of in-person training sessions, the creation of community centers for digital health literacy, the use of intergenerational mentoring, and the training of caregivers. Measures were also suggested, such as providing accessible materials, in video format and with visual aids, ensuring data protection and privacy as a prerequisite for trust, and developing teleconsultation and remote prescription services.

Figure H.7. eHealth - Solutions

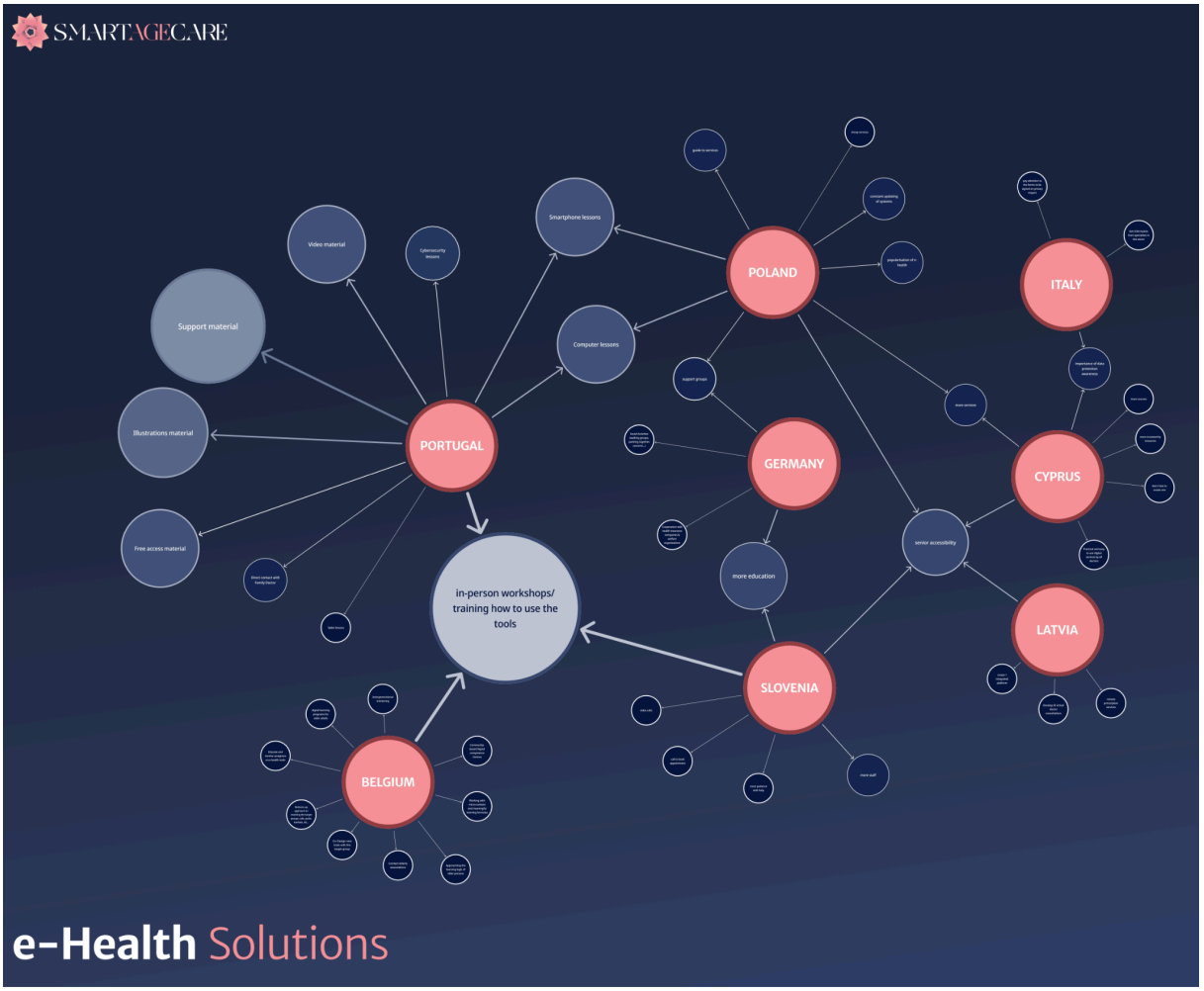
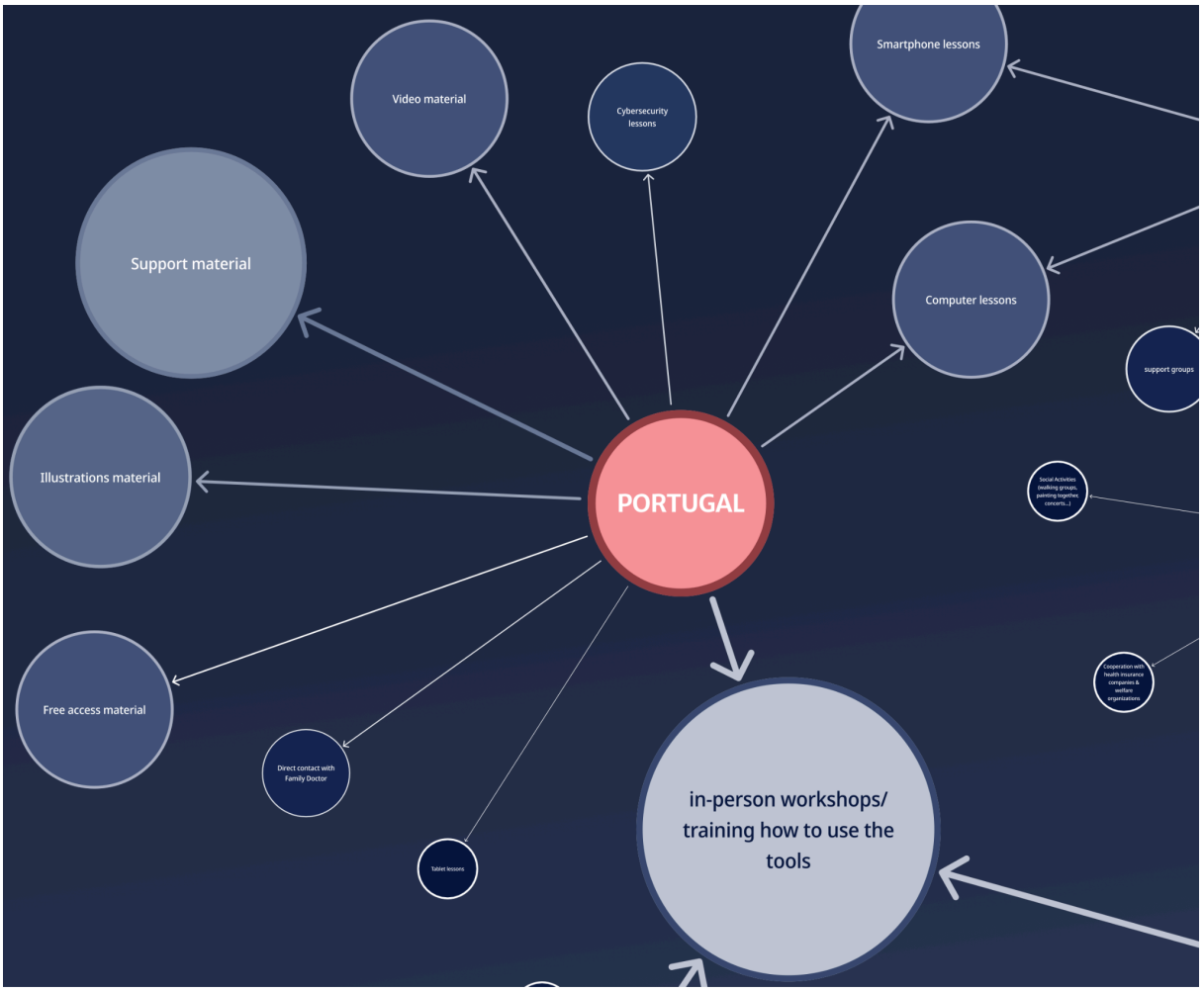


Figure H.8. Zoom In: Key eHealth solutions



Citizenship

The main pain points and solutions identified in this area are summarized in the table below.

Table H.3. Key pain points and solutions for citizenship.

Pain Points	Solution
Housing and Cost of Living Issues	Lifelong Learning (Senior University)
Social Isolation and Loneliness	Social Engagement
Limited Public Transport Access	Routine-Breaking Activities
Low and Inadequate Pensions	Increased Pension and Financial Support
Lack of Elderly Support Services	Enhanced Public Transport and Connectivity
Political Inaction and Lack of Reforms	Accessible and Affordable Housing
Accessibility Challenges (Stairs, Small Text Print)	Improved Health Access and Relations

Pain Points

In the area of citizenship, the data reflect a broader dimension of social and administrative exclusion. Participants reported barriers related to the high costs of public services and long-term care, social and physical isolation, insufficient representation of older adults' interests in public policy, and accessibility challenges in urban settings. Systemic concerns were also mentioned: administrative inefficiencies, risks of identity theft, and perceptions of corruption, as well as the impact of phenomena such as gentrification and mass tourism on the quality of life of older populations. These challenges are accompanied by a sense of pessimism regarding the capacity for change and resistance to social transformation.

Figure H.9. Citizenship - Pain points

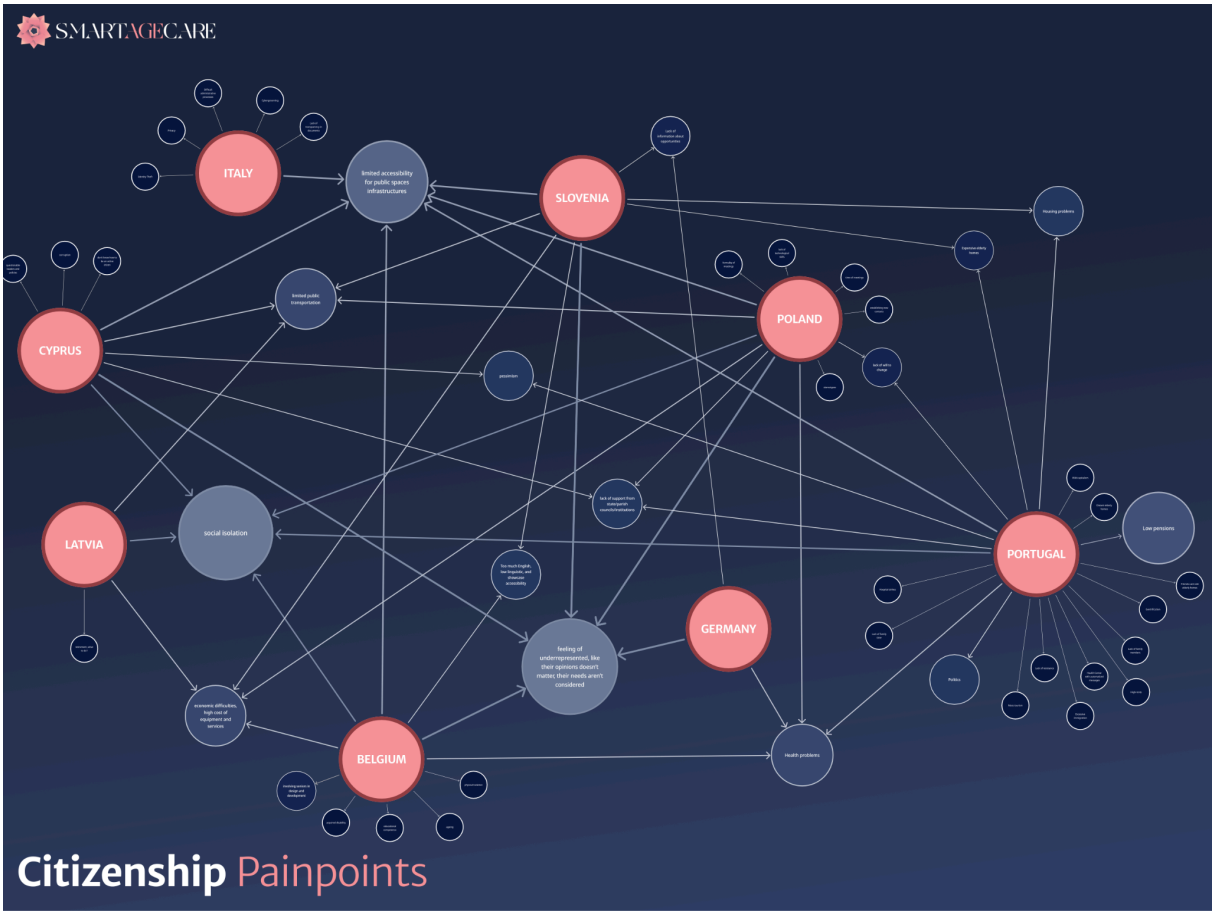
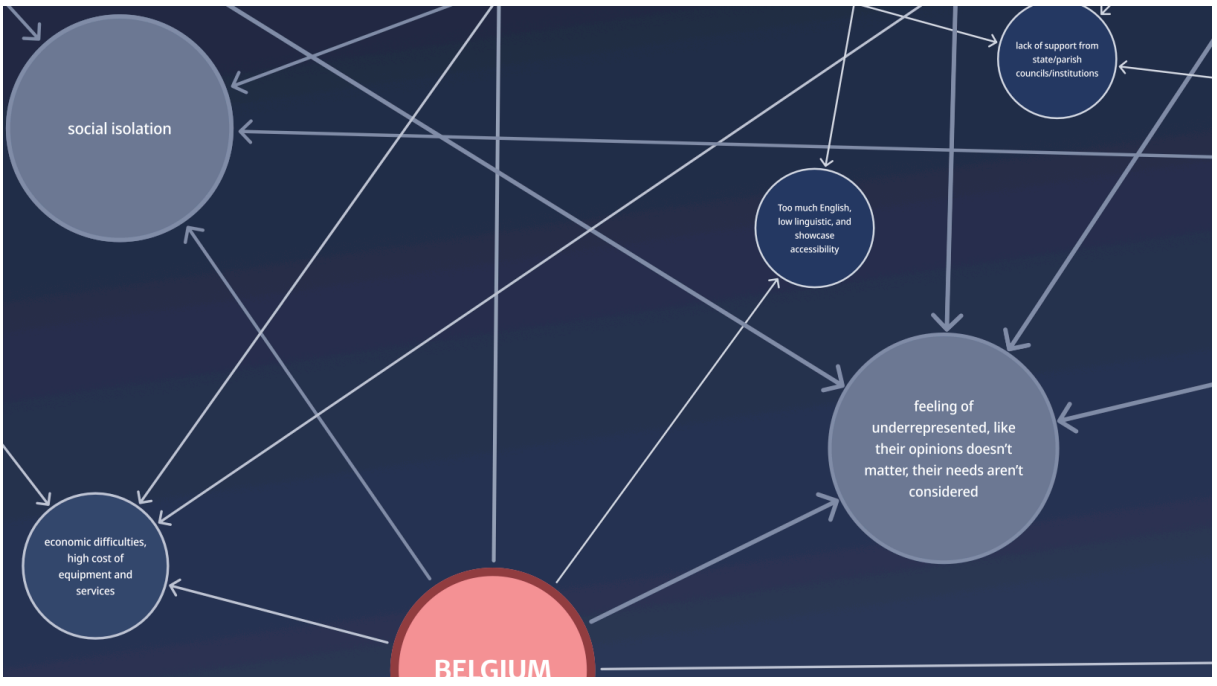


Figure H.10. Zoom In: Key citizenship pain points



Proposed Solutions

In terms of solutions, participants proposed measures aimed at civic empowerment and the creation of more inclusive environments. Among the strategies identified were the development of digital ambassador programs, the improvement of urban accessibility, the streamlining of bureaucratic processes, the promotion of community workshops and cultural and physical activities, and the strengthening of intergenerational support networks. Socioeconomic measures were also mentioned, such as increasing pension benefits and strengthening health services, as well as digital security measures, particularly the fight against cybercrime.

Figure H.11. Citizenship - Solutions

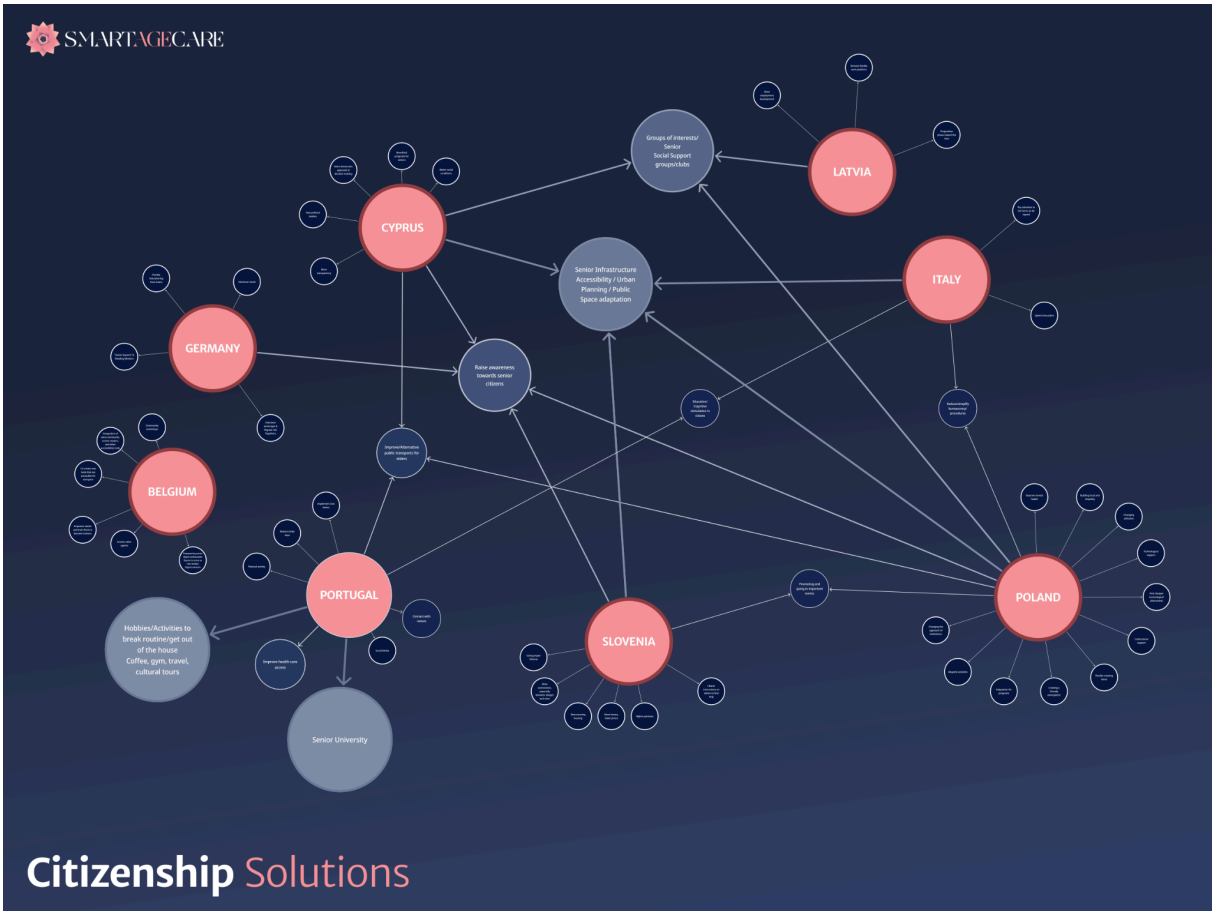
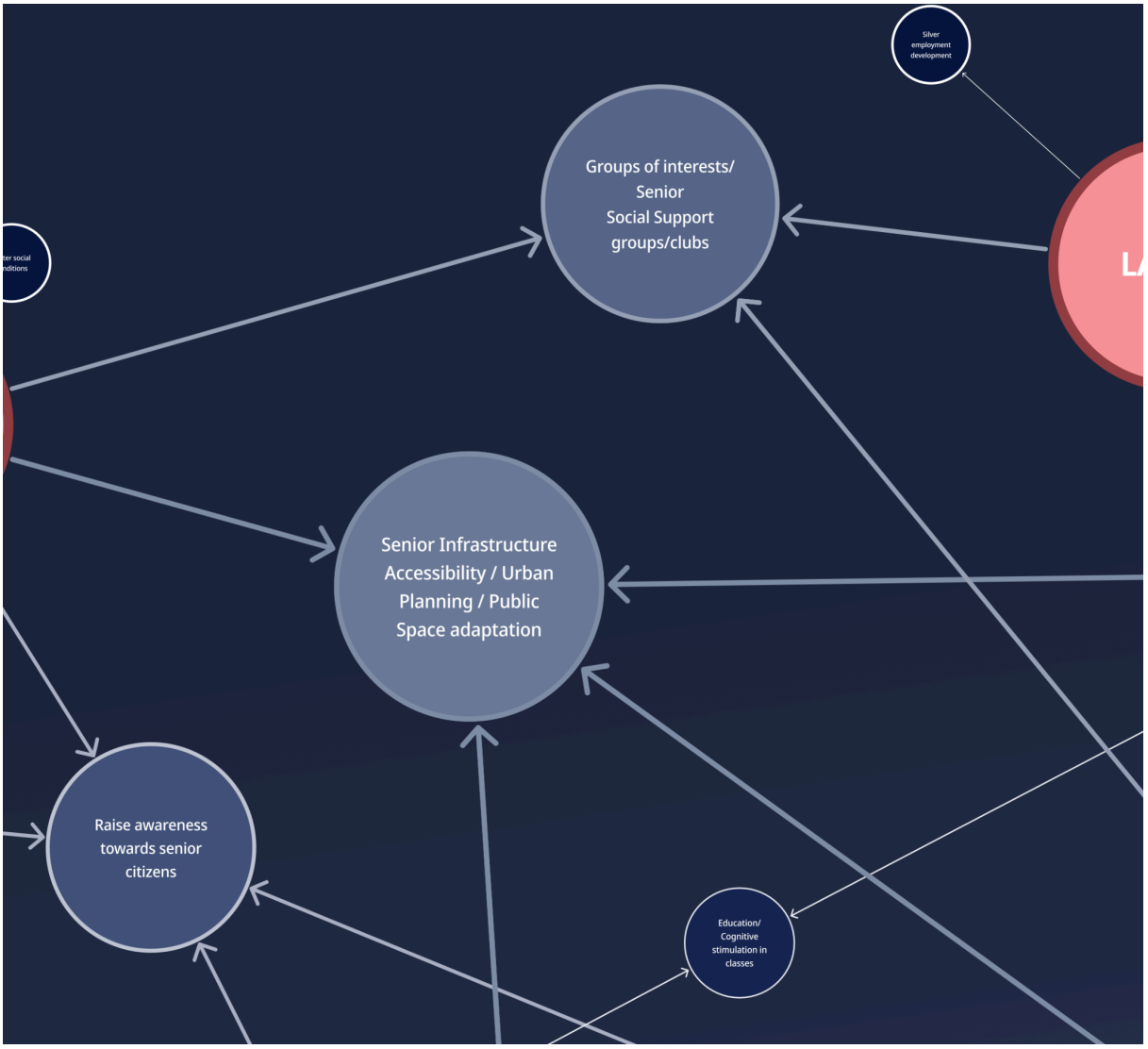


Figure H.12. Zoom In: Key citizenship solutions



Appendix I. Descriptive Statistics from the Technology Usage Questionnaire

Note: *This document was developed as part of the ERASMUS+ SMARTageCARE project in collaboration with the design team.*

Table H1. Demographic characteristics of respondents by country of residence (N = 57).

País	***n***	**%**
Chipre	11	19%
Alemanha	10	18%
Portugal	9	16%
Itália	9	16%
Eslovénia	8	14%
Polónia	6	11%
Letónia	4	7%

Table H2. Descriptive results from the Technology Use Questionnaire by dimension (N = 57).

Dimension	**Result**
Frequent computer use	31 Yes (54%) / 26 No (46%)
Frequent smartphone use	52 Yes (91%) / 5 No (9%) — 51 (88%) "several times a day"
Length of smartphone use	5–9 years: 32%; 10–19 years: 28%; <5 years: 12%; ≥20 years: 9%; no use/not applicable: 7%
Reported difficulties	20 Yes (35%) / 37 No (65%)
Self-rated difficulty — making calls (1–10)*	Median = 1; M = 2.26 (SD = 2.42); 14% report meaningful difficulty
Self-rated difficulty — sending texts (1–10)*	Median = 1; M = 2.70 (SD = 2.72); 18% report meaningful difficulty
General fear of smartphone	15 Yes (26%) / 42 No (74%)
Use for entertainment	28 Yes (49%) / 29 No (51%)
Social media use	28 Yes (49%) / 29 No (51%)
Knows the concept of an "app"	40 Yes (70%) / 17 No (30%)
App recognition (0–10 icons)	M = 4.77 (SD = 3.2); median = 5.0
Most frequent purposes of use	Calls (93%), Texts (91%), Internet (75%), Photos (67%), Social media (44%), Music (26%)

***Note:** Likert scale from 1 to 10, where 1 = No difficulty / Very easy, and 10 = Extreme difficulty / Very difficult.

Table H3. Specific difficulties reported by respondents (n = 22 responses with text).

Category	*n*	Illustrative examples
Motor/sensory (small buttons, touch sensitivity, vision)	4	DE: "meet a (small) button wanted; sudden reaction to a light touch by trembling finger; too small buttons"; IT: "Seeing small text, using advanced functions"; SL: "ne vidim" ("I don't see")
General navigation / digital literacy	5	CY: "Typing" (×2); CY: "Too Complicated"; DE: "totally puzzling if not frustrating informations"; SL: "Sliding to answer the phone, don't know where some things are located"
Cognitive	1	IT: "Deficit of memory"
Intentional minimal use / non-adoption	5	PT: "I just use to receive phone calls and text messages" (×2 variants); LV: "none"; DE: "My main struggle is to use no smartphone!"
Security/data loss framed as “difficulty”	3	IT: "Sicurezza" ("Security"); IT: "Data lost"; IT: "Dipendenza e isolamento" ("Dependency and isolation")

Table H4. Safety concerns reported by respondents (n = 57, all responses; approximately 19 with no stated concern).

Category	*n*	Illustrative examples
No concern	19	CY: "Nothing" (×4); SL: "/" (×3); PL: "No fear", "nothing worries me"
Phone scams/fraud	7	PT: "Phone call scams", "Message scams", "Scams"; IT: "Frauds by calls or messages", "Truffe" ("burlas")
Personal data theft/exposure	10	CY: "Personal data" (×5, variants); PL: "Data theft"; LV: "This is identity theft", "Information Leak"; DE: "That personal data get in wrong hands"
Hacking	4	IT: "Hacker" (×2); LV: "hackers"; SL: "somebody will hack the application"
Surveillance/privacy	3	DE: "that I am being observed"; DE: "Google and Trump is watching you!"; PT: "People invading our privacy"
Financial loss	2	PT: "Money transfers or payments"; IT: "paying money unwillingly"
Self-doubt about own behaviour (user error)	3	IT: "not knowing what to do"; PT: "Click in some button I shouldn't"; PT: "Almost everything"
Specific technical threat (phishing/spoofing)	1	DE: "my e-Mail app does not indicate the address of the real sender, only the indicated address, which may be a fake"
Proactive attitude (no fear, but cautious)	2	PL: "I try to use it safely" (×2)

Note: Approximate counts (n) are based on open-ended responses coded by thematic category. Country codes indicate the respondent's country of residence.

Appendix J. Representative Sample of the final version of Ikigai Play Toolkit

The activities selected for this appendix illustrate the range of formats across the four modules and include examples directly discussed in the results, particularly those that underwent refinement through the HCD iterative cycle. Each activity is presented with its applicable components, which vary according to the nature of the activity and may include the facilitation manual, card set, solutions book, and/or printable materials. The complete toolkit, comprising 38 activities, is available at: https://smartagecare.fba.up.pt/tool-kit.

Note: *This document was developed as part of the ERASMUS+ SMARTageCARE project in collaboration with the design team.*

Module A - Ikigai

Activity 1.2 - IKIGAI 9

- Facilitator Manual
- Printable Material

Module B - Digital Transition

Activity 2.1 - Guess the App

- Facilitator Manual
- Card Set (Only a set of cards is presented for illustrative purposes)

Module C - eHealth

Activity 3.6 - 2 Truths and 1 Lie:Active and Healthy Aging

- Facilitator Manual
- Card Set (Only a set of cards is presented for illustrative purposes)

Module D - Citizenship

Activity 4.11 - You Are Probably Wrong About Ageism

- Facilitator Manual
- Card Set (Only a set of cards is presented for illustrative purposes)
- Solutions Book

MODULE A

ACTIVITY 1.2

BENEFITS	TOPICS
Personal Reflection	Ikigai
Wellbeing Awareness	Meaning & Satisfaction
Purpose & Fulfillment	Self-assessment & Growth

ACTIVITY 1.2

IKIGAI 9

Learning Outcomes

- Reflect on personal wellbeing, meaning, and purpose in daily life
- Increase self-awareness around satisfaction and fulfillment across life areas
- Identify areas of strength and areas for potential growth

Summary

• Use the Ikigai-9 Scale to reflect individually on different aspects of meaning and fulfillment in the participants' lives. Through scoring, visual mapping, and group discussion, gain insight into what currently nourishes sense of purpose and where small changes could improve wellbeing.

Materials

- Activity Sheets
- Pens
- Ruler (optional)

Setup

- Print the activity sheets

! NOTE

If you can't print the sheets, just read them out loud for the group, and have the participants write down the answers. This will disable the visual mapping afterwards.

Make sure to have completed activity 1.1 before this activity

smartagecare.fba.up.pt /toolkit/1.2

APPROACH

STEP	SAY
Introduction	"Today, we'll be using something called the Ikigai-9 Scale. It's a simple reflection tool that helps us think about how much meaning, fulfillment, and enjoyment we feel in different parts of our lives. It comes from research in Japan around the idea of ikigai"
Setting Expectations	"I'll read nine short statements aloud, and I'll invite you to reflect on each one and give your answer on your sheet. When we're finished, we'll have a helpful picture of the areas where you may be feeling strong and satisfied, and the areas where there may be opportunities for growth or change." *Distribute the work sheets and pens amongst participants*
Scale Explanation	"For each statement, you'll choose a number from 1 to 5: 1 means 'This doesn't really apply to me' 5 means 'This applies to me very much' Take your time, and answer honestly based on how you feel right now." *Continuation on the following page*

APPROACH

STEP	SAY
Scale Completion	"Let's begin." **Read each of the nine statements slowly, allowing time for participants to respond before moving on.**
Score Calculating	"Now that you've answered all nine statements, it's time to calculate your IKIGAI score. Take your smartphone and open the calculator app. Add together all the numbers you chose for each statement. This total gives you an overall sense of how much meaning, fulfillment, and enjoyment you feel across the different areas. If you're not sure how to use the calculator, or want a hand adding the numbers, I'm here to help and we can do it together. After you have your total number, write it on the sheet where it says 'IKIGAI Score'"
Visual Mapping	**After everyone fills out their activity, distribute the second sheet (Ikigai mapping diagram).** "Now you'll transfer your answers to this new sheet. For each question, find the number you chose and mark the circle next to it. The number 1 starts in the centre, and the numbers grow outward." "Once all circles are marked, use a ruler or your pencil to connect neighbouring points. Then shade in the area you've created. This gives you a visual picture of your current ikigai." **Show an example so participants can follow easily.**

DEBRIEF

STEP	SAY
First Impressions	"Take a look at your IKIGAI shape. What do you notice first? Is there any area that feels strong or full? Any area that feels smaller or less present?"
Daily Life	"Pick one area of your IKIGAI: How does this show up in your daily life right now? Is it something you spend time and energy on, or something that's missing?"
Scores	"Now, let's think about the numbers you gave each statement. You calculated the total number that is between 9 and 45. With your results, you have the different levels: 41–45: Very strong sense of IKIGAI 36–40: Strong sense 31–35: Moderate sense 26–30: Developing sense 9–25: Areas for growth More important than the total score are the individual items with lower ratings, they show where you might want to focus, explore, or take action."

Continuation on the following page

DEBRIEF

STEP	SAY
Change & Support	"Look at an area you'd like to strengthen: What is one small step you could take to improve it? Who or what could help? A person, a habit, or a service? Think of this as a way to reconnect with curiosity, contribution, growth, and meaning."
Closing	"This activity shows that purpose and fulfillment aren't about big achievements. They're built through everyday actions, choices, and relationships. Even one small change can make life feel more meaningful."

MODULE A
IKIGAI

ACTIVITY 1.2

IKIGAI 9

SMARTAGECARE

IKIGAI-9

ACTIVITY 1.2

1. I believe that I have some impact on someone.

1 — **2** — **3** — **4** — **5**

2. My life is mentally rich and fulfilled.

1 — **2** — **3** — **4** — **5**

3. I am interested in many things

1 — **2** — **3** — **4** — **5**

4. I feel that I am contributing to someone or to society.

1 — **2** — **3** — **4** — **5**

5. I would like to develop myself.

1 — **2** — **3** — **4** — **5**

6. I often feel that I'm happy.

1 — **2** — **3** — **4** — **5**

7. I think that my existence is needed by something or someone.

1 — **2** — **3** — **4** — **5**

8. I would like to learn something new or start something.

1 — **2** — **3** — **4** — **5**

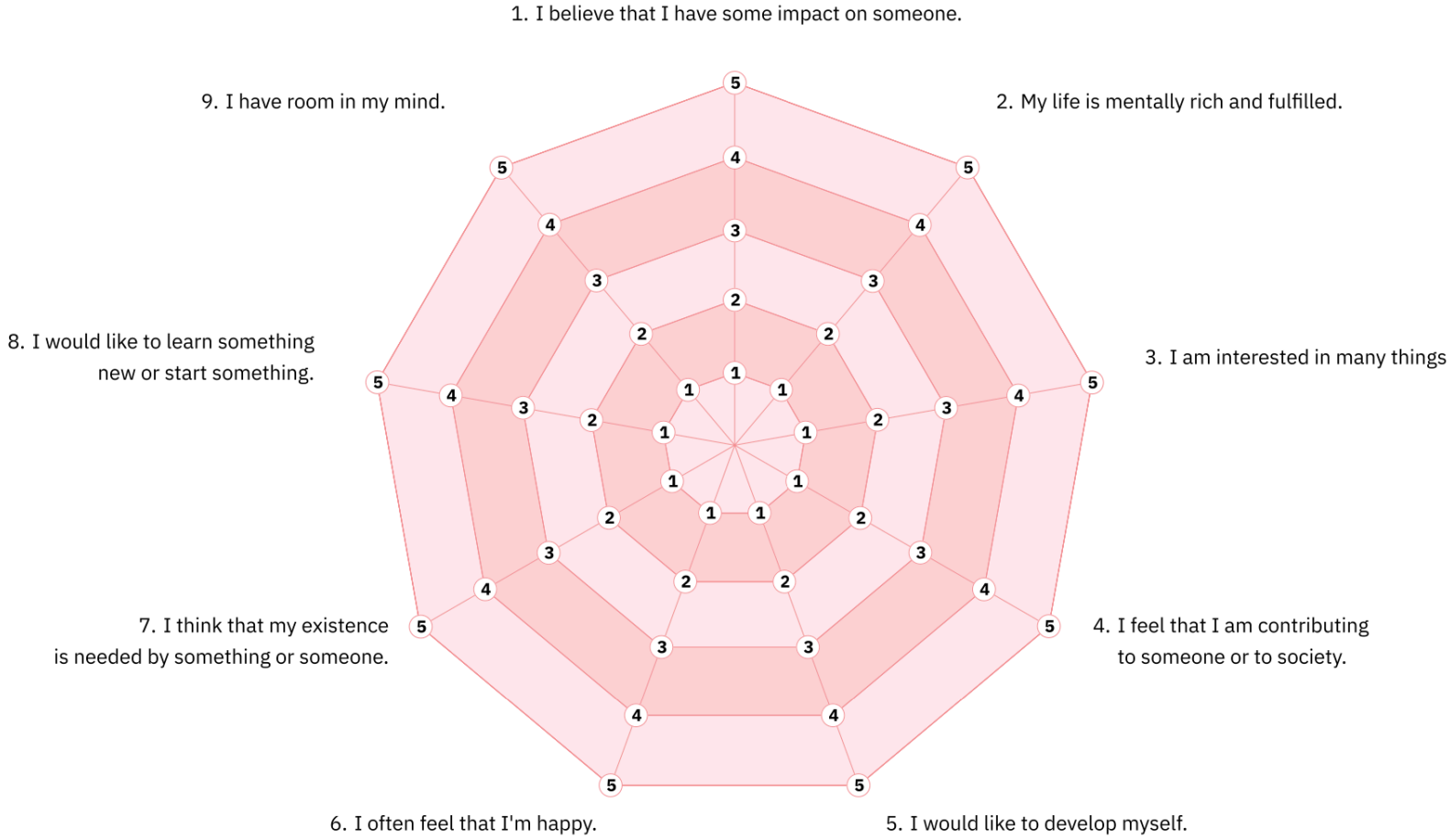
9. I have room in my mind.

1 — **2** — **3** — **4** — **5**

SMARTAGECARE

IKIGAI SCORE _____

IKIGAI-9


1. I believe that I have some impact on someone.
2. My life is mentally rich and fulfilled.
3. I am interested in many things
4. I feel that I am contributing to someone or to society.
5. I would like to develop myself.
6. I often feel that I'm happy.
7. I think that my existence is needed by something or someone.
8. I would like to learn something new or start something.
9. I have room in my mind.

MODULE B

ACTIVITY 2.1

BENEFITS	TOPICS
Confidence Building	Mobile Apps
App Awareness	Digital Use
Memory Skills	Websites

ACTIVITY 2.1

Guess The App

Learning Outcomes

- Understand more about mobile applications and their purpose
- Gain more confidence when talking about mobile applications

Summary

- Encourages visual recognition, and works the memory of participants.

Materials

- Printable Cards
- Solutions Sheet

Setup

- Print all the material and cut out the activity cards.
- Shuffle the deck thoroughly.
- The facilitator keeps the answer sheet.

smartagecare.fba.up.pt /toolkit/2.1

NOTE

If you can't print the material, you can use the digital material, through the QR Code, and make it in a form of a verbal quizz

APPROACH

STEP	SAY
Introduction	"We are going to play a guessing game. The goal is to guess mobile apps and websites and talk about them in a fun, relaxing way."
Explanation	"Each card has a different mobile application or website. I'll be taking a card from the deck and the rest of the group will then have to try and guess what is on the card. You can do that by asking 'Yes' or 'No' questions regarding the purpose of different mobile applications or websites"
Examples	"For example: 'Is it for communication? 'Would I use this for leisure?' 'Is it something I use every day?' The player answers each question with 'yes' or 'no'. "
Guessing	"Anyone can guess at any time. When someone guesses correctly, the card is revealed. If needed, I'll read some small hints on the card. Afterwards, we can talk more about the content of the card"

! NOTE

It is important for the facilitator to open dialogue throughout the activity, and lead conversations about with the players, such as:
"Have you faced struggles using this app?"
"In what context would you use the app?"
"How do they feel about the app and using it?"

DEBRIEF

STEP	SAY
Initial Reactions	"How do you feel about this game? Was it easier or harder than what you expected?"
Conversation	"Did you recognise more or less apps than what you thought you would? How did it feel to discuss them throughout the game?"
Relevance	"Which apps or websites do you find more familiar or useful? Are these applications that you would like to use more?"
Closure	"Hopefully this game showed that these mobile applications and websites don't have to be intimidating. By asking questions and showing interest together, we can understand them better. Learning is something we can do together, at any age, we don't have to do it alone."

MODULE B
Digital Transition

ACTIVITY 2.1

Guess The App

SMARTAGECARE

1

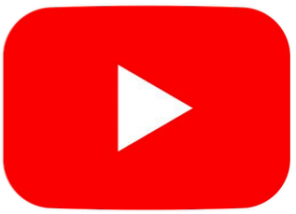


Facebook

Tips

- Connect with friends and family
- Share posts, photos, and videos
- Join groups and follow pages

2



Youtube

Tips

- Watch and upload videos
- Subscribe to favorite channels
- From tutorials to entertainment

3



Spotify

Tips

- Stream music and podcasts
- Create custom playlists
- Discover new artists

4



Uber

Tips

- Book a ride anytime
- Track the driver on the map
- Pay directly in the app

MODULE C

ACTIVITY 3.6

BENEFITS

Healthy Aging

Teamwork

TOPICS

Healthy Lifestyle Habits

Myths of Aging

ACTIVITY 3.6

2 Truths and 1 Lie: Active and Healthy Aging

Learning Outcomes

• Raise Awareness about the myths and realities of active and healthy aging.

• Understand the importance of autonomy, adequate sleep, physical activity, and healthy eating for quality of life in old age.

Summary

• The activity is a question and answer competition divided into thematic rounds (aging process, sleep, physical activity, and nutrition). Participants, divided into groups, must analyze three statements and identify which one is false in order to earn points for their team, promoting reflection and collective learning.

Materials

• Printable Cards

• Paper

• Pens

Setup

• Print all the material and cut out the activity cards.

• Shuffle the deck thoroughly.

• The facilitator keeps the answer sheet.

• Split the participants in groups

• Make the columns necessary for the amount of groups on a piece of paper

smartagecare.fba.up.pt /toolkit/3.6

NOTE

If you can't access a printer, you can use the material online, available through the QR Code, and make the activity verbally

APPROACH

STEP	SAY
Introduction	"This is a card game called Two Truths and One Lie about active and healthy ageing. The goal is not only to find the correct answer, but to learn together, share experiences, and reflect on common myths and facts about ageing, sleep, physical activity, and nutrition. There is no pressure to be right, this is a safe space to talk, ask questions, and learn from each other."
Explanation	"Each round, I will read three statements related to a specific topic. Two of them are true and one is false. Your task is to discuss with the group and decide which one you think is the lie. Take your time to listen, think, and share your opinion."
Group Discussion	"After you choose which statement is the lie, we will talk briefly about your choice. You can explain why you selected it and share any personal experiences or thoughts related to the topic."
Solution	"I will then reveal the correct answer and explain why that statement is false and why the others are true. This is a moment for learning and clarification." "We will repeat this process for each round
Final	"We will play for as long as everyone feels comfortable. At the end, the goal is shared learning and reflection. Does anyone have any questions before we start?"

DEBRIEF

STEP	SAY
Initial Reactions	"Now that we have completed the game, what stood out to you the most? Was there any statement that surprised you or changed the way you think about ageing or health?"
Reflection on Myths and Beliefs	"Were there any myths you believed before playing that you now see differently? Which topic was the most difficult or interesting for you: ageing, sleep, physical activity, or nutrition?"
Key Takeaway	"Some important messages from today include: • Ageing is different for each person and is influenced by lifestyle and environment. • Many health problems are not inevitable and can be prevented or managed. • Autonomy and independence are not the same thing and should both be respected. • Healthy sleep, physical activity, and nutrition support quality of life at any age."
Closing	"Thank you for participating and sharing your ideas today. Remember: healthy ageing is not about being perfect, but about making informed choices that support your well-being. If you have doubts about your health, sleep, or diet, it is important to seek guidance from a health professional."

MODULE C
E-Health & Wellbeing

ACTIVITY 3.6

2 Truths and 1 Lie: Active and Healthy Aging

SMARTAGECARE

What does it mean to grow old?

A) Aging is a universal and natural process, but each person ages at their own pace, influenced by their genetics and lifestyle.

B) Aging is a process that is the same for all human beings, necessarily following a fixed pattern of biological losses. *(LIE)*

C) Old age should be understood not only in terms of the physical body, but also encompassing the social and cultural dimensions of an individual's life.

WHY IS IT A LIE?

Aging is heterogeneous. This means it varies from person to person and is influenced by much more than just biology, including culture, society, and lifestyle.

Changes in the Brain and Body (Senescence)

A) Having gray hair, wrinkles, and subtle changes in the perception of food smells are expected signs of normal aging.

B) Gradual changes in hearing and vision can occur in old age without preventing a person from managing their own life.

C) Losing the ability to perform daily activities, such as dressing or eating independently, is a natural and inevitable consequence of aging. *(LIE)*

WHY IS IT A LIE?

Changes associated with senescence are gradual and should not interfere with daily executive activities. The loss of this ability is linked to functional disability or senility.

MODULE D

ACTIVITY 4.11

BENEFITS

- Challenge Stereotypes
- Inclusive Attitudes
- Ageism Awareness

TOPICS

- Impact On Well-being
- Myths About Aging
- Ageism

ACTIVITY 4.11

You Are Probably Wrong About Ageism

Learning Outcomes

- Increase participants' awareness of what ageism is and how it operates.
- Challenge common myths about ageing using evidence-based data.

Summary

- This activity uses a quiz-style card game inspired by the WHO Global Report on Ageism. Through multiple-choice questions, participants reflect on common misconceptions about ageing and compare their assumptions with scientific evidence.

Materials

- Printable Cards
- Solutions Sheet

Setup

- Print all the material and cut out the activity cards.
- Shuffle the deck thoroughly.
- The facilitator keeps the answer sheet.

smartagecare.fba.up.pt /toolkit/4.11

NOTE

If you can't access a printer, you can use the material online, available through the QR Code, and make the activity verbally

APPROACH

STEP	SAY
Introduction	"This is a quiz game about ageing and ageism. The goal is not just to get the right answers, but to explore what we think we know about ageing and compare it with real evidence. There is no pressure, this is a safe space to reflect and share experiences."
Explanation	"Each card contains a multiple-choice question related to ageing or ageism. I will take one card at the time, read the question and the possile answers outloud. Afterwards, we'll discuss the content in group, where each of you can give your opinion and thoughts.
Solution	"After you answer, I'll check the Solution Sheet, and provide more insight on the answer, and we can have a short pause for discussion regarding the content of the card, to see if everyone understands and if there are any difficulties"
Final	"After you answer, I'll check the Solution Sheet, and provide more insight on the answer, and we can have a short pause for discussion regarding the content of the card, to see if everyone understands and if there are any difficulties"

DEBRIEF

STEP	SAY
Initial Reactions	"Now that we've gone through several questions, what surprised you the most? Was there anything you believed before that changed today?"
Personal Reflection	"Have you ever witnessed ageism in daily life, at work, in healthcare, in media, or within families? Have you ever limited yourself because you thought you were 'too old' for something?"
Key Takeaways	"Some important reminders from today include: - Ageism operates through stereotypes, prejudice, and discrimination. - It can reduce life expectancy and harm mental and physical health. - It affects not only individuals but also economies and healthcare systems. - Positive perceptions of ageing can improve quality of life. - Policies, education, and intergenerational contact help reduce ageism."
Closing	"Thank you for participating and sharing openly. Remember: ageing is a natural and diverse process. Challenging ageism starts with questioning our assumptions and changing small daily behaviours. If you notice ageist language or attitudes in the future, you now have the awareness to challenge them."

MODULE D
Citizenship

ACTIVITY 4.11

You Are Probably Wrong About Ageism

SMARTAGECARE

What defines 'ageism' or 'age discrimination'?

A) It is simply the act of mistreating or insulting an elderly person in public.

B) It is the body's natural aging process that limits physical activity.

C) It is the combination of stereotypes (how we think), prejudices (how we feel), and discrimination (how we act) towards people based on age.

D) It is a medical term used to describe memory loss in people over 60 years of age.

According to global data from the World Health Organization (WHO), what proportion of people demonstrate prejudiced attitudes towards older people?

A) 1 in 10 people.

B) 1 in 2 people (half the world's population).

C) Only 5% of the population.

D) Healthcare professionals only.

MODULE D
Citizenship

ACTIVITY 4.11

You Are Probably Wrong About Ageism

SMARTAGECARE

YOU ARE PROBABLY WRONG ABOUT AGEISM 1/3 Solutions

1 **C** Ageism operates on three levels:

- **Cognitive (Stereotypes)**: Ex: ""Older people don't know how to use technology.""

- **Affective (Prejudice)**: Ex: Feeling pity or irritation because of someone's age.

- **Behavioral (Discrimination)**: Ex: Not hiring someone or excluding a family member from a decision because they are ""too old."" It can be directed at others or at ourselves.

2 **B** Ageism is one of the most socially accepted and invisible prejudices. Studies indicate that half of the world's population holds moderate or highly ageist attitudes.

3 **B** People with a positive self-perception about aging live, on average, seven and a half years longer. Internalized prejudice generates biological stress and reduces the will to live and take care of oneself.

4 **B** There is no single "typical profile" of an elderly person. Old age is characterized by immense diversity, which requires flexible public policies that cater to both independent and dependent individuals.

5 **B** The combination of a person's physical and mental capabilities (known as intrinsic capacity) is a more accurate indicator of their health and well-being than the presence or absence of disease. Integrated services focused on improving the intrinsic capacity of older adults yield better results and are likely no more expensive than services focused on a specific disease.

6 **C** Only about 25% of longevity is genetic. The other 75% results from the cumulative impact of interactions with the physical and social environment, which shape our behaviors throughout life.

7 **B** When we accept the label of "incapable," our body and mind tend to confirm that expectation. This is known as the "stereotype threat."

Appendix K. Published Book Chapter

Reference: Giesteira, B., Souza, T., Sousa, A., Rodrigues, L., & Vila Maior, G. (2026). Ikigai Play: Towards an Ikigai Paradigm of Healthy and Active Ageing in Europe. In S. R. Costa & J. Remondes (Eds.), *Reshaping Health Promotion and Disease Prevention Through Digital Innovation* (pp. 217–254). IGI Global. https://doi.org/10.4018/979-8-3373-3531-5.ch008

Note: *This paper was co-authored by the candidate as part of the research conducted for this dissertation.*

Chapter 8
Ikigai Play:
Towards an Ikigai Paradigm of Healthy and Active Ageing in Europe

Bruno Giesteira
https://orcid.org/0000-0003-4896-6659
University of Porto, Portugal

Tainá Souza
https://orcid.org/0009-0008-4947-6436
University of Porto, Portugal

Andreia Sousa
https://orcid.org/0000-0001-8070-8970
Lusófona University, Portugal

Liliana Rodrigues
More Than Humans, Portugal

Guilherme Vila Maior
University of Porto, Portugal

ABSTRACT

This chapter is grounded in the results of the ERASMUS+ funded project SmartAgeCare, which investigated active and healthy ageing strategies across eight European countries. The project aims to foster digital inclusion, civic participation, and psychosocial well-being among older adults by exploring innovative models of engagement. This chapter introduces the concept of 'Ikigai Play' as a transdisciplinary framework rooted in a meta-narrative review and inspired by the Japanese philosophy of Ikigai—meaning 'reason for being'. Synthesising evidence from national studies and digital ageing strategies, the chapter identifies regional disparities, psychosocial drivers, and the transformative potential of inclusive technologies. 'Ikigai Play' is proposed as a culturally adaptive model to support autonomy, well-being, and digital health equity.

DOI: 10.4018/979-8-3373-3531-5.ch008

Copyright ©2026, IGI Global Scientific Publishing. Copying or distributing in print or electronic forms without written permission of IGI Global Scientific Publishing is prohibited.

1. INTRODUCTION

This chapter is developed within the framework of the SmartAgeCare project, an international research initiative funded by the Erasmus+ programme of the European Union. The project explores innovative approaches to promote healthy and active ageing across Europe, with a strong focus on digital inclusion, civic engagement, and meaningful participation. Through cross-national collaboration among researchers and institutions from eight European countries, the project addresses how emerging digital technologies and psychosocial paradigms can enhance the autonomy, health, and sense of purpose of older adults.

At the heart of this approach lies the Japanese concept of Ikigai—meaning 'reason for being'—which this chapter proposes as a culturally sensitive and emotionally resonant tool for guiding innovation in age-friendly ecosystems. The main objectives of the SmartAgeCare project are: (1) to investigate the role of digital technologies in improving health outcomes and social participation among older adults; (2) to assess regional disparities in digital and health equity; and (3) to develop a conceptual model that integrates cultural, social, and technological perspectives into a cohesive framework for active ageing.

This chapter proposes the 'Ikigai Play' paradigm — a novel framework that connects health, digital equity, and citizenship with older adults' search for meaning and purpose. Drawing from extensive literature reviews conducted across eight European countries, we argue that Ikigai can serve as a transdisciplinary and humanistic lens for designing inclusive ageing policies and technologies. The global demographic transition toward an ageing population presents both challenges and opportunities for societies across Europe. As populations grow older, the pursuit of healthy and active ageing becomes not only a health imperative but also a social and economic necessity (World Health Organization, 2015). To navigate this shift, new paradigms are required — frameworks that not only support longevity but also emphasize purpose, connection, and wellbeing in later life (Foster & Walker, 2015).

In response to these imperatives, the Ikigai concept—originating from Japanese philosophy—has gained traction in Western health discourse as a model for promoting wellbeing among older adults (García & Miralles, 2017; Imai, 2018). Ikigai, loosely translated as "a reason for being," integrates personal fulfillment, community engagement, and a sense of meaning, making it a powerful lens through which to examine ageing policies and interventions (Sone et al., 2008).

European initiatives focused on active ageing have increasingly turned toward holistic approaches that incorporate psychological, social, and cultural factors (Walker, 2002; WHO, 2020). While biomedical models remain central to healthcare delivery, they are often insufficient to address the multidimensional aspects of ageing. Instead, interdisciplinary and participatory frameworks that center lived experience and purpose are gaining prominence (Buse, Martin, & Nettleton, 2018; Marston & van Hoof, 2019). As a dynamic and context-sensitive concept, *ikigai* also aligns with European ideals of active citizenship, where engagement in community, intergenerational solidarity, and digital participation contribute to a sense of purpose.

Against this backdrop, this chapter addresses the following research question: How can *ikigai* values and approaches be integrated with content on active and healthy ageing, digital transition, and European citizenship to develop a culturally appropriate training program for EU citizens over 65? In answering this question, we seek to bridge psychological well-being, technological innovation, and civic engagement through a unified, human-centered framework.

The chapter is structured as follows: Section 2 outlines the theoretical background, introducing core concepts such as eHealth, digital equity, health literacy, and Ikigai. Section 3 presents the methodology used in conducting a meta-narrative review. Section 4 synthesizes country-specific findings. Section 5

introduces the 'Ikigai Play' conceptual model. Section 6 discusses future research directions. Section 7 concludes with implications for policy, practice, and society. The last section lists the references used throughout the chapter.

2. LITERATURE REVIEW: DIGITAL TRANSFORMATION AND ACTIVE AGEING

This literature review first explores the theoretical foundations of healthy ageing and digital innovation, then focuses on the psychosocial relevance of ikigai, and finally synthesizes recent empirical and policy research across the European digital health landscape.

2.1 Conceptual Foundations: From Deficit to Purpose-Driven Ageing

This section lays the groundwork for the Ikigai Play framework by highlighting the shift from deficit-based to asset-based and purpose-driven approaches to later life. The theoretical framework for this chapter lies at the intersection of four core concepts: healthy and active ageing, digital health innovation, cultural models of wellbeing, and the Japanese concept of Ikigai. Each of these concepts has been studied in various disciplinary contexts, yet their integration remains underexamined in ageing policy and practice (Foster & Walker, 2015; Marston & van Hoof, 2019). As defined by the World Health Organization (WHO, 2015), Healthy and active ageing refers to the process of developing and maintaining the functional ability that enables wellbeing in older age. This approach represents a paradigmatic shift in gerontology and public health, emphasizing autonomy, participation, and functional capacity rather than the mere absence of disease (Steptoe & Fancourt, 2019). For training programs aimed at older adults, this perspective underscores the value of empowerment, engagement, and continuity across physical, social, and emotional domains.

Digital health innovation encompasses a range of technologies—from mobile health (mHealth) applications and telecare services to robotics and smart home ecosystems—that have the potential to support ageing in place, enhance autonomy, and increase access to care (Buse et al., 2018; Marston et al., 2020). However, these technologies often fail to address the sociocultural dimensions of ageing, such as identity, belonging, and a sense of purpose (Neven & Peine, 2017). Bridging this gap is essential for developing human-centered digital tools that are meaningful to diverse older populations. A 2022 scoping review by Kebede et al. further underscores this need by identifying the key barriers and facilitators of digital engagement among older adults. The study conceptualizes digital engagement as a three-stage continuum—from technological nonuse and initial adoption to sustained use. It found that the most cited barriers are a lack of capability (e.g., physical and psychological changes, lack of skill), opportunity (e.g., technological features, environmental context), and motivation (e.g., lack of perceived usefulness or confidence). These findings highlight the importance of designing tailored interventions that account for these intertwined factors, advocating for affordable, usable technologies and lifelong learning opportunities to empower older adults.

Cultural models of wellbeing, including ikigai, provide a more holistic understanding of health by integrating psychological and social factors. Ikigai, a Japanese term loosely translated as “reason for being,”, has gained prominence in global ageing discourses. It emphasizes meaning, connectedness, and personal fulfilment (García & Miralles, 2017; Nakanishi, 2019). It blends personal fulfillment, life

purpose, and community contribution. Empirical studies have associated Ikigai with increased longevity, mental health, and life satisfaction among older adults (Sone et al., 2008; Imai, 2018).

Recent research by Fukuzawa and Sugawara (2023) highlights that *ikigai*—defined not only as life satisfaction but also as perceived social roles and future orientation—plays a distinct role in wellbeing among older adults. They found that among Japanese individuals aged 75 and older, *ikigai* was significantly more sensitive to loneliness, social support, and participation than life satisfaction. Their findings support the idea that Ikigai uniquely integrates both hedonic and eudaimonic elements of wellbeing and may decline in contexts of low social engagement. Importantly, they found that social support and frequent participation buffered the negative effects of loneliness on ikigai, reinforcing its value as a psychosocial anchor for designing community and health interventions aimed at older adults. This enables a shift from deficit-based to opportunity-driven narratives of ageing, offering a humanistic anchor for innovation.

Furthermore, a 2024 study by Chen et al. demonstrated the efficacy of using a "teachable agent" to enhance Ikigai in seniors. Based on the "learning by teaching" theory, the study introduced a pedagogical agent named Akeso, which seniors could interact with and teach about health-related topics. A user study revealed that this interaction significantly enhanced the participants' sense of fulfilment, fostered a feeling of being needed, stimulated new life goals, and strengthened their self-esteem. The authors argue that by having older adults teach the agent, they experienced a sense of purpose and self-worth, which in turn improved their Ikigai. These findings suggest that human-agent interaction can be a powerful tool for developing interventions that address the psychosocial dimensions of ageing.

Digital Transformation in Health: Europe is experiencing a profound shift toward digital-first healthcare delivery through platforms such as electronic health records (EHRs), mobile health (mHealth), telemedicine, and integrated smart city ecosystems. These tools are designed to increase access, enhance continuity of care, and support data-driven decision-making. However, disparities in adoption remain, particularly among older adults with lower digital literacy or in rural and underserved regions. Addressing these inequities is crucial to ensuring that digital health tools benefit all citizens.

Healthy Life Years (HLY): Healthy Life Years (HLY), a key European Union indicator, measures not only longevity but also the quality of those additional years—free from disability and chronic illness. HLY is central to the EU's active ageing strategies and underlines the necessity of upstream investments in prevention, education, and community health. Integrating *ikigai* into such strategies helps extend their impact beyond physical health, toward purpose and quality of life.

Digital Health Equity and Health Literacy: Digital health equity refers to the fair and inclusive access to health technologies regardless of age, socioeconomic status, or location. Central to this is that health literacy—especially digital health literacy—is critical for ensuring individuals can engage meaningfully with new technologies. Evidence shows strong associations between health literacy and better self-care, chronic disease management, and psychological resilience. Embedding these capacities in training programs for older adults is essential for ensuring their inclusion in digital societies. The challenges identified in the Kebede et al. (2022) study, such as a lack of skills and motivation, are directly tied to the need for improved digital health literacy and equitable access to technology for all citizens.

Together, these interrelated domains provide a robust lens through which to analyze Europe's ageing transition—not only in clinical or technological terms, but as a cultural, ethical, and participatory endeavor. This section establishes the conceptual foundation for the proposed Ikigai Play framework by integrating these interrelated domains. It argues for a shift from deficit-based models of ageing toward asset-based and purpose-driven approaches that reflect the complex realities of older adults' lives across diverse European contexts (Walker, 2002; WHO, 2020).

While Section 2.1 established the theoretical pillars of a purpose-driven approach to ageing, the following section synthesizes how these principles interact with real-world digital health initiatives and governance frameworks across Europe

2.2 A Meta-Narrative of the European Digital Health Landscape

The digital transformation in health has accelerated in recent decades in Europe, driven by technological advances, policy guidelines, and the growing demand for more accessible, efficient, and equitable health systems. In this context, this narrative synthesis examines studies on the implementation of digital technologies such as eHealth, mHealth, telehealth, and smart cities, with an emphasis on promoting active ageing, digital inclusion, and equity for the elderly population. By integrating ethical, legal, financial, technological, and social dimensions, the aim is to understand the structural factors that condition a sustainable and inclusive adoption of these innovations, with a focus on the European context and complementary global references.

Health Outcomes and Digital Equity

Increased longevity is one of the factors driving the ageing of the European population; however, as Liotta et al. (2018) argue, this increase has not been accompanied by proportional gains in Healthy Life Years (HLY), showing ageing marked by fragility. The authors therefore recommend integrated prevention strategies, focusing on promoting healthy habits, combating social isolation, and strengthening digital literacy, emphasizing that the digital transformation in health will only be effective if aligned with education, inclusion, and health promotion actions.

Promoting digital equity is intrinsically linked to people's health literacy. This factor is particularly relevant in active and healthy ageing, as adequate levels of health literacy favor the appropriate use of services, informed decision-making, and autonomous health management.

Based on data from the SHARE project, Terraneo (2015) analyzed educational inequalities in the use of health services by people aged 50 and over in 12 European countries. The results indicate greater use of specialized and preventive services among individuals with more schooling, suggesting that education facilitates access. Tavares (2020), also using SHARE and the DESI index, found that elderly internet users reported better self-perceived health, especially in countries with less developed digital infrastructures.

Barriers and Challenges

Complementing this perspective, Bente et al. (2024) examine the legal, ethical, financial, and technological barriers to the adoption of eHealth in Europe. Legal barriers involve privacy and compliance with regulations such as the GDPR and MDR. Ethical challenges include informed consent and technological validation. Financial sustainability is limited by insufficient reimbursement models, while technical problems of interoperability, usability, and reliability prevail. The study reinforces the need for an integrated and collaborative approach.

Cibin (2023) draws attention to the risks of digital exclusion arising from technological acceleration. European policies, while recognizing this exclusion, tend to be limited to aspects of access and basic technical skills, neglecting socio-cultural barriers faced by vulnerable groups such as the elderly. The analysis of public policies and data from 30 European countries during the pandemic reveals that rapid digitalization has exacerbated inequalities by ignoring contextual needs and offering few analog alternatives.

Inequality also manifests in regional dynamics, as demonstrated by Caravella et al. (2023), who analyzed the distribution of digital skills in 179 European regions. They identified a strong regional polarization, where regions with high digital levels consolidate their advantage, while others face persistent difficul-

ties. This divergence has direct implications for equity in access to digital health. Gullslett et al. (2024), based on WHO data, reveal advances in the adoption of telehealth in Europe, driven by the pandemic. The main obstacles, however, include funding, infrastructure, and professional qualifications. The study highlights the lack of systematic evaluation of initiatives, which jeopardizes evidence-based expansion.

Strategic and Policy Frameworks

In a similar vein, Odone et al. (2019) discuss the strategic role of digital technologies in consolidating the fundamental principles of public health: quality, accessibility, efficiency, and equity. By analyzing the potential and challenges of digitizing European public health, the authors propose a framework that connects innovations such as genomics, artificial intelligence, big data, and mHealth to the fields of promotion, prevention, surveillance, and policy formulation. They highlight five characteristics with high transformative potential: personalization, automation, predictive capacity, data analysis (including interoperability), and interaction.

Bıçakçı (2024) analyze the Digital Europe program (2021-2027), which aims to achieve technological sovereignty for the European Union by investing in AI, high-performance computing, cybersecurity, digital skills, and digital public services. This program is presented as a strategy to consolidate a resilient digital ecosystem.

In the field of urban inclusion, Kolotouchkina et al. (2024) examine smart cities from the perspective of digital equity. The study critiques the technocentric focus of these initiatives, which often prioritize economic efficiency over social well-being, thereby widening existing inequalities. They propose a reflexive framework for inclusive governance to promote more equitable urban policies, guided by digital citizenship, active participation, and social justice.

Bousquet et al. (2015) and Bousquet et al. (2017) highlight the need for a standardized definition of "Active and Healthy Ageing" (AHA) and propose a multidimensional model based on physical, cognitive, and psychosocial capacities. They reinforce the importance of collaborative governance in health innovation. Finally, Falanga et al. (2020) analyzed 37 European initiatives for the civic participation of seniors, finding that most are consultative, while co-decisional forms—though less frequent—have greater potential for empowerment.

Specific Interventions and Tools

Jose et al. (2024) mapped 100 digital technologies for older people with neurocognitive disorders in Europe and Canada. They found that most solutions were not specific to these disorders and that only 28% had scientific evidence of effectiveness, highlighting the need for robust validation. Additionally, Spargo et al. (2021) present the European SHAPES project, which aims to develop an open digital platform to support active and healthy ageing through integrated technological solutions, particularly in supporting medication management among older adults with multimorbidity.

The wide-ranging literature reviewed in this section highlights a complex and fragmented landscape where digital health innovations often fail to align with the psychosocial needs of an ageing population. The presence of legal, ethical, and socio-cultural barriers, coupled with a lack of policy integration, underscores a significant gap between technological potential and real-world implementation. To address this complexity, the present study employs a meta-narrative review methodology, as detailed in the subsequent section. This approach is uniquely suited to synthesizing this diverse and multidisciplinary body of work, allowing us to move beyond siloed findings to identify overarching thematic patterns. By synthesizing the literature through the lens of the Ikigai Play framework and applying a country-specific analysis, our methodology aims to bridge the identified gaps and provide a more holistic, integrated understanding of how to foster purpose-driven and equitable ageing in the digital era.

3. METHODOLOGY

This chapter employs a meta-narrative review methodology, guided by the PRISMA framework for systematic reviews (Moher et al., 2009). This approach is particularly suitable for synthesizing diverse literature across disciplines, allowing the researcher to identify thematic patterns, conceptual shifts, and methodological tensions (Greenhalgh et al., 2005). The procedural steps for literature retrieval and analysis were detailed in a unified methodological guide to ensure a consistent approach among project partners.

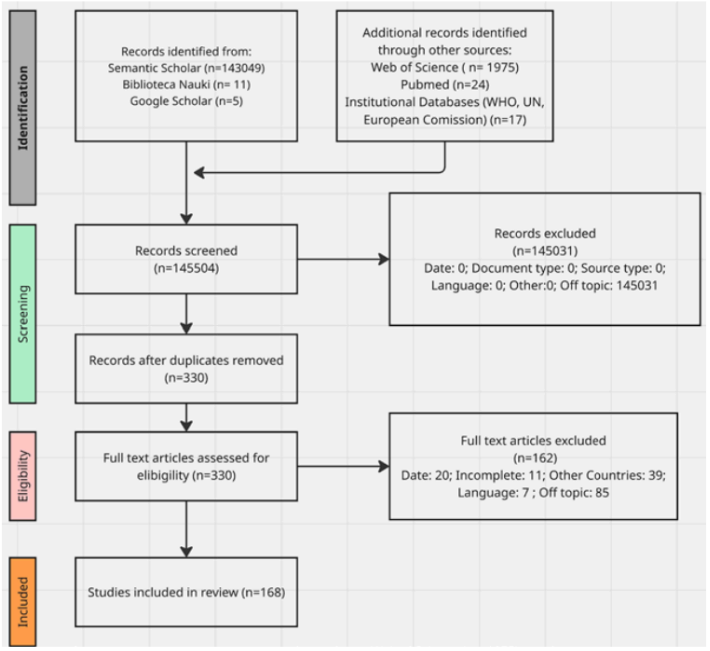
Eligibility criteria

The inclusion criteria for the review were: (i) written in English; (ii) full-text available in PDF format; (iii) conducted in a participating SmartAgeing project country; (iv) published within the last 10 years; and (v) addressed at least one of the core thematic axes (ikigai, eHealth, Healthy & Active Ageing, Digital Transition, Inclusion of Older Adults, European Citizenship). To ensure an exploratory and multidisciplinary perspective, no restrictions were placed on the type of document (e.g., scientific articles, reports, policy documents). The exclusion criterion was the failure to meet one or more of the inclusion criteria. All selected documents were read in full, and key information was extracted into a shared digital spreadsheet, General Catalog of Studies, for further thematic organization and analysis.

Information sources and search strategy

A structured search was conducted across academic databases including Scopus, Web of Science, and PubMed, as detailed in the PRISMA flowchart (Figure 1).

Figure 1. PRISMA flowchart outlining identification, screening, eligibility, and inclusion stages of literature selection



The keywords related to “ikigai,” “active ageing,” “digital health,” and “Europe.” Inclusion criteria focused on peer-reviewed studies published within the last 10 years with emphasis on cross-national European initiatives. Exclusion criteria included studies lacking methodological transparency or empirical grounding.

An initial pool of sources was gathered using academic databases (PubMed, Scopus, Google Scholar), project deliverables from the SmartAgeCare initiative, grey literature, and policy documents from EU and national bodies. Keywords included: healthy ageing, digital health, active ageing, eHealth, mHealth, citizenship, ikigai, and digital literacy.

Each partner was instructed to carry out an initial search using Semantic Scholar, which was selected for its open-access nature and broad disciplinary coverage. However, it was later realized that Semantic Scholar does not support Boolean operators, which necessitated a refined approach. Concurrently, each partner conducted complementary searches in national databases specific to their respective countries. Poland accessed the national scientific repository Biblioteka Nauki, while Latvia expanded its research using Google Scholar. As the coordinating partner, Portugal further expanded the scope by incorporating Web of Science and PubMed, along with institutional and policy-related databases such as WHO Europe, the United Nations, and the European Commission. This broadened the geographic and thematic coverage to include both national and European perspectives.

Notably, the original review protocol did not include the term ikigai among predefined keywords or thematic categories. As the review progressed, a need emerged to explore this concept in greater depth due to its conceptual alignment with the project's goals. Consequently, an additional exploratory search was conducted. Initial searches for ikigai in Semantic Scholar and Web of Science yielded limited results, indicating the need for a more comprehensive strategy. A refined and extended advanced search was then carried out on Web of Science and PubMed. The Web of Science was selected for its multidisciplinary nature, and the PubMed database was used to deepen the investigation of links between digital health and older adult well-being. All selected documents were read in full, and key information was extracted into a shared digital spreadsheet and the Notion platform for further thematic organization and synthesis. The final set of 60+ sources was included across the eight European countries (Figure 2). These were synthesized narratively within country-specific profiles, and the ikigai literature, largely from Japan, was reviewed separately and integrated conceptually. Thematic axes—health, digital transition, and citizenship—structured the synthesis.

Figure 2. Papers by Country

Number of Papers by Partner

	Belgium	Cyprus	Germany	Italy	Latvia	Poland	Portugal	Slovenia	TOTAL
Papers **Before** Filtering	338	110	138 866	414	1 314	666	2 661	248	144 876
Papers **After** Filtering	22	11	66	17	33	26	199	12	386
Papers **After** Duplicates	20	11	56	14	32	14	161	9	317

- **Step 1: Identification**

An initial pool of sources was gathered using academic databases (PubMed, Scopus, Google Scholar), project deliverables from the SmartAgeCare initiative, grey literature, and policy documents from EU and national bodies. Keywords included: *healthy ageing*, *digital health*, *active ageing*, *eHealth*, *mHealth*, *citizenship*, *ikigai*, and *digital literacy*.

- **Step 2: Screening**

Duplicate entries were removed, followed by a title and abstract screening to assess relevance. Inclusion criteria: (1) published between 2015–2025; (2) focused on older adults or ageing; (3) related to digital health, well-being, citizenship, or purpose. Exclusion criteria included language barriers (non-English/Portuguese), lack of full-text access, or limited empirical detail.

- **Step 3: Eligibility**

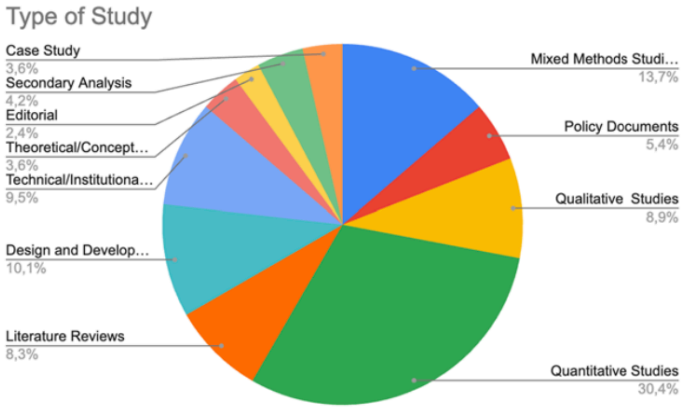
Full-text articles were then assessed for eligibility. Studies were categorized by country, methodology (quantitative, qualitative, mixed), and thematic relevance (digital access, health outcomes, social participation, psychosocial models).

- **Step 4: Inclusion and Synthesis**

A final set of over 60 sources was included across the eight European countries. These were synthesized narratively within country-specific profiles. The Ikigai literature, largely from Japan, was reviewed separately and integrated conceptually. Thematic axes—health, digital transition, and citizenship—structured the synthesis.

Data extraction followed PRISMA guidelines and incorporated thematic synthesis techniques as outlined by Thomas and Harden (2008). Each study was coded according to population, intervention, context, and outcomes, enabling comparative analysis across different health systems and cultural settings. Documents were grouped thematically for analysis, based on their alignment with the core domains.

Figure 3. Types of Study



The study types were classified based on the methodologies explicitly stated in the publications. In cases where the methodology was not clearly specified, an informed classification was conducted by the researchers (Figure 3).

Based on the provided data, the global distribution of study types is dominated by quantitative research, which accounts for the largest share at 30.4%. Following this, mixed methods studies represent a significant portion at 13.7%, indicating a strong preference for research that combines both quantitative and qualitative approaches. Other notable study types include design and development (10.1%), technical/institutional (9.5%), and qualitative studies (8.9%). The remaining categories, which each make up less than 10% of the total, include literature reviews (8.3%), policy documents (5.4%), secondary analysis (4.2%), as well as a small number of theoretical/conceptual studies (3.6%), case studies (3.6%), and editorials (2.4%).

The results confirm that this approach yielded a robust and multidisciplinary literature review grounded in empirical evidence. The distribution of study types—quantitative, mixed methods, design/development, and qualitative—demonstrates that the review captures a comprehensive spectrum of research. It reflects not only statistical rigor but also practical applicability and contextual understanding.

Ethical considerations were addressed by following the principles of informed consent, data anonymization, and responsible reporting, in line with the Helsinki Declaration (World Medical Association, 2013).

This PRISMA-informed approach supports clarity in the review process and facilitates cross-country comparison while respecting contextual specificity. It also accommodates diverse types of evidence, aligning with the transdisciplinary goals of the SmartAgeCare project.

4. RESULTS AND SYNTHESIS

This section presents a meta-narrative synthesis of the literature, exploring key findings across different European countries and their connection to the ikigai paradigm. The analysis highlights regional

disparities, digital inclusion, health promotion, and the potential for ikigai as a unifying framework for health, digital transition, and citizenship goals.

4.1 Ikigai Literature Review

The meta-narrative synthesis revealed four primary clusters of empirical research related to the ikigai paradigm and healthy ageing: (1) longitudinal cohort studies from Japan, (2) cross-national studies comparing European and Japanese populations, (3) psychometric evaluations of ikigai-related instruments, and (4) technology-supported ageing interventions.

Studies from Japan, such as the Ohsaki Cohort Study, have consistently demonstrated a positive correlation between ikigai and longevity, with findings suggesting that older adults who report a strong sense of purpose have significantly lower mortality rates (Sone et al., 2008). Similarly, longitudinal analyses by the Japan Gerontological Evaluation Study (JAGES) reinforce the importance of psychological and social determinants in health outcomes among older populations (Kondo et al., 2009).

Cross-national studies conducted in Portugal, Germany, and the United States have attempted to validate the ikigai-9 instrument in Western contexts, showing moderate to strong reliability and construct validity (Fido et al., 2019; Schnell, 2020). These studies highlight the cultural adaptability of the ikigai construct, while also revealing nuances in how purpose and fulfilment are culturally expressed.

In these countries, ikigai is adapted to reflect purpose through work, recognition, or personal fulfillment. Digital tools supporting ikigai include conversational AI, learning platforms, and therapeutic games; however, ethical concerns—such as dependency and data privacy—remain. The integration of ikigai with technology must respect cultural expectations, focusing on user-centered, values-driven design.

Standardized psychometric tools such as the Geriatric Depression Scale (GDS-15), Mini-Mental State Examination (MMSE), and Purpose in Life Test (PIL) have been used in tandem with ikigai measures to explore mental health correlations (Yesavage et al., 1982; Ryff & Keyes, 1995; Lawton et al., 2002). For instance, findings from SmartAgeCare pilot studies in Ireland and Portugal indicate that digital interventions can improve cognitive scores and ikigai-related outcomes among older adults.

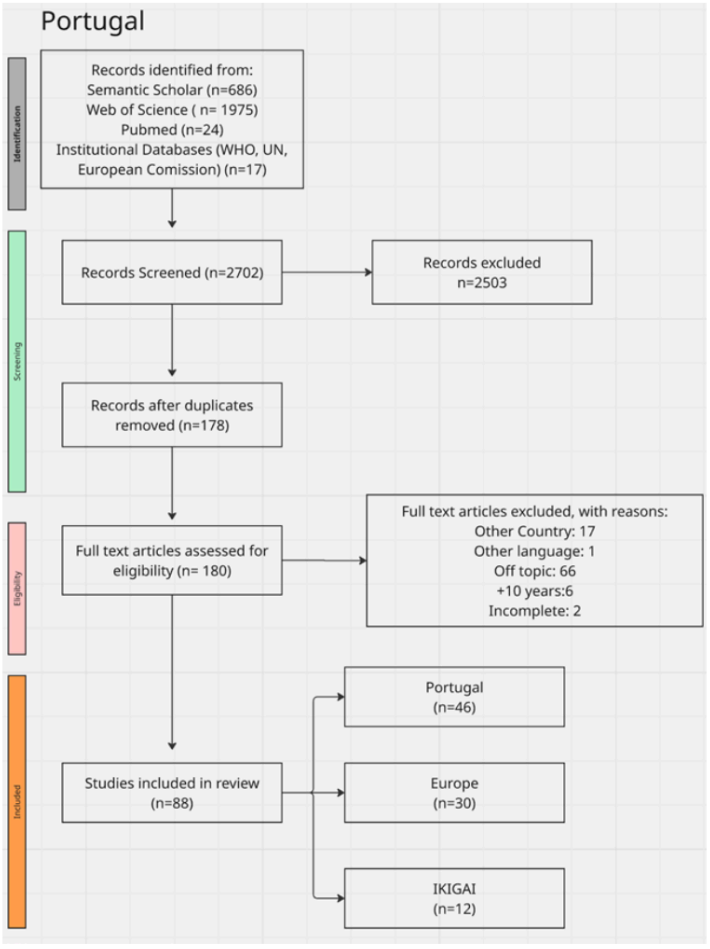
The synthesis also indicates a growing trend toward integrating social technologies into healthy ageing strategies. Social participation, emotional bonds, and health behaviors reinforce ikigai. Community-based programs like the Chofu-Digital-Choju Movement integrate digital and in-person socialization to boost subjective well-being. Cultural differences are evident: Japanese participants embrace assistive technologies like social robots more openly than Western counterparts, where autonomy and privacy concerns dominate. Initiatives in Sweden, the Netherlands, and Denmark have incorporated serious games, digital storytelling, and social robots into elder care programs with measurable psychosocial benefits (Neven & Peine, 2017; Marston et al., 2020). These approaches align with the ikigai Play framework by emphasizing engagement, creativity, and meaning-making in later life.

Overall, the findings suggest that the ikigai paradigm is not only measurable and transferable across cultures, but also offers a promising framework for aligning digital innovation with well-being–enhancing strategies that foster purpose, motivation, and healthy ageing across cultures supporting ageing populations in a more human-centered and purposeful manner.

4.2 Portugal

The methodological analysis of studies related to Portugal includes a total of 82 initially identified documents, of which 36 were excluded based on pre-established criteria. The main reasons for exclusion were: different country of origin (n=17), lack of adherence to the topics (off-topic; n=12), publication prior to the 10-year time limit (n=4), incomplete document (n=1), and incompatible language (n=1). Thus, 46 studies were deemed eligible and included in the final analysis (Figure 4).

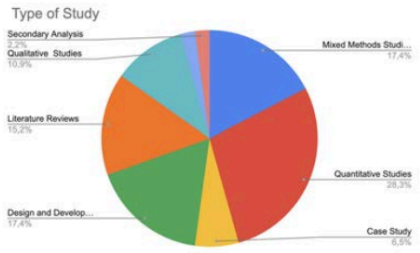
Figure 4. PRISMA, Portugal



Among the included studies, there is a predominance of quantitative approaches (28.3%), followed by mixed-methods studies (17.4%) and design and development research (17.4%). Literature reviews accounted

for 15.2% of the sample, while qualitative methods represented 10,9%. Case studies (6.5%), one public policy document (2.2%), and one secondary data analysis (2.2%) were also identified, demonstrating the diversity of Portuguese scientific output in the field of active ageing and digital inclusion (Figure 5).

Figure 5. Types of Data Resources in Portugal



Portugal presents a complex case for active ageing due to persistent inequalities in income, health, and digital literacy (Eurostat, 2022). Older adults, especially in rural areas, face limited access to digital infrastructure and public health services (Loureiro et al., 2021). Nonetheless, regional projects like Ageing@Coimbra and +TV4E have made significant strides in promoting digital inclusion among elderly populations (Barros et al., 2020). The AGAPE initiative in Lisbon illustrates how digital storytelling and social technologies can enhance wellbeing and a sense of purpose among older adults (Ferreira et al., 2018).

Portugal is facing one of the most significant ageing transitions in Europe, marked by increased longevity and declining birth rates. Between 2010 and 2019, life expectancy at age 60 rose— from 23.1 to 24.3 years— but, this was accompanied by a decline in health-related quality of life (HRQoL), particularly among older individuals with multimorbidity and excess weight. Education and physical activity have been shown as protective factors, while self-perception of health reveals gender differences, with women reporting worse health but greater engagement in active ageing activities.

Beyond clinical metrics, ageing in Portugal is shaped by psychosocial determinants. Mental health and subjective well-being, especially after age 75, emerge as stronger predictors of active ageing than physical conditions. Longitudinal evidence links anxiety and depression to lower quality of life, while retirement stress impacts life purpose. These findings affirm the 'ageing paradox'—a tendency for subjective well-being to remain stable or even improve with age.

Portugal's social networks among older adults are categorized into family, friendship, neighborhood, and institutional ties, with varying degrees of emotional and practical support. Yet, over 1.2 million Portuguese seniors live alone or only with other elderly people, increasing risks of isolation and institutionalization, particularly in rural areas. Community initiatives show promise but struggle against demographic decline. Programs like Ageing@Coimbra embody intersectoral strategies through mobile units, brain health education, and citizen engagement. Participants have acknowledged improvements in health and support services but also point out gaps in housing and social participation.

Despite progress, national policy remains fragmented. Only 4.3% of Portuguese municipalities have local ageing plans. The national system is marked by weak coordination, low effectiveness, and heavy reliance on informal networks. The COVID-19 pandemic exposed these vulnerabilities but also

spotlighted new directions in digital health, like telemedicine, user portals, and mobile applications. However, there is still no structured national strategy for using big data, and the regulation of wellness apps remains underdeveloped.

Digital literacy is a crucial enabler for active ageing. Programs like AUDID and OITO have increased older adults' confidence with digital tools, though gains in health literacy were limited. Television-based platforms (e.g., +TV4E) show promise by aligning with familiar user habits. Yet barriers persist, including sensory limitations, design mismatches, and trust in digital services. Effective strategies include tailored pedagogies, simplified interfaces, and long-term user support.

The role of mHealth is also expanding. Apps that deliver short videos or reminders have been shown to improve adherence and knowledge. Training caregivers through platforms like Help2CARE indirectly benefits elderly users. Game-based solutions are another frontier—digital games have shown potential for supporting mental health, emotional expressiveness, and social connectedness. Platforms developed by Costa et al. and Regalado et al. improved mental health indicators and digital skills aligned with EU standards (e.g., DigComp).

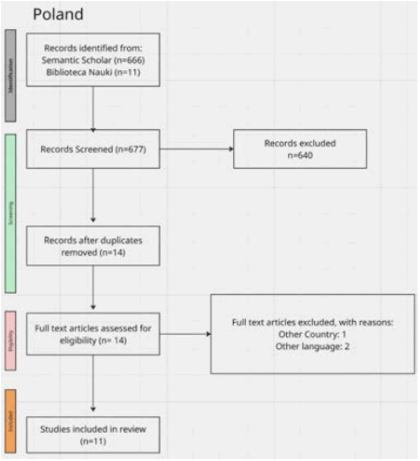
Portugal is also leading the way in smart health ecosystems. Projects like AGAPE and My-AHA integrate IoT and predictive analytics to personalize monitoring and care. Other platforms, such as CoaFEld and HELASCOL, blend AI, gamification, and environmental data. These systems share a commitment to co-design and usability evaluation with and for the elderly.

Ultimately, ageing in Portugal is a multidimensional experience shaped by intersecting physical, digital, and psychosocial factors. Despite a strong research ecosystem and innovative practices, national fragmentation hinders widespread impact. Bridging digital and social inclusion with culturally sensitive design—especially through concepts like ikigai—can offer pathways to more purposeful, connected, and equitable ageing futures.

4.3 Poland

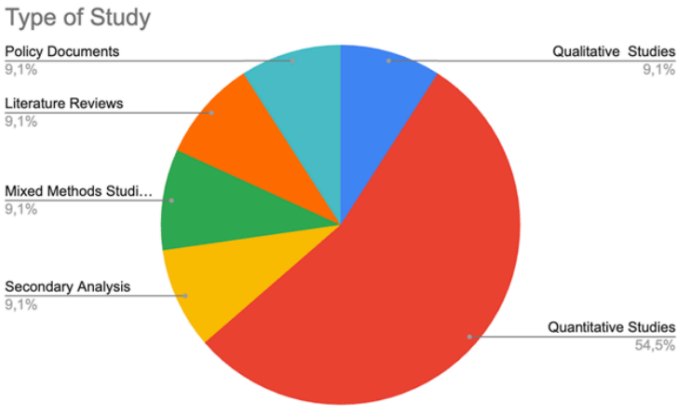
Of the 14 articles initially selected for full-text reading, 11 met the eligibility criteria: publication within the last 10 years, written in English, authorship linked to Poland, and relevance to at least one of the central themes of the review *(e-health/digital health, healthy & active ageing, digital transition, digital inclusion, citizenship, and ikigai).* The three excluded studies were removed for the following reasons: one was conducted in other countries, and two were written in a language other than English (Figure 6).

Figure 6. PRISMA, Poland



The analysis of these studies revealed a clear predominance for quantitative methods, which represented 54.5% of the total sample. The remaining studies were evenly distributed, at 9.1% each, among qualitative research, literature reviews, policy analyses, mixed methods, and secondary data studies. This distribution is shown in Figure 7, highlighting the central role that statistical and numerical approaches still play in the Polish academic production related to digital inclusion and ageing.

Figure 7. Types of Data Resources in Poland



Poland's ageing population faces systemic health inequalities and fragmented care services, particularly in post-industrial regions (OECD, 2021). While digital health strategies have been introduced, implementation is uneven. Local projects such as "Aktywni+" and Senior+ initiatives emphasize digital education and intergenerational activities that align with the ikigai model by fostering social connection and purpose (Kubiak, 2020). However, high levels of ageism and limited digital trust remain key challenges (Domagała & Wilk, 2020).

Poland is undergoing rapid demographic ageing, marked by regional imbalances and structural limitations in health, social services, and digital infrastructure. Rural areas such as the Opole Voivodeship face population shrinkage, prompting calls for "silver economy" strategies to view ageing as an opportunity. Despite progress in eHealth policies, digital literacy among older adults remains low, and inequalities in access are widespread, especially between regions.

Studies reveal that digital inclusion supports mental well-being. For example, internet use among older adults correlates with reduced depression symptoms, particularly for those living alone. Participation in lifelong learning programs, such as Universities of the Third Age, plays a critical role in boosting ICT skills and digital confidence. Factors influencing digital health acceptance include perceived usefulness, ease of use, and social influence—core dimensions of the UTAUT model.

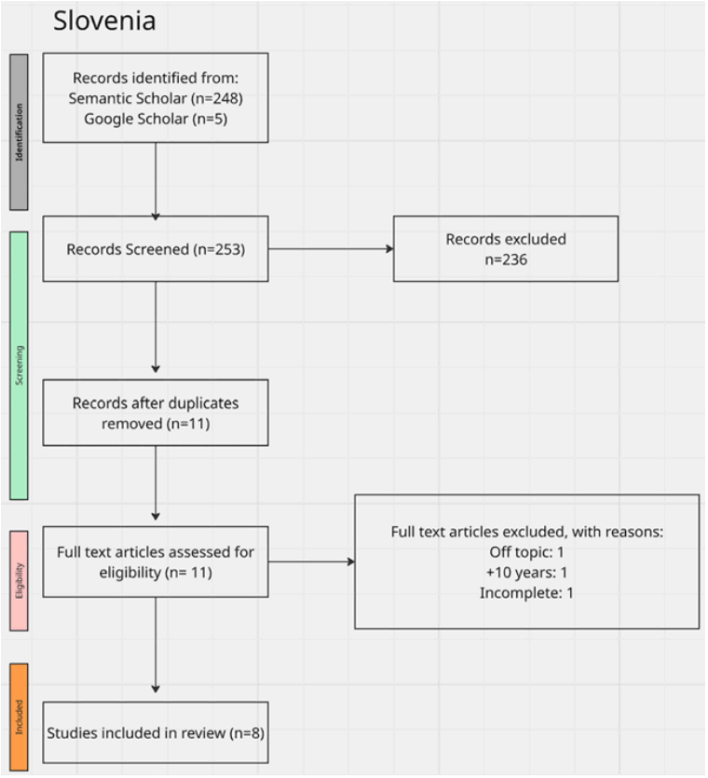
Local governments play a mixed role in promoting active ageing, with some initiatives in small towns fostering healthy lifestyles despite limited budgets. However, smart ageing strategies are underutilized, and there is often a disconnect between digital and social policies. Policy analysis reveals fragmented governance, weak integration of health and digital strategies, and a lack of funding for age-friendly infrastructure.

Cultural values and priorities are central. Older adults value independence, privacy, strong social connections, and access to healthcare—values that shape their willingness to engage with digital tools. Poland's digital health transformation, while promising, requires deeper alignment with these individual motivations and regional needs, ensuring equity and long-term effectiveness.

4.4 Slovenia

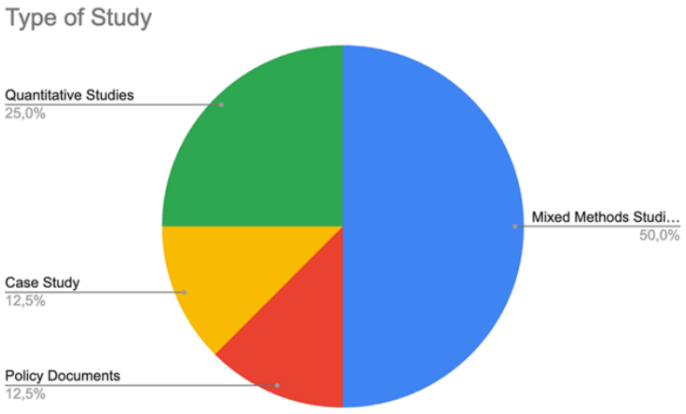
Of the 11 articles initially selected for full-text reading, 8 met the eligibility criteria: publication within the last 10 years, written in English, authorship linked to Slovenia, and relevance to at least one of the central themes of the review (e-health/digital health, healthy & active ageing, digital transition, digital inclusion, citizenship, and ikigai). The three excluded studies were removed for the following reasons: one was considered off topic, one was published more than 10 years ago, and one was incomplete (Figure 8).

Figure 8. PRISMA, Slovenia



A methodological analysis of these 8 selected studies revealed that mixed methods designs were predominant, accounting for 50% of the sample (Figure 9). These studies combined qualitative and quantitative techniques with the aim of capturing both measurable results and the depth of individual and contextual experiences. In addition to the mixed-methods studies, 25% of the sample was made up of quantitative investigations, and the other types of studies were case study (12.5%) and also policy document (12,5%).

Figure 9. Types of Data Resources in Slovenia



In Slovenia, active ageing policies are integrated into broader national health and innovation frameworks (European Commission, 2020). Programmes like "Simbioza" have successfully increased digital competence among older people by encouraging intergenerational mentoring (Novak et al., 2017). Studies indicate that Slovenian older adults value ikigai-related domains such as autonomy and social participation, although rural-urban disparities persist (Hribernik & Dolničar, 2019).

Slovenia demonstrates considerable progress in digital health, characterized by robust electronic health records (EHR), integrated patient data platforms like zVEM, and national registries such as CRPD. During the COVID-19 pandemic, these tools proved essential, although limitations remain in infrastructure, professional training, and user digital skills.

Mixed-methods research reveals strong civic engagement in digital design, such as gardening apps co-created with older users and intergenerational mentorships where senior entrepreneurs support young NEETs. These programs foster well-being and social inclusion across age groups.

Social isolation and unhealthy behaviors remain challenges, especially in home care environments. Preferences lean toward informal caregiving, with low coverage of formal services. Despite campaigns like the European Year for Active Ageing (2012), long-term care reform remains stalled. Less than 3% of older people receive home care.

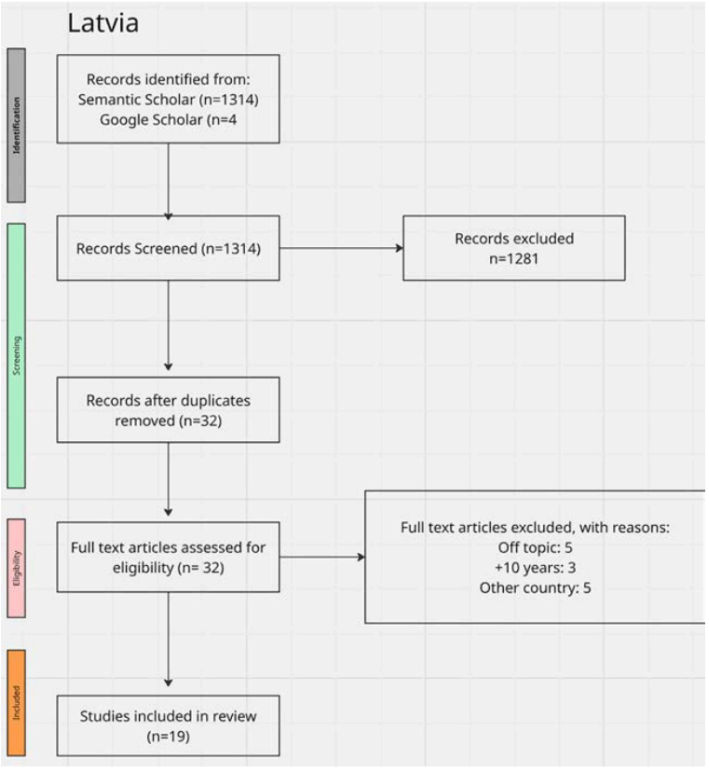
Slovenia's strategic direction is promising, but implementation requires better coordination and evaluation. Bridging digital literacy gaps, supporting caregivers, and expanding inclusive participation are key to sustaining progress in active ageing and digital equity.

4.5 Latvia

Of the 32 articles initially selected for full-text reading, 19 met the eligibility criteria: publication within the last 10 years, written in English, authorship linked to Latvia, and relevance to at least one of the central themes of the review *(e-health/digital health, healthy & active ageing, digital transition, digital inclusion, citizenship, and ikigai).*The thirteen excluded studies were removed for the following

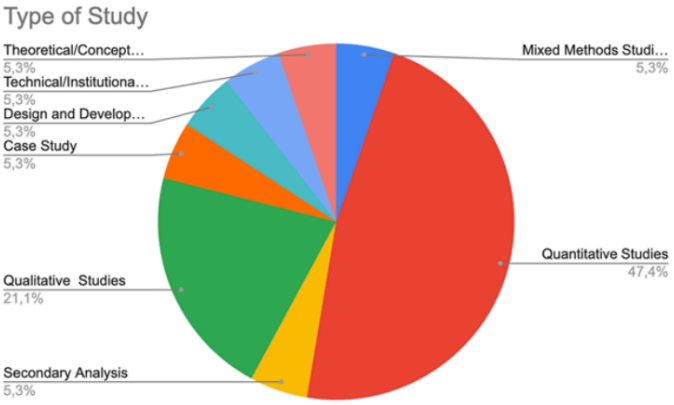
reasons: five were conducted in other countries, five were considered off topic, three were published more than 10 years ago, and four were written in a language other than English (Figure 10).

Figure 10. PRISMA, Latvia



The methodological review of the 19 selected studies from Latvia highlights a clear predominance of quantitative research (47.4%), qualitative designs accounted for 21.1%. Additional contributions included a mixed methods study, a case study, a design and development, a secondary analysis, a theoretical/conceptual studies and a technical/institutional each representing 5.3% of the total (Figure 11).

Figure 11. Types of Data Resources in Latvia



Latvia faces demographic decline and high rates of elderly poverty, particularly in rural regions (European Commission, 2021). Access to digital technologies and health services remains uneven, despite national eHealth initiatives. Local programs like "Senioru Skola" aim to enhance digital skills among older adults, promoting a sense of community and purpose (Ozola & Lapiņa, 2020). However, structural barriers such as broadband infrastructure gaps persist.

Latvia faces stark structural inequalities shaping the experience of ageing, especially along dimensions of geography, education, and ethnicity. Older adults in rural regions experience social exclusion, economic precarity, and poor digital access. Despite these challenges, Latvia has made strides in eHealth infrastructure, telemedicine, and patient portal expansion, particularly following the COVID-19 pandemic.

Research shows that digital skills among older Latvians are generally low, but peer-led and intergenerational learning methods are effective. Civic engagement is closely linked to perceived health and autonomy. Projects like "Connect, Latvia!" aim to boost digital citizenship in regions impacted by youth migration and ageing.

The economic need drives many seniors to remain in or return to the workforce. However, this does not necessarily reflect active ageing but rather financial insecurity. Retirement migration to other EU countries is also common.

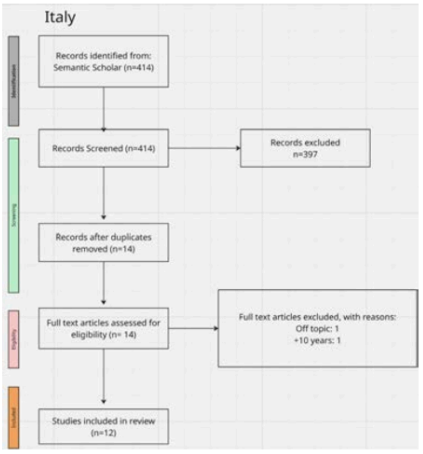
Care initiatives—such as intergenerational programs in care homes—show emotional and cognitive benefits but are often underfunded. Overall, Latvia shows potential for transformative ageing strategies, but current efforts remain fragmented and unevenly distributed across the country.

4.6 Italy

Of the 14 articles initially selected for full-text reading, 12 met the eligibility criteria: publication within the last 10 years, written in English, authorship linked to Italy, and relevance to at least one of the central themes of the review *(e-health/digital health, healthy & active ageing, digital transition, digital

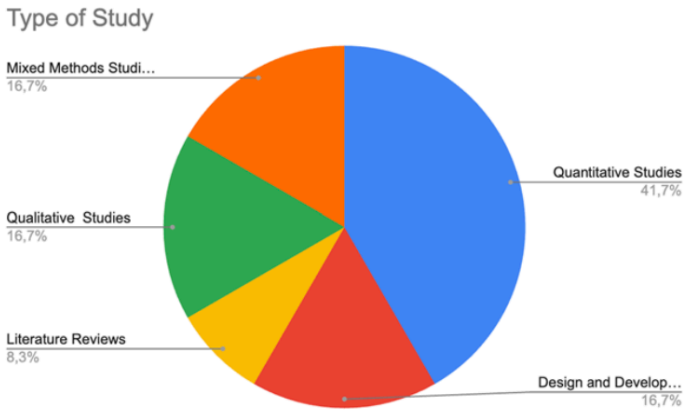
inclusion, citizenship, and IKIGAI).*The two excluded studies were removed for the following reasons: one were considered off topic, one were published more than 10 years ago (Figure 12).

Figure 12. PRISMA, Italy



The methodological analysis of the 12 selected records indicates a predominance of quantitative studies, representing 41.7% of the total. Mixed methods, qualitative, and design and development studies each accounted for 16.7% of the records. One literature review (8.3%) (Figure 13).

Figure 13. Types of Data Resources in Italy



Italy's ageing population reflects strong intergenerational caregiving practices but also significant regional disparities in access to care and technology (ISTAT, 2021). Northern regions demonstrate higher uptake of telemedicine and social innovation platforms, whereas southern areas lag behind (Santoni et al., 2015). Community-based digital storytelling projects, such as "Nonni Digitali," have fostered a sense of ikigai among participants by highlighting meaningful life narratives and intergenerational.

Italy's ageing population is one of the oldest globally, with over 23% aged 65 or older. Challenges include limited digital literacy among older adults and pronounced regional disparities in healthcare and connectivity. Rural regions, especially in the South, face systemic exclusion from eHealth and digital services.

Policy responses include national telemedicine initiatives and regional eHealth portals, but implementation is inconsistent. Civic participation in digital design remains limited. Cultural norms around familial caregiving dominate, placing stress on informal carers without adequate state support.

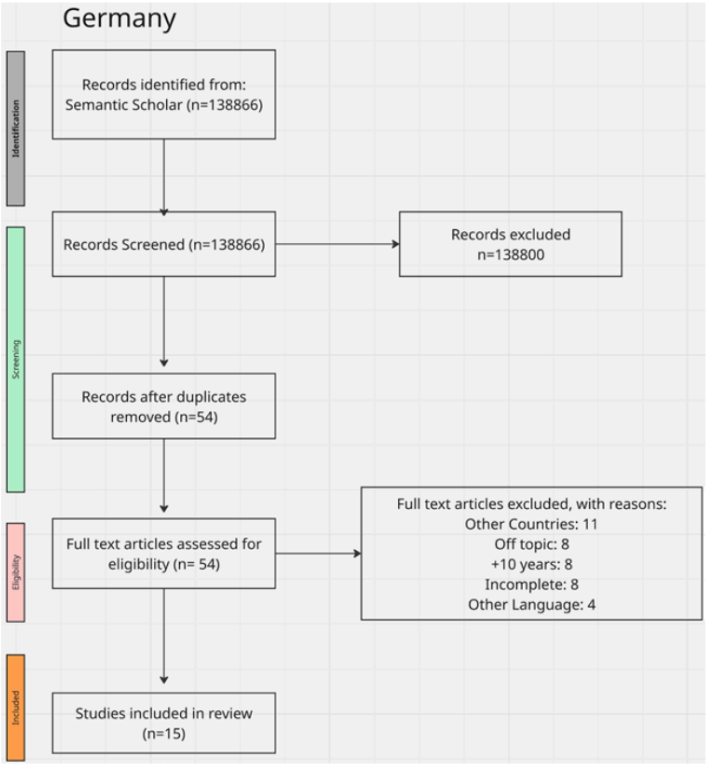
Educational attainment and socioeconomic status greatly influence digital engagement. Projects addressing digital inclusion through intergenerational learning and community hubs have shown promise but lack national scale.

Italy's success in ageing well will depend on bridging North-South divides, investing in digital health infrastructure, and fostering inclusive models that respect local culture while empowering older adults through purpose and agency.

4.7 Germany

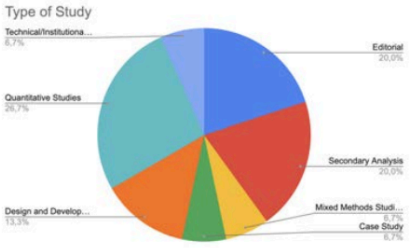
From the initial selection of 54 full-text articles, 15 met the eligibility criteria: published within the last 10 years, written in English, authored or co-authored by researchers affiliated with institutions in Germany, and aligned with at least one of the central themes of this review (e-health/digital health, healthy & active ageing, digital transition, digital inclusion, citizenship, and ikigai). The thirty-nine excluded studies were removed for the following reasons: thirteen were conducted in other countries, eight were considered off topic, eight were published more than 10 years ago, eight were incomplete, and four were written in a language other than English.

Figure 14. PRISMA, Germany



The methodological overview of the 15 studies from Germany reveals notable diversity, with a predominance of quantitative approaches (26.7%), followed by editorials and secondary analyses (20% each). Design and development studies accounted for 13.3%, while mixed methods, conceptual, institutional, and case studies each represented 6.7% of the total (Figure 15).

Figure 15. Types of Data Resources in Germany



Germany has a robust ageing policy landscape supported by strong institutional frameworks and funding mechanisms (BMFSFJ, 2020). Nevertheless, disparities persist between urban and rural regions in terms of digital inclusion and healthcare access. The "DigitalPakt Alter" program is one of the flagship initiatives aimed at bridging these gaps through community-based digital learning centers for older adults (von Eitzen et al., 2021).

Germany offers one of the most advanced healthcare systems in Europe, with substantial investment in eHealth, yet ageing populations still face gaps in digital inclusion. A strong federal system results in regional differences in implementation.

SHARE data indicates that education, income, and region significantly affect seniors' access to digital tools and healthcare. Ikigai-relevant research shows that health and close relationships are predictors of life satisfaction, with German seniors scoring high on valuation of life (VOL).

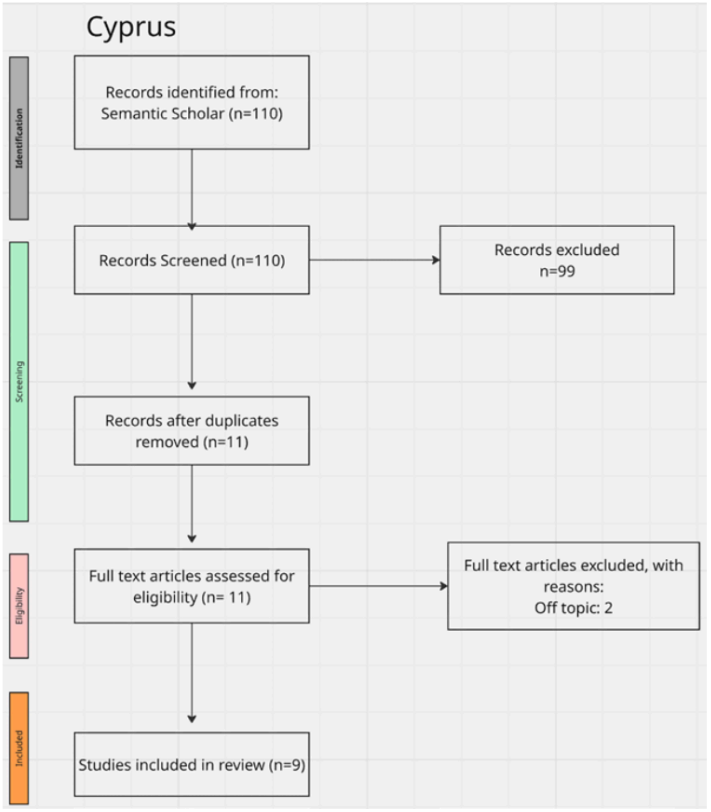
Digital health initiatives include smart health cards, patient portals, and regional telemedicine networks. Public awareness campaigns and senior-focused education programs have made strides in improving digital engagement.

However, barriers persist: older adults with lower socioeconomic status are underrepresented in digital transformation. Integrating psychosocial models like ikigai into Germany's healthcare narrative can help address subjective well-being and participation more holistically.

4.8 Cyprus

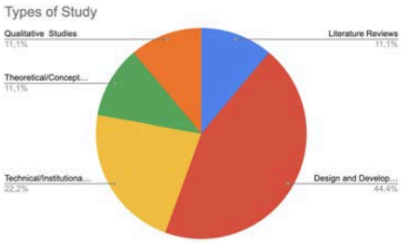
Of the 11 articles initially selected for full-text reading, 9 met the eligibility criteria: publication within the last 10 years, authorship linked to Cyprus, and relevance to at least one of the central themes of the review *(e-health/digital health, healthy & active ageing, digital transition, digital inclusion, citizenship, and ikigai)*. The two excluded studies were removed for the following reasons: two were considered off topic.

Figure 16. PRISMA, Cyprus



The analysis of the 9 selected records reveals a predominance of design and development studies, representing 44.4% of the total. Technical and institutional reports account for 22.2% of the records. The remaining studies are distributed between qualitative studies (11.1%), teoreticat/concepts (11,1%) and literature review (11.1%) (Figure 17).

Figure 17. Types of Data Resources in Cyprus



Cyprus faces a unique blend of rural ageing, high dependency ratios, and fragmented service delivery systems (European Commission, 2022). While digital literacy among older adults remains limited, EU-funded programs such as "e-Inclusion" and "Active Ageing Cyprus" have begun addressing this gap (Theodoulou-Loizidou et al., 2020). Studies report that Cypriot elders place strong emphasis on family, spiritual engagement, and meaningful routines—key tenets aligned with ikigai values (Kouta & Kaite, 2011).

Cyprus is experiencing steady demographic ageing, particularly in rural and semi-urban areas. The health system is undergoing reform, including efforts to expand digital services, yet older adults face persistent challenges in access and usability.

Digital health adoption is growing, driven by new platforms and EU-funded projects. However, health literacy and confidence with digital tools remain low, especially among those over 70. Regional inequality, language diversity, and underdeveloped public transport hinder inclusion.

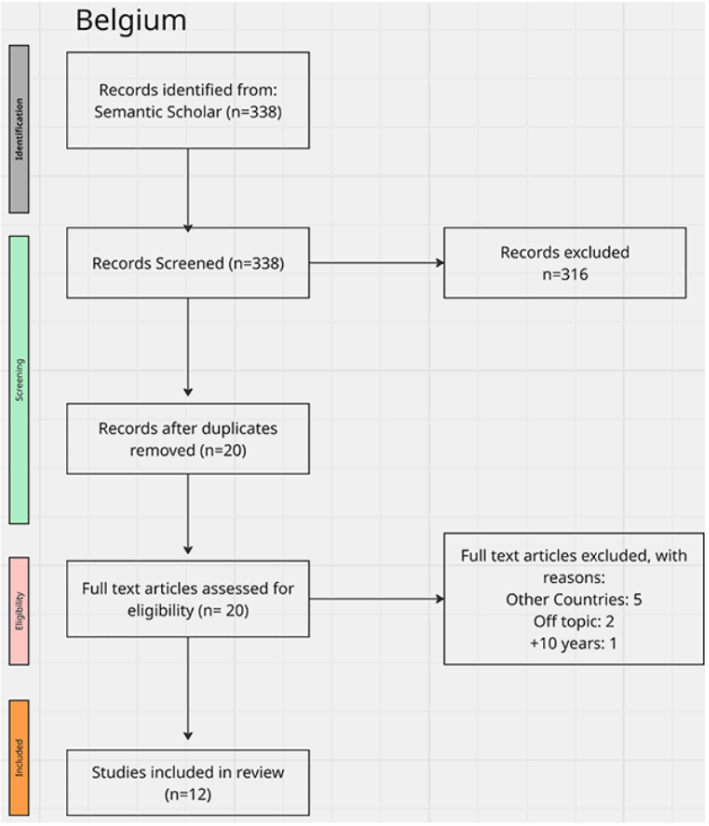
Community-based programs, including senior centers and digital literacy workshops, have shown effectiveness in bridging gaps. Cross-generational learning and gamified apps are emerging as key tools.

To align with European active ageing goals, Cyprus must invest in user-centered digital solutions, enhance caregiver support, and tailor interventions that emphasize meaning, interdependence, and social connectivity—aligning with ikigai principles.

4.9 Belgium

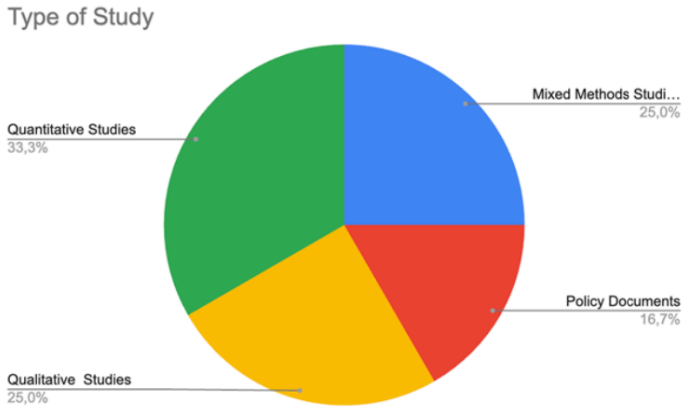
Of the 20 articles initially selected for full-text reading, 12 met the eligibility criteria: publication within the last 10 years, written in English, authorship linked to Belgium, and relevance to at least one of the central themes of the review *(e-health/digital health, healthy & active ageing, digital transition, digital inclusion, citizenship, and IKIGAI).* The seven excluded studies were removed for the following reasons: five were conducted in other countries, two were considered off topic, and one was published more than 10 years ago (Figure 18).

Figure 18. PRISMA, Belgium



The methodological analysis of the 12 studies from Belgium indicates a predominance of quantitative approaches (33.3%), followed by mixed methods and qualitative designs (25% each), and public policy analyses (16.7%) (Figure 19).

Figure 19. Types of Data Resources in Belgium



Belgium's digital health landscape is well-developed, with coordinated public policies and technology initiatives. The national digital health strategy, combined with robust regulations, supports large-scale services such as telehealth and patient portals.

A key focus is on solutions co-created with users, aligning with citizen-centered design. Studies demonstrate how regional projects and data utilization can influence policy and practices, thereby improving care integration and participation.

Digital applications emphasize subjective well-being, promoting autonomy and creating new opportunities for older adults. The integration of digital tools with social networks is also a key theme, with one study demonstrating that internet use significantly mitigates feelings of loneliness.

However, barriers to access and use remain, particularly for older adults with cognitive impairments. Challenges related to ageism and health literacy can compound exclusion. The need for ongoing adaptation to users' evolving needs is also a recognized challenge.

In summary, Belgium stands out for its technological infrastructure and its integration with public policies and user-focused research. The country's ecosystem offers insights into creating inclusive, adaptive, and supportive digital systems for lifelong well-being, with strong ties to the pillars of ikigai.

This section synthesizes literature across eight European countries and ikigai-specific studies. The analysis highlights regional disparities, digital inclusion, health promotion, and the potential for ikigai as a framework to unify health, digital transition, and citizenship goals.

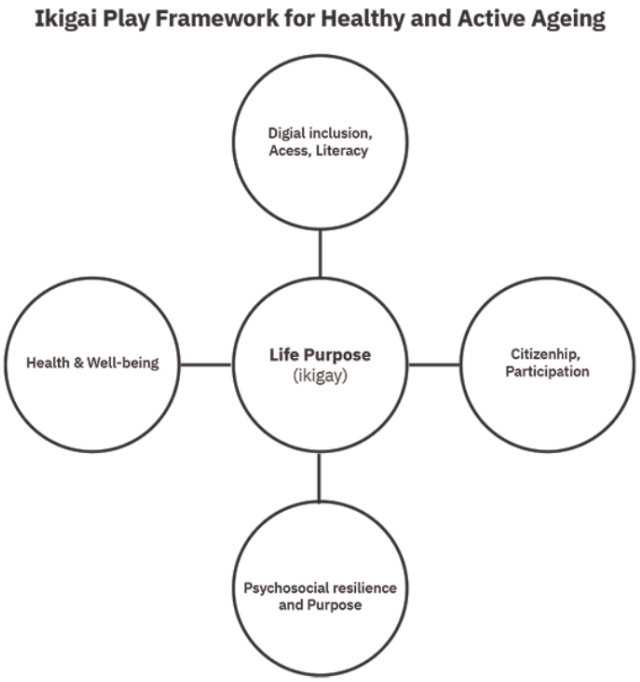
A summary of findings, reflection on the 'Ikigai Play' paradigm as a response to ageing inequalities, and implications for European policy and innovation.

5. DISCUSSION

The analysis of ikigai-related initiatives across diverse European contexts highlights both shared challenges and context-specific innovations. The findings of this chapter suggest that national health

systems, digital infrastructures, and sociocultural norms have a profound impact on the ageing experience in Europe. Across the eight countries reviewed, distinct patterns emerge that influence how purpose, participation, and digital health coverage are approached.

Figure 20. Ikigai Conceptual Framework



A key theme that emerged is the importance of cultural sensitivity in applying the ikigai paradigm. While the core elements of ikigai—purpose, community, and meaningful engagement—are widely applicable, their interpretation varies considerably across national and regional contexts (Mathews, 1996; Kumano, 2018).

The country-specific findings illustrate this:

- **Portugal:** Ageing is challenged by institutional fragmentation and low digital literacy, yet enriched by local innovations like Ageing@Coimbra and emotionally resonant digital games.
- **Poland:** Active ageing is closely tied to the role of local governments and peer networks, but is often hindered by structural disparities and weak integration of ageing and digital policy.
- **Slovenia:** The country offers a model of civic co-design and strong eHealth infrastructure, but lags in formal care provision and long-term system reform.

- **Latvia:** Digital exclusion, rural ageing, and economic stress dominate the narrative, yet peer learning and intergenerational programs show promise.
- **Italy:** Regional inequalities and overburdened informal carers are significant challenges, but community hubs and digital upskilling efforts are growing.
- **Germany:** The country has a robust policy landscape and flagship initiatives like the "DigitalPakt Alter," but disparities persist between urban and rural regions and among different socioeconomic groups.
- **Cyprus:** This context highlights the need for culturally tailored interventions and regional sensitivity to infrastructure gaps, with a strong emphasis on family and spiritual engagement.
- **Belgium:** Belgium stands out for its well-developed digital health infrastructure and coordinated public policies that support user-centered co-design and the integration of digital tools with social networks.

The findings support prior research emphasizing that psychological well-being and perceived purpose are crucial determinants of active ageing (Ryff, 1989; Steptoe et al., 2015). Countries with robust community-based programs, such as Portugal's Ageing@Coimbra and Germany's DigitalPakt Alter, demonstrate stronger alignment with ikigai principles. These cases suggest that purpose-driven ageing can be promoted through inclusive, localized digital health interventions (Marston et al., 2020).

Moreover, the role of technology as an enabler, rather than a replacement, for human connection was evident in several national case studies. This reflects critiques of techno-solutionism and highlights the importance of co-creation, storytelling, and intergenerational dialogue (Neven & Peine, 2017). For example, projects such as Nonni Digitali in Italy and Simbioza in Slovenia demonstrate how digital tools can reinforce rather than undermine human-centered values in ageing.

The discussion also raises broader implications for European health policy. While frameworks such as the WHO Decade of Healthy Ageing promote integrated approaches, practical implementation still faces fragmentation at the local level (WHO, 2020). The ikigai paradigm offers a heuristic that may help unify biomedical, psychological, and sociocultural aspects of ageing strategies.

Ultimately, the findings suggest that ikigai is not merely a cultural curiosity but a potentially transformative concept for rethinking healthy ageing. The Ikigai Play framework (Figure 20), grounded in local realities, offers a framework that can help unify biomedical, psychological, and sociocultural aspects of ageing strategies. When tailored to context and embedded in community innovation, it offers a foundation for more meaningful and humanized digital health ecosystems, inviting each country to cultivate purpose through digital inclusion, civic design, and psychosocial resilience. When tailored to context and embedded in community innovation, it offers a foundation for more meaningful and humanized digital health ecosystems.

The Ikigai Play Framework

The insights from the country reviews confirm that a humanistic, integrative model is needed to address these local realities. In response, this chapter introduces the concept of Ikigai Play as an integrative and transdisciplinary framework for promoting healthy, active, and meaningful ageing in the digital era. Drawing from country-specific literature across eight European nations and grounded in psychosocial theory, 'Ikigai Play' advances a model where ageing well is tied to life purpose, digital empowerment, civic engagement, and equitable access to health technologies.

The framework is composed of four core pillars:

- **Digital Inclusion**: Older adults require not only access to devices and connectivity, but also tools tailored to their preferences, limitations, and learning styles. Digital literacy efforts must move beyond traditional training to include co-design and human-centered development.
- **Health and Well-being**: Digital health (eHealth/mHealth) must integrate mental and emotional dimensions, emphasizing prevention, autonomy, and usability across socioeconomic strata.
- **Citizenship and Participation**: Ageing populations must be included as rights-bearing contributors in policymaking, digital innovation, and knowledge production. Their involvement ensures more ethical, relevant, and sustainable outcomes.
- **Psychosocial Resilience and Purpose**: The ikigai concept enables a humanistic view of ageing—focusing on meaning, connection, and self-worth as primary health outcomes.

Together, these dimensions shape Ikigai Play, a vision of ageing where purpose, participation, and technology converge. The model challenges current silos in health, digital strategy, and social inclusion by proposing an integrated approach rooted in equity, dignity, and motivation.

Ultimately, the findings suggest that ikigai is not merely a cultural curiosity but a potentially transformative concept for rethinking healthy ageing. The Ikigai Play framework, grounded in local realities, offers a framework that can help unify biomedical, psychological, and sociocultural aspects of ageing strategies. When tailored to context and embedded in community innovation, it offers a foundation for more meaningful and humanized digital health ecosystems, inviting each country to cultivate purpose through digital inclusion, civic design, and psychosocial resilience.

6. LIMITATIONS AND FUTURE RESEARCH DIRECTIONS

6.1 Limitations of the Study

This chapter, grounded in a meta-narrative review for the SmartAgeCare project, provides a comprehensive conceptual framework but is subject to methodological and conceptual limitations:

The inclusion criterion of a 10-year publication window (2015–2025) is broad for the field of Digital Health. Given the rapid pace of technological change and the profound acceleration of digital adoption post-2020, data from the earlier part of the decade may reflect outdated digital contexts, policies, and literacy rates, potentially limiting the immediate currency of findings related to eHealth and digital equity.

To meet the transdisciplinary goals, the review placed no restrictions on document type (including reports and policy documents), thereby introducing heterogeneity in the evidence. While necessary for contextual breadth (European Citizenship axis), the synthesis relies on data with varying levels of methodological rigour, compared to evidence sourced exclusively from highly indexed, peer-reviewed databases. Furthermore, the search strategy was affected by inconsistencies across partner countries (e.g., limitations of Semantic Scholar; uneven use of national databases), potentially resulting in asymmetrical depth in the national literature profiles.

The core empirical evidence for the psychosocial benefits of Ikigai, as acknowledged in the review, is sourced mainly from the Japanese cultural context. Although the chapter proposes a culturally sensitive adaptation, the transferability and precise interpretation of Ikigai across the highly diverse social and political landscapes of Europe (Mediterranean, Central/Eastern, Northern) remain conceptual challenges requiring future empirical validation.

The primary contribution of this chapter is the conceptual model, 'Ikigai Play,' which is grounded in synthesis rather than primary data collection or empirical validation. Consequently, the synthesised relationships among the three core axes (meaning/Ikigai, digital equity, and citizenship) constitute theoretical integrations that require comprehensive testing through mixed-methods and longitudinal studies to confirm their efficacy in developing training programs.

6.2 Future Research Directions

To consolidate the conceptual and empirical advances proposed in this chapter, several future research directions should be prioritized. The exploration of ikigai as a framework for digital health and active ageing opens promising avenues for interdisciplinary inquiry. Future research should focus on empirically validating the impact of ikigai-oriented interventions on physical health, psychological well-being, and social inclusion across diverse ageing populations (Kumano, 2018; Schnell, 2020). Cross-cultural studies are particularly necessary to understand how ikigai is interpreted and enacted in various European contexts. While Japanese origins provide a strong conceptual foundation, adaptations must be sensitive to local values, identities, and socio-political conditions (Mathews, 1996; Gordon, 2022). Such comparative research could inform culturally competent policy and program development. Further investigation is needed into the role of digital storytelling, intergenerational platforms, and participatory design in enhancing purpose among older adults. These methods may offer innovative ways to translate ikigai principles into practice (Marston et al., 2020; Neven & Peine, 2017). Lastly, future studies should evaluate long-term outcomes of ikigai-based interventions, including metrics related to quality of life, healthcare usage, and civic engagement. Mixed-method and longitudinal designs would provide deeper insights into how ikigai contributes to sustainable and inclusive ageing models within Europe.

The following research directions should be prioritized:

- **Comparative longitudinal studies** across EU member states that measure changes in digital health access, purpose-driven well-being, and civic participation among older adults.
- **Development and validation of ikigai-based interventions**, including mobile apps, social prescribing models, and culturally adapted digital content aimed at enhancing meaning and mental health.
- **Evaluations of co-design methodologies** that engage older adults in the development of smart health systems, ensuring that age-friendly technologies reflect their life experience and capabilities.
- **Policy research on digital equity**, analyzing how public infrastructure, subsidies, and education policy support or hinder inclusive digital ageing.
- **Cross-cultural adaptation of the ikigai model,** exploring its resonance in Mediterranean, Central/Eastern European, and Northern contexts to define common ground and divergent values.

Research in this space must go beyond measuring deficits and instead center older people as agents of change, wisdom, and innovation. The Ikigai Play model offers not only a research lens but also an agenda for policy and practice that dignifies ageing as an active, connected, and purposeful life stage.

7. CONCLUSION

This chapter has explored the potential of the ikigai paradigm as a holistic and culturally resonant framework for advancing healthy and active ageing in Europe. By synthesizing evidence across diverse national contexts, the findings suggest that ikigai can enrich existing models of digital health, community engagement, and purpose-driven policy (Kumano, 2018; Marston et al., 2020).

Key themes that emerged include the importance of intergenerational connectivity, the value of local digital storytelling projects, and the need for inclusive co-design in technology development. These approaches align with contemporary calls for more person-centered and participatory paradigms in ageing research (Neven & Peine, 2017; WHO, 2020).

Importantly, the ikigai model invites a shift away from deficit-based narratives of ageing toward an emphasis on meaning, dignity, and lifelong potential. Future digital innovation in ageing must build upon this foundation, incorporating both technological and humanistic dimensions to support resilient and inclusive ageing societies.

As Europe continues to grapple with demographic transitions, the ikigai paradigm offers a timely and adaptable lens to promote well-being, equity, and flourishing in later life.

Our study proposed a new way to frame ageing in Europe: not simply as a challenge to be managed, but as an opportunity to empower older citizens to lead lives filled with purpose, connection, and health. Based on a meta-narrative review conducted through the SmartAgeCare project, we identified disparities and innovations across eight countries in areas of digital access, health outcomes, civic engagement, and psychological well-being.

Ikigai Play offers a conceptual framework to unify diverse efforts across sectors, highlighting that successful ageing is not only about preventing disease, but also about cultivating meaning, agency, and community belonging in later life. Digital health tools, participatory governance, and purpose-centered interventions must be designed inclusively, embracing the diversity of ageing experiences in Europe.

To move forward, researchers and policymakers must reframe technology not as a solution imposed on older people, but as a set of co-created tools that empower them. Embedding Ikigai as a guiding paradigm offers the potential to build more inclusive, joyful, and equitable futures for ageing societies.

ACKNOWLEDGMENTS

Research has been conducted within the ambit of the project "SmartAgeCare" Cofunded by the ERASMUS+ KA220-ADU – Cooperation for innovation and the exchange of good practices – Capacity Building in the field of Higher Education (2023-1-PT01-KA220-ADU-000166402 - S05597-202307)

This work was funded by Fundação para a Ciência e Tecnologia (FCT), under HEI-Lab R&D Unit (UIDB/05380/2020, https://doi.org/10.54499/UIDB/05380/2020).

The authors acknowledge the use of OpenAI's ChatGPT-4 (March 14 version) and Google's Gemini for assistance with refining the language and grammar of this manuscript. The authors reviewed and edited the content as needed and took full responsibility for the final publication.

REFERENCES

Barros, P. P., Machado, S. R., & Simões, J. A. (2020). Portugal: Health system review. *Health Systems in Transition*, *22*(2), 1–122. PMID: 22222781

Bente, B. E., Van Dongen, A., Verdaasdonk, R., & van Gemert-Pijnen, L. (2024). eHealth implementation in Europe: A scoping review on legal, ethical, financial, and technological aspects. *Frontiers in Digital Health*, *6*, 1332707. DOI: 10.3389/fdgth.2024.1332707 PMID: 38524249

Bıçakçı, A. S. (2024). Digital Europe Program: Nurturing Technological Sovereignty for a Resilient European Digital Ecosphere. *Ankara Avrupa Çalışmaları Dergisi, 23*(Özel Sayı-Future of Europe: Reflections from Türkiye), 135–174. https://doi.org/DOI: 10.32450/aacd.1439811

BMFSFJ. (2020). *DigitalPakt Alter*. Federal Ministry for Family Affairs, Senior Citizens, Women and Youth.

Bousquet, J., Bewick, M., Cano, A., Eklund, P., Fico, G., Goswami, N., Guldemond, N. A., Henderson, D., Hinkema, M. J., Liotta, G., Mair, A., Molloy, W., Monaco, A., Monsonis-Paya, I., Nizinska, A., Papadopoulos, H., Pavlickova, A., Pecorelli, S., Prados-Torres, A., & de Oliveira-Alves, B. (2017). Building bridges for innovation in ageing: Synergies between action groups of the EIP on AHA. *The Journal of Nutrition, Health & Aging*, *21*(1), 92–104. DOI: 10.1007/S12603-016-0803-1 PMID: 27999855

Bousquet, J., Kuh, D., Bewick, M., Standberg, T., Farrell, J., Pengelly, R., Joel, M. E., Rodriguez Mañas, L., Mercier, J., Bringer, J., Camuzat, T., Bourret, R., Bedbrook, A., Kowalski, M. L., Samolinski, B., Bonini, S., Brayne, C., Michel, J. P., Venne, J., & Zins, M. (2015). Operational Definition of Active and Healthy Ageing (AHA): A Conceptual Framework. *The Journal of Nutrition, Health & Aging*, *19*(9), 955–960. DOI: 10.1007/s12603-015-0589-6 PMID: 26482699

Caravella, S., Cirillo, V., Crespi, F., Guarascio, D., & Menghini, M. (2023). The diffusion of digital skills across EU regions: Structural drivers and polarisation dynamics. *Regional Studies, Regional Science*, *10*(1), 820–844. DOI: 10.1080/21681376.2023.2265498

Cibin, R. (2023). When Sociotechnical Imaginaries Become True: Digital Transition of Public Services and Inequalities during the Pandemic. *Societies (Basel, Switzerland)*, *13*(10), 220. DOI: 10.3390/soc13100220

European Commission. (2020). The 2020 Ageing Report: Economic and Budgetary Projections for the EU Member States (2019–2070).

Falanga, R., Cebulla, A., Principi, A., & Socci, M. (2020). The Participation of Senior Citizens in Policy-Making: Patterning Initiatives in Europe. *International Journal of Environmental Research and Public Health*, *18*(1), 34. DOI: 10.3390/ijerph18010034 PMID: 33374566

Foster, L., & Walker, A. (2015). Active and successful aging: A European policy perspective. *The Gerontologist*, *55*(1), 83–90.

Fukuzawa, A., & Sugawara, I. (2023). Social Support and Participation as Factors Relating to Ikigai and Life Satisfaction in Lonely Older Japanese. *Ageing International*, *48*(2), 465–481. DOI: 10.1007/s12126-022-09486-6

Gordon, C. (2022). The anthropology of purpose: Ikigai and cultural translation. *Journal of Cross-Cultural Studies*, *33*(1), 55–72.

Gullslett, M. K., Ronchi, E., Lundberg, L., Larbi, D., Lind, K. F., Tayefi, M., Ngo, P. D., Sy, T. R., Adib, K., & Hamilton, C. (2024). Telehealth development in the WHO European region: Results from a quantitative survey and insights from Norway. *International Journal of Medical Informatics*, *191*, 105558. DOI: 10.1016/j.ijmedinf.2024.105558 PMID: 39084085

ISTAT. (2021). *Italy's demographic trends and projections*. Italian National Institute of Statistics.

Jose, A., Sasseville, M., Gorus, E., Giguère, A., Bourbonnais, A., Abbasgholizadeh Rahimi, S., Balley, C., Buyl, R., & Gagnon, M.-P. (2024). Existing Digital Health Technology Index Summary Report for Older Adults Living with Neurocognitive Disorders (Mild and Major) and Their Informal Caregivers: An Environmental Scan. *Geriatrics (Basel, Switzerland)*, *9*(4), 85. DOI: 10.3390/geriatrics9040085 PMID: 39051249

Kebede, A. S., Ozolins, L. L., Holst, H., & Galvin, K. (2022). Digital Engagement of Older Adults: Scoping Review. In Journal of Medical Internet Research (Vol. 24, Issue 12). JMIR Publications Inc. https://doi.org/DOI: 10.2196/40192

Kolotouchkina, O., Ripoll González, L., & Belabas, W. (2024). Smart Cities, Digital Inequalities, and the Challenge of Inclusion. *Smart Cities*, *7*(6), 3355–3370. DOI: 10.3390/smartcities7060130

Kondo, N., Sembajwe, G., Kawachi, I., Van Dam, R. M., Subramanian, S. V., & Yamagata, Z. (2009). Income inequality, mortality, and self rated health: Meta-analysis of multilevel studies. *BMJ (Clinical Research Ed.)*, ●●●, 339.

Kouta, C., & Kaite, C. (2011). Spirituality and ageing in Cyprus: A qualitative study. *Journal of Religion and Health*, *50*(4), 869–878.

Kumano, M. (2018). On the concept of ikigai: A psychosocial perspective. *The Japanese Psychological Research*, *60*(4), 205–217.

Liotta, G., Canhao, H., Cenko, F., Cutini, R., Vellone, E., Illario, M., Kardas, P., Poscia, A., Sousa, R. D., Palombi, L., & Marazzi, M. C. (2018). Active Ageing in Europe: Adding Healthy Life to Years. *Frontiers in medicine*, *5*, 123. DOI: 10.3389/fmed.2018.00123 PMID: 29780804

Loureiro, A., Brites, R., & Domingues, M. (2021). Ageing and digital participation: A case study of Portuguese older adults. *Gerontechnology (Valkenswaard)*, *20*(2), 100–108.

Marston, H. R., & Van Hoof, J. (2019). "Who doesn't think about technology when designing urban environments for older people?" A case study approach to a proposed extension of the WHO's age-friendly cities model. *International Journal of Environmental Research and Public Health*, *16*(19), 3525.

Marston, H. R., Musselwhite, C., & Hadley, R. (2020). Active ageing and the role of technology: A critical review. *The Gerontologist*, *60*(7), e294–e305.

Mathews, G. (1996). *What makes life worth living? How Japanese and Americans make sense of their worlds*. University of California Press.

Nakanishi, M. (2019). Purpose in life and health outcomes among older Japanese adults. *Aging & Mental Health*, *23*(8), 1010–1016. DOI: 10.1080/13607863.2018.1471587

Neven, L., & Peine, A. (2017). From triple win to triple sin: How a problematization approach can help re-imagine care technology innovation. *Technological Forecasting and Social Change*, *118*, 153–160.

Odone, A., Buttigieg, S., Ricciardi, W., Azzopardi-Muscat, N., & Staines, A. (2019). Public health digitalization in Europe. *European Journal of Public Health*, *29*(Supplement_3), 28–35. DOI: 10.1093/eurpub/ckz161 PMID: 31738441

OECD. (2021). [OECD Publishing.]. *Health at a Glance. Europe*, •••, 2021.

Ryff, C. D. (1989). Happiness is everything, or is it? Explorations on the meaning of psychological well-being. *Journal of Personality and Social Psychology*, *57*(6), 1069–1081.

Ryff, C. D., & Keyes, C. L. M. (1995). The structure of psychological well-being revisited. *Journal of Personality and Social Psychology*, *69*(4), 719.

Santoni, G., Marengoni, A., & Calderón-Larrañaga, A.. (2015). Defining health trajectories in older adults with multimorbidity. *BMC Geriatrics*, *15*, 1–10.

Schnell, T. (2020). *The psychology of meaning in life*. Routledge.

Spargo, M., Goodfellow, N., Scullin, C., Grigoleit, S., Andreou, A., Mavromoustakis, C. X., Guerra, B., Manso, M., Larburu, N., Villacañas, Ó., Fleming, G., & Scott, M. (2021). Shaping the Future of Digitally Enabled Health and Care. *Pharmacy (Basel, Switzerland)*, *9*(1), 17. DOI: 10.3390/pharmacy9010017 PMID: 33445509

Steptoe, A., Deaton, A., & Stone, A. A. (2015). Subjective wellbeing, health, and ageing. *Lancet*, *385*(9968), 640–648. PMID: 25468152

Steptoe, A., & Fancourt, D. (2019). Older adults' electronic media use and loneliness: Time trends and associations, 2012–18. *EClinicalMedicine*, *9*, 42–49. DOI: 10.1016/j.eclinm.2019.08.015

Terraneo, M. (2015, February). Inequities in health care utilization by people aged 50+: Evidence from 12 European countries. *Social Science & Medicine*, *126*, 154–163. DOI: 10.1016/j.socscimed.2014.12.028 PMID: 25562311

Theodoulou-Loizidou, M., Polycarpou, A., & Stylianou, A. (2020). Digital inclusion and older adults in Cyprus. *European Journal of Ageing Studies*, *9*(1), 22–34.

Thomas, J., & Harden, A. (2008). Methods for the thematic synthesis of qualitative research in systematic reviews. *BMC Medical Research Methodology*, *8*(1), 45.

von Eitzen, S., Schroeder, K., & Braun, A. (2021). Community-based ageing and digital inclusion in Germany. *Social Policy and Administration*, *55*(3), 394–409.

WHO. (2020). *Decade of Healthy Ageing: 2020–2030*. World Health Organization.

World Medical Association. (2013). World Medical Association Declaration of Helsinki: Ethical principles for medical research involving human subjects. *Journal of the American Medical Association*, *310*(20), 2191–2194. DOI: 10.1001/jama.2013.281053 PMID: 24141714

Yesavage, J. A., Brink, T. L., Rose, T. L., Lum, O., Huang, V., Adey, M., & Leirer, V. O. (1982). Development and validation of a geriatric depression screening scale: A preliminary report. *Journal of Psychiatric Research*, *17*(1), 37–49.

KEY TERMS AND DEFINITIONS

Ikigai: A Japanese term loosely translated as "a reason for being." It represents the intersection of personal fulfillment, life purpose, community engagement, and a sense of meaning that drives daily activities and contributes to long-term well-being.

Ikigai Play: A novel, transdisciplinary conceptual framework proposed in this chapter that integrates the psychosocial pursuit of meaning (Ikigai) with the challenges of digital equity, active health, and European citizenship among older adults.

Digital Health Equity: The fair and inclusive access to, and meaningful use of, health technologies (e.g., eHealth, mHealth) regardless of an individual's age, socioeconomic status, location, or digital literacy level.

Active European Citizenship: In the context of ageing, this refers to the meaningful engagement of older adults in social, cultural, and political life—including intergenerational solidarity and active participation in digital decision-making and services—contributing to both personal purpose and democratic vitality.

Health & Active Ageing (HAA): As defined by the WHO, it is the process of developing and maintaining the functional ability that enables well-being in older age, emphasizing autonomy, participation, and functional capacity rather than just the absence of disease.

Healthy Life Years (HLY): A key European Union indicator that measures the expected number of years a person will live free from disability or chronic illness. It serves as a metric for the success of active aging and public health strategies.

Appendix L. Published Conference Paper

Reference: Giesteira, B., Souza, T. (2026). IKIGAI PLAY: Requirements for the Development of a Lúdic Toolkit Oriented to Smart Ageing Through a Human-Centered Design Approach. In: Brooks, A.L. (eds) ArtsIT, Interactivity and Game Creation. ArtsIT 2025. Lecture Notes of the Institute for Computer Sciences, Social Informatics and Telecommunications Engineering, vol 696. Springer, Cham. https://doi.org/10.1007/978-3-032-26999-7_16

Note: *This paper was co-authored by the candidate as part of the research conducted for this dissertation. The full published version (pp. 230–239, 10 pages) is included below. Reproduced with permission from Springer Nature.*



IKIGAI PLAY: Requirements for the Development of a Lúdic Toolkit Oriented to Smart Ageing Through a Human-Centered Design Approach

Bruno Giesteira(✉) and Tainá Souza

Universidade do Porto, Porto 4099-002, Portugal
bgiesteira@fba.up.pt, up202301150@up.pt

Abstract. Population aging and digital transformation pose complex challenges for social inclusion, autonomy, and active participation of older adults. This paper presents the conceptual and methodological foundations for the development of IKIGAI PLAY, a ludic educational toolkit created within the European project SMARTageCARE. The aim is to promote Smart Ageing through playful and meaningful activities that integrate digital, health, and civic competences. Grounded in the Japanese philosophy of Ikigai and the Positive Play game design framework, the toolkit fosters purpose-driven engagement, emotional well-being, and digital inclusion. The methodology followed a Design Thinking approach using the Double Diamond model, combining a meta-narrative literature review and participatory co-creation workshops with older adults in the eight countries participating in the project. From this process, speculative design requirements were formulated to guide the creation of human-centered interventions. Results reveal seven design guidelines addressing usability, self-efficacy, resilience, and social connectedness. The study concludes by highlighting the potential of combining purpose-oriented philosophy with ethical game design to support meaningful ageing trajectories. Future work will focus on prototype development and empirical testing to validate the proposed requirements.

Keywords: Smart Ageing · Ikigai · Positive Play · Design Thinking · Digital Inclusion

1 Introduction

Population aging is one of the most significant demographic shifts of the 21st century, particularly in Europe, where low birth rates, increased longevity, and migration patterns accelerate the phenomenon. According to Eurostat, the EU population aged 65 and over could reach nearly 130 million by 2050, posing increasing challenges in multiple social and institutional spheres [1].

In response to these challenges, new models of aging have emerged, aiming to redefine how societies support the well-being, and autonomy of older people. Among

© ICST Institute for Computer Sciences, Social Informatics and Telecommunications Engineering 2026
Published by Springer Nature Switzerland AG 2026. All Rights Reserved
A. L. Brooks (Ed.): ArtsIT 2025, LNICST 696, pp. 230–239, 2026.
https://doi.org/10.1007/978-3-032-26999-7_16

them, the Smart Ageing model stands out by adopting a person-centered and problem-oriented approach that goes beyond normative ideals of "successful" or "healthy" aging. Grounded in a socio-ecological perspective, Smart Ageing emphasizes the interaction between individual capacities and environmental opportunities, advocating for inclusive systems that empower older adults to actively shape their own aging trajectories in alignment with their personal values and aspirations [2, 3]. Thus, as society becomes increasingly digital, it is essential to prepare individuals for this new reality by supporting the development of digital skills that enable active participation.

Within this context, the European project SMARTageCARE (SAC), a pan-European initiative coordinated by the University of Porto and supported by partners from eight countries, seeks to embody this new model of aging by integrating innovation, and design to create solutions that enhance the digital capabilities of older adults, fostering their full participation in contemporary society. One of the project's main outcomes is the development of a ludified educational toolkit, IKIGAI PLAY, designed to empower older adults in their sense of life through playful and meaningful experiences that enhance their digital skills.

To ensure this toolkit is human centered, the project adopts the Japanese concept of Ikigai as a motivational foundation and the Positive Play philosophy as a game design framework. This article, therefore, aims to explore how this philosophical articulation can guide a playful design process, applying a design thinking approach to propose speculative requirements for game-based activities that promote smart aging.

2 The SMARTageCARE Project: Smart Aging with Purpose[1]

SMARTageCARE (SAC) is a European project co-funded by the Erasmus+ program, whose main objective is to promote digital inclusion, civic participation, and psychosocial well-being among older adults by exploring innovative models of engagement. Developed by a consortium of eight countries (Portugal, Germany, Latvia, Cyprus, Italy, Poland, Slovenia, and Belgium) and nine institutional partners, with the University of Porto as the coordinating entity, the project seeks to address "Smart Aging" in terms of skills development structured around three interdependent axes: Health & Care, Digital Transition, and Citizenship.

The Health & Care axis promotes digital health literacy, empowering older adults to make informed decisions, effectively use technologies to monitor their well-being, and adopt sustainable self-care practices.

The Digital Transition axis targets digital exclusion by offering training in Information and Communication Technologies (ICTs). It emphasizes facilitating older adults' access to information, online services, entertainment, and strengthening their autonomy and digital citizenship.

The Citizenship axis fosters active participation of older adults in community, political, and cultural life. It emphasizes respecting individual identities, personal histories, diversity, and combating social isolation.

To operationalize these three axes, the project is structured around three main actions: the creation of a Smart Aging Ecosystem (including a Network of Ambassadors, a

[1] Official website: https://smartagecare.fba.up.pt/

Training Program, an Advisory Board, and Strategic Plan); the implementation of a Pilot Campaign (with usability and impact studies); and, as the focus of analysis in this article, the development of a ludified Toolkit, the IKIGAI play.

Drawing on the concept of Ikigai and the Positive Play game design philosophy, the toolkit seeks to foster motivation, autonomy, and a sense of purpose, while also promoting digital inclusion and active citizenship. Designed to be adaptable for various educational and training contexts, including both formal and informal learning environments, the toolkit is intended for use by older adults, caregivers, educators, and community organizations. By leveraging co-creation and design thinking methodologies, the development process ensures that the toolkit addresses real needs, anticipates future challenges, and is aligned with the values and aspirations of its users.

2.1 Games as Tools for Aging with Purpose

Technological advances and demographic changes highlight the urgency of designing user-centered interventions that respond to the needs of an aging population. As research in HCI4D advances, games have been recognized as recreational and psychoeducational tools capable of motivating older adults to remain cognitively, physically, and socially active [4]. The literature highlights their benefits in health, education, and rehabilitation, including exergames, memory games, and gamified health platforms [5–7]. Playful strategies promote engagement, support the development of social skills, and reduce feelings of loneliness or inadequacy, going beyond entertainment by addressing universal human motivations such as pattern recognition, problem solving, and gathering behavior, while encouraging cooperation, empathy, and positive social interactions [8, 9].

Accordingly, within the context of the project, the learning objects in the toolkit will be designed to support real-world problem solving by promoting digital and social inclusion in a meaningful way, functioning not only as an educational resource but also as a reflection of values, identities, and aspirations in different European contexts.

3 Theoretical Framework

This study is grounded in the intersection of two complementary theoretical approaches: the existential philosophy of Ikigai and the design game of Positive Play. Together, these paradigms offer a foundation for developing playful experiences that are not only functional or didactic but also transformative, affective, and ethically situated.

3.1 Ikigai: Purpose as Lifelong Vitality

Ikigai (生き甲斐) is a Japanese term formed by “iki” (生き), meaning life, and “gai” (甲斐), meaning value or merit. It is commonly translated as “that which makes life worthwhile.” [10]. According to psychiatrist Mieko Kamiya, who introduced Ikigai into Japanese scientific literature, it is an existential experience rooted in both intrinsic motivations (such as joy and curiosity) and extrinsic ones (such as social recognition),

though it is more closely associated with intrinsic motivations, especially in cultures focused on quality of life [11, 12].

While often simplified in the West as the intersection of passion, vocation, mission, and profession, the original concept is broader and more fluid. Living with purpose involves keeping the mind active and adaptable, not only through learning but also through social interactions and playful challenges, conditions that promote a state of "flow," where competence and challenge are balanced [13]. These experiences strengthen Ikigai, fostering personal fulfillment in meaningful activities and resilience.

The literature highlights that people with a greater sense of Ikigai have lower mortality, lower allostatic load, and better immunity. These effects are mediated by healthy behaviors and a sense of control over one's own health [12]. In addition, it emphasizes the importance of considering both the cultural context and age-related changes when seeking to enhance the sense that life is meaningful and valuable for older adults [14].

In the context of Smart Age Care, Ikigai proves to be a promising way to design interventions centered on the values, interests, and experiences of older adults. As a dynamic and context-sensitive concept, it dialogues with European ideals of active citizenship, intergenerational solidarity, and digital participation, reinforcing the potential of programs that promote empowerment, engagement, and continuity in the physical, social, and emotional domains.

3.2 Positive Play: A Human-Centered Game Design Methodology

Derived from the concept of Positive Computing, which proposes technologies focused on well-being and human fulfillment, Positive Play is a human-centered approach that uses games as tools for personal development. Integrating design studies and procedural rhetoric, the focus is on how game mechanics communicate ideas, evoke reflection, and construct meaning for players [15, 16].

Unlike models focused solely on entertainment, Positive Play aims for learning and transformation, aligning with Human Potential Theory by nurturing virtues, autonomy, and purpose. In Maslow's widely known hierarchy of needs, these dimensions correspond to higher-order motivations, and well-designed games can catalyze self-actualization, the apex of the pyramid [15, 16].

Pedro Cardoso, Bruno Giesteira, and colleagues [16] analyzed games from the industry and academic contexts, synthesizing eight Positive Play maxims that guide the design of meaningful experiences:

- Make Possible: Build bridges between players and their goals, facilitating actions that promote autonomy and self-efficacy
- Follow-Up: Enable the monitoring of behaviors or emotional states, serving as a support tool for clinical or educational decisions.
- Make Adjustments: Help players reconfigure routines or beliefs, promoting positive behavioral changes.
- Keep Going: Strengthen existing healthy behaviors, promoting their continuity and reinforcement.
- Make Headway: Encourage personal, cognitive, and social growth, broadening horizons and promoting new learning.

- Stay Away From: Warn about harmful behaviors or risky situations, promoting prevention and critical awareness.
- Hype Up: Generate enthusiasm, engagement, and motivation for actions that benefit the player.
- Have an Aha! Moment - Facilitate moments of discovery and deep understanding, revealing new perspectives about oneself or the world.

These maxims are not exclusive; the same game can activate multiple maxims, depending on the audience and the project's objectives. In the context of Ikigai Play, they support the creation of games that evoke emotions, foster meaningful connections, and share knowledge in an ethical, empathetic, and human-centered way. Positive Play thus offers a strong foundation for developing playful artifacts that respect the dignity and autonomy of older adults, combining smart aging values with Ikigai to guide meaningful and enjoyable ludified educational interventions.

4 Methodology

Given the human-centered nature of SMARTageCARE, Design Thinking [17] was adopted to guide the development of requirements for the IKIGAI PLAY Toolkit. Using the Double Diamond model (Discover, Define, Develop, Deliver), the process alternated between divergence (exploring possibilities) and convergence (refining ideas) [18] to integrate diverse knowledge, respect sociocultural values, and challenge dominant narratives about aging and technology. The first three phases are presented here, while deliver—the results—is discussed separately

4.1 Discover

The Discover phase aimed to understand the context and identify users' needs and aspirations. To achieve this, two main strategies were combined: a meta-narrative literature review and participatory co-creation sessions conducted in the eight consortium countries.

To address the cultural and technological diversity of the consortium countries, a meta-narrative literature review was conducted to inform toolkit development. From a corpus of 330 studies, 168 were selected for analysis. The review aimed to identify and examine literature on IKIGAI values and educational approaches for older adults, with emphasis on active and healthy ageing, e-health, digital transition, and European citizenship.

In parallel, to ensure the intervention met the real needs of the target audience, participatory co-creation sessions were conducted in the eight partner countries with Senior Ambassadors, using affinity mapping to identify barriers, pain points, and aspirations regarding technology aligned with the three axes of the project.

4.2 Define

In the Define phase, data were analyzed to identify patterns and core problems.

Results from Metanarrative Review
The literature review highlighted that national health systems, digital infrastructures, and sociocultural norms strongly shape the ageing experience in Europe. Across the eight countries analyzed, distinct patterns emerge that influence how purpose, participation, and digital health coverage are approached. A key insight is the need for cultural sensitivity when applying the ikigai paradigm, as its core elements—purpose, community, and meaningful engagement—are interpreted differently across contexts.

These findings align with prior research emphasizing psychological well-being and perceived purpose as key determinants of active ageing. Countries with established community-based programs, such as Ageing@Coimbra in Portugal and Germany's DigitalPakt Alter, illustrate stronger alignment with ikigai principles. These cases suggest that purpose-driven ageing can be promoted through inclusive, localized digital health interventions.

Furthermore, evidence underscores the role of technology as an enabler rather than a substitute for human connection, countering techno-solutionist approaches. Co-creation, storytelling, and intergenerational dialogue emerge as critical elements. Initiatives such as Nonni Digitali in Italy and Simbioza in Slovenia demonstrate how digital tools can reinforce human-centered values in later life [19].

Results from Co-Creation Sessions[2]
The co-creation sessions held in the eight partner countries identified common barriers to digital inclusion, e-health, and citizenship, such as lack of accessibility, digital illiteracy, high costs of electronic equipment and services, excessive bureaucracy, social isolation, and low trust in digital services. The proposed solutions converge on accessible and personalized digital education strategies, such as intergenerational mentoring, the creation of community digital competence centers, the co-design of digital tools with older adults, the simplification of processes, the improvement of urban accessibility, the strengthening of support networks, and the promotion of cultural, social, and health activities.

4.3 Develop

The Develop phase consisted of articulating the empirical data with the theoretical frameworks of Ikigai and Positive Play. This combination enabled the creation of speculative requirements aligned with the intrinsic motivations of older adults, grounded in their life experiences, values, and desires for social contribution.

Ikigai Was Related to the Project's Three Axes as Follows:

[2] Full description of results available at: https://smartagecare.fba.up.pt/workPackages/wp3

- Health & Care: Digital health (eHealth/mHealth) should encompass mental and emotional aspects, promoting prevention, autonomy, and accessibility for all social groups. The Ikigai concept supports a human-centered perspective on ageing, highlighting purpose, connection, and self-value as essential outcomes for well-being.
- Digital Transition: The development of skills must be aligned with the learner's personal interests and values to ensure sustainability. Ikigai supports this by anchoring learning in individual purpose, thus increasing engagement, curiosity, and long-term adoption.
- Citizenship: Digital tools enable civic participation, access to services, and involvement in collective life. Ikigai enhances this potential by affirming the role of older adults as active contributors to society, encouraging engagement in causes and communities that matter to them.

The Positive Play game design philosophy was used to translate this articulation into gamified strategies. The integration of active listening, empirical data, and theoretical foundations resulted in the formulation of speculative requirements for the activities proposed by the toolkit.

5 Results and Discussion

In the Delivery phase, instead of producing a tangible prototype, the result is expressed in the form of speculative requirements. These requirements synthesize the insights generated throughout the double diamond process and translate them into practical recommendations that will guide the construction of the toolkit.

5.1 Speculative Requirements

Below is a detailed description of each speculative requirement, accompanied by its theoretical justification, highlighting how Ikigai values and Positive Play maxims inform the proposed game design strategies.

Requirement 1 – Usefulness, Simplicity, and Adaptability of Activities
The toolkit's activities should be perceived as useful, easy to navigate, and adaptable to each user's personal needs and goals. To achieve this, the activities need to be broken down into steps, yet guided and celebrated, so that the user feels "it's possible" and that they can do it.

Justification: For older adults, technological or trust barriers may hinder first steps. Ikigai emphasizes purpose through active, adaptable minds fostered by learning, social interaction, and play. Aligned with Positive Play's *Make Possible* maxim, the toolkit should simplify processes, turning intention into action and creating immediate empowerment.

Requirement 2 – Visualization and Tracking of Progress
Toolkit activities should provide ways to visualize and track progress, focusing on monitoring users' behaviors or emotional states to understand where they are experiencing problems and what type of intervention is best suited to help them.

Justification: Tracking progress reinforces the sense that daily activities have value. Ikigai is the "subjective perception that life has purpose and direction." Combined with the *Follow-Up* maxim, visualizing progress and reflecting on one's actions makes this perception concrete.

Requirement 3 – Safe Environment for Experimentation and Learning.
The activities should provide a safe environment where mistakes are treated as opportunities for learning and self-discovery, enabling users to adjust strategies, adopt positive behaviors, and build resilience.

Justification: Creating a safe space where mistakes foster learning allows failures to drive growth. The *Make Adjustments* maxim supports self-discovery, guiding improvements and building resilience—an essential source of Ikigai

Requirement 4 – Integration with Daily Routines and Continuity of Healthy Behaviors.
The activities in the toolkit should fit into players' routines, reinforcing healthy habits by linking game tasks to real-life actions (e.g., squatting in reality mirrors squatting in the game).

Justification: Ikigai is the "happiness of always being busy" with meaningful activities. Continuity is key. The toolkit's activities, by encouraging self-care through the preservation of existing routines or behaviors, follow the Keep Going maxim which are games that aim to support, persist, and nurture existing behaviors.

Requirement 5 – Encouraging the Flow State
The toolkit's activities must encourage a state of flow in players by promoting progress and growth without causing frustration or boredom. By expanding horizons and refining worldviews, players gain new digital skills. Therefore, the system must adapt automatically to players' needs based on their results.

Justification: The *Make Headway* maxim is the embodiment of flow in experience design. The concept of flow is one of the pillars of Ikigai, described as a state of total immersion in an activity that, by combining competence and challenge, reinforces a sense of purpose. The feeling of progressing, learning, and overcoming challenges in the right measure is what nourishes vitality and the will to continue.

Requirement 6 – Safe Simulation of Risk Scenarios
The toolkit should simulate risk scenarios in a safe and controlled space, which can be guided by a facilitator to build new awareness in players regarding online risks, preparing them for the real world. This way, we can educate users so they can reflect on digital risk situations, such as digital scams and fake news.

Justification: Low digital literacy exposes older adults to scams, misinformation, and isolation, harming both finances and well-being. Living with purpose means resisting such risks. The *Stay Away From* maxim empowers users to avoid them, while *Have an Aha! Moment* fosters discovery and new insights about the digital world.

Requirement 7 – Inclusion of Relevant Content for Older Adults and Caregivers The game should include space for caregivers to also access content related to digital literacy, health, and citizenship, thus ensuring both seniors and their support network have a better quality of life.

Justification: The *Hype Up* maxim fosters engagement with meaningful content. By including relevant information for older adults and caregivers, the toolkit strengthens emotional bonds and reinforces Ikigai's intrinsic sense of purpose.

6 Discussion and Conclusion

In summary, the IKIGAI PLAY Toolkit will be conceived not only as an intervention, but as a pedagogical response to the demand for methodologies capable of mobilizing personal narratives and intrinsic purpose, particularly among populations frequently marginalized within digital and political agendas. By acting at the intersection of play and purpose, the toolkit can offer older adults playful experiences that simultaneously affirm their rights, life stories, and social belonging.

By conceptualizing games as critical and speculative artifacts, IKIGAI PLAY underscores the potential of ludic design as a practice of social innovation, fostering debate, enhancing awareness, and promoting civic engagement [20, 21]. Building upon the established requirements, it becomes possible to design playful scenarios that advance digital inclusion and strengthen competencies across the three axes of SMARTageCARE, while also encouraging intergenerational dialogue. These scenarios will enable the deployment of games as discursive tools that stimulate reflection on both current and future social challenges relevant to the European Union.

Furthermore, they are aligned with the New European Bauhaus initiative,[3] a community-driven movement aimed at enriching human life through art, culture, and design, while simultaneously addressing the pressing needs of the planet. Accordingly, the toolkit is not only expected to support digital inclusion and self-efficacy, but also to create spaces for mutual learning and collective reflection, serving both as a laboratory for ludic experimentation and as an instrument of social innovation.

Nevertheless, the present study entails certain limitations, such as the absence of empirical testing with end users and the current lack of definition regarding the final format (online or offline) of the toolkit. To overcome these limitations, subsequent iterations of the work will integrate participatory workshops and pilot activities designed to test these hypotheses, thereby enabling the refinement of the toolkit's structure and its methodological implications.

References

1. European Commission: Statistical Office of the European Union. Ageing Europe: looking at the lives of older people in the EU: 2020 edition. [Internet]. LU: Publications Office (2020). [cited 2025 May 15]. Available from: https://data.europa.eu/doi/10.2785/628105

[3] New European Bauhaus iniatiave: https://new-european-bauhaus.europa.eu/

2. Song, I.Y., Song, M., Timakum, T., Ryu, S.R., Lee, H.: The landscape of smart aging: topics, applications, and agenda. Data Knowl. Eng. **115**, 68–79 (2018)
3. Su, Z., Zhang, R., McDonnell, D., Bentley, B.L., Adobor, Y.K., Jiang, J., et al.: Smart ageing with sway: opportunities and challenges. Arch. Gerontol. Geriatr. Plus. **1**(4), 100079 (2024)
4. Devezas, T., Domingos, L., Vasconcelos, A., Carreira, C., Giesteira, B.: Malariascope's user interface usability tests: results comparison between European and African users. In: International Conference on e-Infrastructure and e-Services for Developing Countries, pp. 241–250. Springer (2014)
5. Giesteira, B., Silva, J., Sarmento, T., Abreu, P., Restivo, M.T.: Carnival play: eHealth solution to evaluate, rehabilitate, and monitor dexterity and manual strength. In: Advances in Medical Technologies and Clinical Practice, pp. 206–242. IGI Global (2021) Available from: http://services.igi-global.com/resolvedoi/resolve.aspx?doi=10.4018/978-1-7998-7472-0.ch012
6. Costa, L.V., Veloso, A.I., Loizou, M., Arnab, S.: Games for active ageing, well-being and quality of life: a pilot study. Behav. Inf. Technol. **37**(8), 842–854 (2018)
7. DeSmet, A., Van Ryckeghem, D., Compernolle, S., Baranowski, T., Thompson, D., Crombez, G., et al.: A meta-analysis of serious digital games for healthy lifestyle promotion. Prev. Med. **69**, 95–107 (2014)
8. Calvo, R.A., Peters, D.: Positive Computing: Technology for Wellbeing and Human Potential. MIT press (2014)
9. Rauterberg, M.: Positive effects of entertainment technology on human behaviour. In: Building the Information Society: IFIP 18th World Computer Congress Topical Sessions 22–27 August 2004, Toulouse, France, pp. 51–58. Springer, Boston (2004)
10. García, H., Miralles, F.: Ikigai: The Japanese Secret to a Long and Happy Life, p. 194. Penguin Books, New York (2017)
11. Kamiya, M.: Ikigai ni tsuite. (About ikigai), vol. 13, pp. 15–17. Misuzu-Shobo, Tokyo (1966)
12. Kotera Y, Kaluzeviciute G, Garip G, McEwan K, Chamberlain K. Health Benefits of Ikigai: A Review of Literature. 2021
13. Csikszentmihalyi, M., Csikzentmihaly, M.: Flow: The Psychology of Optimal Experience, vol. 1990. Harper & Row, New York (1990)
14. Nakagawa, T., Jopp, D.S., Gondo, Y., Lehrfeld, J., Rott, C., Oswald, F.: Valuation of life among old and very old adults: comparison between Germany and Japan. Innov. Aging. **2**(2) (2018) Available from: https://academic.oup.com/innovateage/article/doi/10.1093/geroni/igy020/5051923
15. Giesteira, B., Berge, G., Peçaibes, V.: Positive play: designing ludic tools for health. Septentrio Rep. (1) 2024 July 8 [cited 2025 July 7]; Available from: https://septentrio.uit.no/index.php/SapReps/article/view/7582
16. Cardoso, P., Peçaibes, V., Giesteira, B., de Castro, L.C.: Positive play: games for human potential and the yet unexplored case of anorexia nervosa. In: Handbook of Research on Solving Modern Healthcare Challenges with Gamification, pp. 154–185. IGI Global (2021)
17. Brown, T.: Design thinking. Harv. Bus. Rev. **86**(6), 84 (2008)
18. Design Council: The Design Process: What is the Double Diamond? Design Council, London (2005) [cited 2025 July 31]. Available from: https://www.designcouncil.org.uk/
19. Ikigai Play: Towards an Ikigai paradigm of healthy and active ageing in Europe: theoretical and evidence-based conceptual chapter, grounded in a meta-narrative review. In: [submitted for publication]. IGI Global (2025)
20. Flanagan, M.: Critical Play: Radical Game Design. MIT Press (2009)
21. Coulton, P., Burnett, D., Gradinar, A.: Games as speculative design: allowing players to consider alternate presents and plausible features (2016)