

A Digital Collaborative Platform for the Silver Economy: Functionalities Required by Stakeholders in a Multinational Baltic Sea Region Project

Sidra Azmat Butt ¹, Shweta Suran ², Robert Krimmer ², Michael Smærup ², and Dirk Draheim ²

¹Tallinn University of Technology

²Affiliation not available

October 30, 2023

Abstract

With the increasing population of the silver economy, many potential economic opportunities appear, in particular, in developed countries. Recently, the European Union and the Baltic Sea Region have been very active with their research on active aging and to tackle the challenges arising from the exponentially increasing ageing population. The OSIRIS project is one such EU-funded initiative to develop a digital platform for the elderly named the Digital Silver Hub, which aims to serve as an ecosystem for the quadruple helix actors (private sector, public sector, academic institutions, senior citizens) to participate in knowledge exchange, collaboration and co-creation of innovative technological solutions to facilitate the elderly population. In this paper, 30 interviews were conducted from the partner heads of the OSIRIS project as well as quadruple helix actors from each region in the Baltic Sea Region (Estonia, Latvia, Finland, Lithuania, and Denmark) in order to deeply understand the functionalities that are needed to be offered by the Digital Silver Hub. A deductive thematic analysis is conducted to analyse these functionalities in terms of Collective Intelligence (CI) components (namely staffing, processes, goals and motivation) based on a most recent generic CI model. The functionalities were further evaluated by experts working in the field of science and technology in the silver economy. As results, the needed functionalities are identified and explained in depth. As an outlook, we discuss how these functionalities can be translated into architectural components of a system design.

A Digital Collaborative Platform for the Silver Economy: Functionalities Required by Stakeholders in a Multinational Baltic Sea Region Project

Sidra Azmat Butt¹ Shweta Suran¹ Robert Krimmer²
Michael Smærup³ Dirk Draheim¹

¹Tallinn University of Technology, Akadeemia tee 15A, Tallinn, Estonia

{sidra.butt, shweta, dirk.draheim}@taltech.ee

²University of Tartu, Ülikooli 18, Tartu, Estonia

robert.krimmer@ut.ee

³ VIA University College, Hedeager 2, Aarhus, Denmark
MISM@via.dk

Abstract

With the increasing population of the silver economy, many potential economic opportunities appear, in particular, in developed countries. Recently, the European Union and the Baltic Sea Region have been very active with their research on active aging and to tackle the challenges arising from the exponentially increasing ageing population. The OSIRIS project is one such EU-funded initiative to develop a digital platform for the elderly named the Digital Silver Hub, which aims to serve as an ecosystem for the quadruple helix actors (private sector, public sector, academic institutions, senior citizens) to participate in knowledge exchange, collaboration and co-creation of innovative technological solutions to facilitate the elderly population. In this paper, 30 interviews were conducted from the partner heads of the OSIRIS project as well as quadruple helix actors from each region in the Baltic Sea Region (Estonia, Latvia, Finland, Lithuania, and Denmark) in order to deeply understand the functionalities that are needed to be offered by the Digital Silver Hub. A deductive thematic analysis is conducted to analyse these functionalities in terms of Collective Intelligence (CI) components (namely staffing, processes, goals and motivation) based on a most recent generic CI model. The functionalities were further evaluated by experts working in the field of science and technology in the silver economy. As results, the needed functionalities are identified and explained in depth. As an outlook, we discuss how these functionalities can be translated into architectural components of a system design. **Keywords:** Information and Communication Technology, Collective Intelligence, Silver Economy, Digital Platform, Agile Methodology, Knowledge Management

1 Introduction

Improvements in the quality of life in the more developed nations of the world have been responsible for extending the life expectancy of their citizens. This in turn has led to a significant demographic change that entails a higher ratio of senior citizens amongst the population of these countries. Based on estimates presented in a United Nations report, 1 out of 6 people will be over the age of 65 by the year 2050. As compared to 2017, the population of ageing citizens is expected to double itself in 2050 [70]. This warrants significant changes that are likely to affect the economic, social and technological fabric of developed nations such as North America and Europe. The ratio of active earners to pensioners which was 4:1 in 2015, is estimated to become 2:1 by 2060¹. The BSR (Baltic Sea Region) countries are also immensely affected by this population shift.

In order to address the effects of this pronounced demographic change, several new concepts and fields of research have emerged over the past few decades and the term “*silver economy*” is a result of such concerns. According to Zsarnoczky, it was coined by the scholars of Oxford University and refers to “*the economy of the 50+ age group, including all their economic activities, products, demands and expenditures*” [75]. In the EU, this concept focuses on creating solutions and strategies for the elderly through innovations in technology services. ICT (Information and Communication Technology) services specialized for the use and convenience of the ageing population are considered to be a prominent factor in the developments related to the silver economy. These services are targeted to improve the living conditions of the ageing populations through technological innovations that encompass their daily lives including governance, healthcare, transportation, housing, and social welfare. Not only developments in Artificial Intelligence (AI) and robotics but also “low tech” products like wheelchairs, hygiene chairs, walking sticks, crutches etc. have led to a plethora of technological solutions for the improvement in the quality of life of the elderly [22].

This phenomenon of population ageing is a cause of concern for many segments of society especially those in the more developed areas of the world. Both the private and the public sectors as well as academia have been working towards solutions that help enhance the quality of life of the silver generation. The OSIRIS project is one such initiative that is part of the myriad efforts streamlined to address the challenges of the ageing population in the BSR countries². It is a transnational endeavour that aims to respond to the needs of the silver economy through ICT innovations and smart specialization approaches. It is based on the idea of developing an innovation ecosystem model that brings together the various segments of the society to contribute towards smart solutions for a comfortable and independent life for the older population. These segments also known as the innovation actors include governments, industry, researchers, product developers and business organizations. The BSR countries involved in the project are: Estonia, Latvia, Lithuania, Finland and Denmark.

However, research suggests that the success of any innovative entrepreneurial approach is highly dependent on the overall environmental system and conditions governing the initiative [24]. This implies that the presence of strong ecosystems can contribute towards the domains of information and knowledge

¹https://ec.europa.eu/info/sites/default/files/1_en_act_part1_v8_0.pdf

²OSIRIS - Smart Silver Economy

management. The idea of knowledge creation and knowledge management has been gaining momentum as businesses shift their focus from natural resources towards intellectual assets. The information age we live in today is characterized by an overload of information; facts and opinions. Brooking defines knowledge as information in context with understanding to apply that knowledge [10]. Vafaie et al. claim that knowledge is a justified personal belief that increases an individual’s capacity to take effective action [71]. Knowledge management is the latest buzzword in the entrepreneurial realm. Some researchers term knowledge management as knowledge-based management that connects people to people and people to information to create synergies and competitive advantage [54].

When it comes to innovations and new ideas that aim to tackle global issues like demographic change, global warming, and pollution, the concept of knowledge management banks on the idea of collective intelligence (CI). CI as defined by Levy is “*a form of universally distributed intelligence, constantly enhanced, coordinated in real-time, and resulting in the effective mobilization of skills.*” [44]. In the context of ICT, CI is described as having three main components “*“individuals (with data/information/knowledge); coordination and collaboration activities (according to a predefined set of rules); and means/platform for real-time communication (viz., hardware/software).*” Suran et al. describe CI as collaborative problem solving and decision making that can be effectively utilized in many areas like sociology, psychology, biology, management, economics, computer sciences and even business success [66].

In a global environment that is built upon “knowledge-based economies”, CI is an effective approach to problem-solving and innovation building. The emergence of an international digital landscape, ICT innovations, AI, and the IoT (internet of things) have provided opportunities for entrepreneurs to materialize their ideas into successful ventures by connecting with relevant expertise and building relationships across the globe. According to Elia and Margherita: “*The incredible development of information and communication technologies (ICT) and the internet are making the achievement of this challenge more feasible. In particular, a new scenario of pervasive collaboration and interaction among people and computers is enabling models of collective intelligence whereby the ‘wisdom of the crowd’ can help to solve complex problems in a more effective way. The undertaking of an entrepreneurship journey can be considered a possible problem to be solved, and thus the new archetype of the entrepreneurship ecosystem is based on the creation of a system of actors, resources, knowledge assets, services, competencies and relationships around the potential entrepreneur that is needed to provide better support for the idea-to-venture process*” [24].

This research paper focuses on building the functionalities for a digital collaborative platform which we refer to as the Digital Silver Hub (DSH) based on the generic CI model of Suran et al. to facilitate independent living solutions for the elderly. It aims to build the features and functionalities of the platform which will be then evaluated by experts and professionals. The DSH incorporates the participation of the quadruple helix innovation actors (See Fig 1); the academia, public sector, private sector and the end-users (senior citizens) for the development of ICT innovations. This ensures a collaborative exchange of ideas and solutions to address the emerging needs of the ageing populations of the world [13]. However, when the processes do not require the involvement of the elderly, but only from the businesses, public sector authorities and academicians, this trio will be referred to as the “triple helix actors”. Nonetheless, this

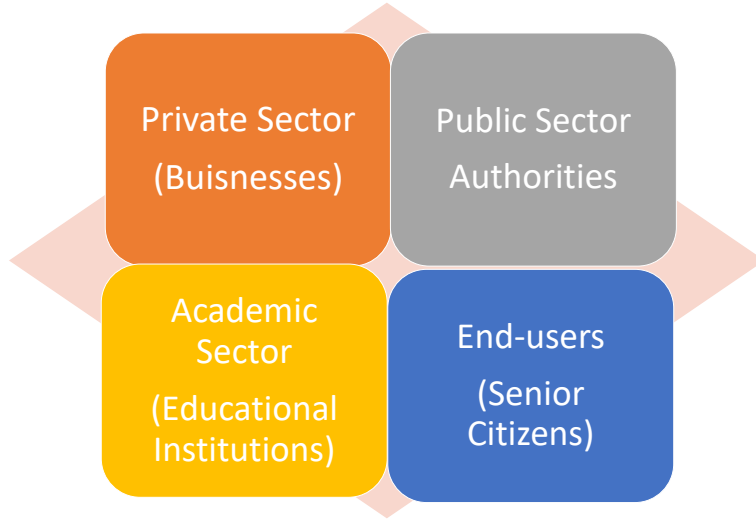


Figure 1: Quadruple Helix Model

issue of demographic shift requires a systematic approach similar to CI to develop ICT solutions through interconnected processes that are fuelled by input from all the stakeholders involved.

In Sect. 2, we provide a theoretical background that covers knowledge management and CI and related work on silver economy and digital platforms to help the silver economy in Sect. 3. It is followed by the description of the research methodology used for the paper in the Sect. 4. In Sect. 5, we provide the results followed by the evaluation and discussion in Sect. 6. We proceed with possible future direction in Sect. 7 and we finish the paper with a conclusion in Sect. 8.

2 Theoretical Background

2.1 Knowledge Management

With the world becoming a global village, environment has become more dynamic as well as competitive, therefore, knowledge is considered as an essential element in order to be able to keep up with the pace and stay in the market. Knowledge in today's world can be deliberated as an asset [21] and a source of competitive edge, therefore, more sophisticated ways have been introduced to manage this valuable resource. Knowledge Management is thus, gaining popularity and viewed as a key factor for an organization's success. In the previous times, wealth and material resources as well as physical power were taken as the capital of an organization [67] but nowadays, knowledge creation and its appropriate utilization is more important [50].

Knowledge Management has been defined by various authors as Bhatt suggests that it's the process of creating, confirming, presenting, distributing and applying knowledge [2] while Davenport and Grover believe that knowledge

management is data management and information management and an inseparable transaction for organizations [18]. For our research purposes, we define knowledge management as a “*range of practices used by organizations to identify, create, represent, and distribute knowledge for reuse, awareness, and learning across the organizations*” [34].

Shared understanding and team work in organizations lead to collaboration which eventually lead to new knowledge creation [61]. This combination of different knowledge resources and expertise ultimately benefits the organization and therefore, makes it highly imperative to adapt ways to manage this collective knowledge [53] [26]. Ideas and thoughts are brainstormed when a problem is identified and a solution is needed while knowledge management investigates different ways to solve a problem, it cannot work at its full potential in isolation and therefore, puts great emphasis on the sharing aspect. Sharing of knowledge is possible using different methods like networking, group meetings, workshops, trainings etc. In an attempt to solve a problem, a goal has to be set which can be linked to any organization, individual, team or even a system [52]. If a goal-oriented system is in question, knowledge should be intrinsically embedded in order to generate value for the organization but this is only possible if the interactions are organized into a coherent system [19].

There are two types of knowledge in an organization; tacit and explicit knowledge [33]. Tacit knowledge is highly human-sensitive and refers to the knowledge and experience carried by an individual’s mind [17] whereas explicit knowledge can be codified and is transferable through formal language [30]. In an organization, tacit knowledge has to be described and made explicit to create a shared understanding and, according to Sarayreh et al., externalization makes tacit knowledge accessible and develop into explicit knowledge which eventually translates to a well-structured collective intelligence system [60]. In the broadest sense, collective intelligence is defined as “*the capacity of a human community to evolve toward higher order complexity thought, problem-solving and integration through collaboration and innovation*” [59].

Knowledge creation is dynamic and this process has to be effectively managed, therefore, Nonaka and Takeuchi proposed a model called the SECI model. It negates the notion of static model and instead emphasizes the continuity of knowledge creation whereby users practice, communicate and learn. When the tacit knowledge interact with explicit knowledge meaning when the individual shares their knowledge and experiences with others, new knowledge is created which can then be internalized back as tacit knowledge (see Fig 2) [53].

The first step of the model is *socialization* which means that the tacit knowledge is moved amongst the individuals as they interact. Interaction can be in the form of guidance, conversation, practice, imitation and even observation [60]. The next step is the *externalization* whereby the tacit knowledge is converted to explicit knowledge as the individual’s subjective knowledge is compiled to written and formal knowledge [33]. In this way, tacit knowledge can be spread across the organization in an understandable and interpretable form and therefore, eventually leads to new knowledge creation [33]. The third step is *combination* that allows externalized explicit knowledge to be compiled, analyzed and organized. This can then be further shared with other organizations and information technology plays an important role as compared to other factors to enable sharing of knowledge using emails, databases, document sharing etc. [60]. The last step is *internalization* when the explicit knowledge is converted

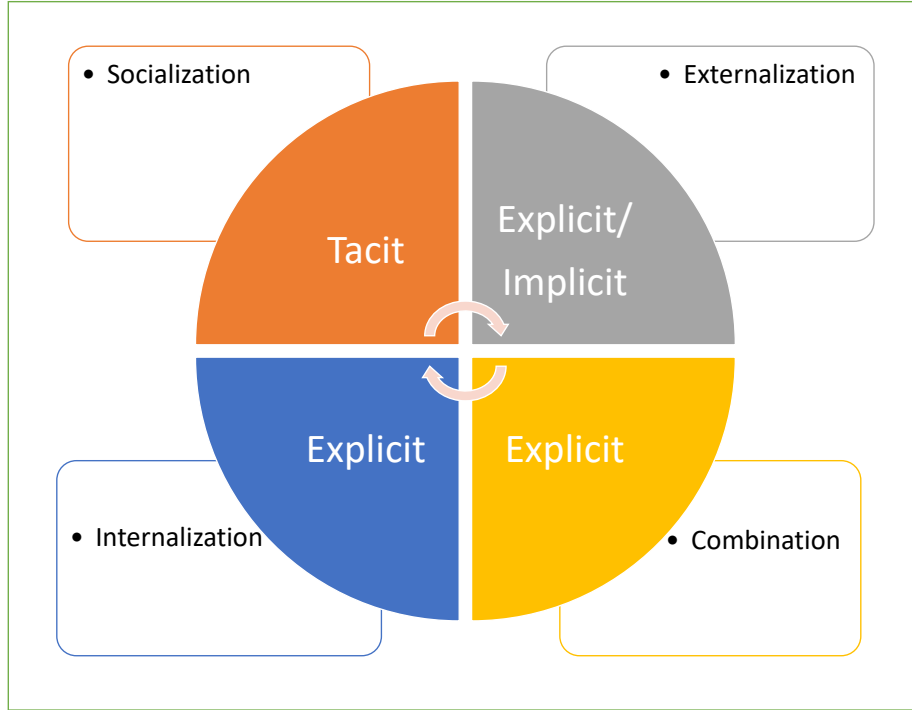


Figure 2: SECI Model by Nonaka and Takeuchi

back to tacit knowledge. As an individual uses and learns the explicit knowledge, it modifies and revises their existing tacit knowledge. This cycle continues in a spiral of knowledge which results in new knowledge creation and changes previous conceptions [60].

2.2 Collective Intelligence

Collective Intelligence (especially known as ‘wisdom of the crowd’ [66]) has been a part of scientific discussions ever since the Jury theorem [42]. Since this era, CI applications and its related concepts (like crowdsourcing, citizen science, open innovation, social norms, and collective behaviour [49]) have expanded throughout a broad range of research fields ranging from biology, sociology, psychology, social networks, computer science, human-computer interaction (HCI), organization and management [66]. CI platforms are primarily used for problem-solving, generating new ideas or solutions, decision making, prediction, and information exchange that benefit both society and individuals [45, 46]. Early examples of CI platforms include WikiWikiWeb [45] (the first wiki) and Gold-Corp [5] (which utilized the collective knowledge of web users to identify new gold mining locations). Since then, progression in ICT technologies like the social web has enabled mass collaboration [62] and lead to the development of novel CI platforms like Wikipedia [45] (use the wisdom of crowd to develop an online encyclopedia), Climate CoLab [45] (harness the collective knowledge of people to solve global climate issues), Tippiancee [56] (harness the collaborative

knowledge of web users to annotate the new content on the web), InnoCentive [45] (use the collective knowledge of the individuals to tackle societal issues) and Reddit [73] (enable sharing of hobbies, ideas, passions and interests). To build these platforms, researchers have proposed many CI models or frameworks such as “genome model” [47], “a new model for CI in organizations” [4], and “resource allocation framework for CI system engineering” [72]; unfortunately these models are domain-specific or use case-specific [65], and also explained using different metaphors such as “genes, system-specific elements, principles, attributes, requirements, or their combinations” [65, 66]. To overcome this problem (i.e, lack of a generic CI framework), Suran et al. proposed a ‘generic’ CI framework (see Fig 3) that allows researchers and stakeholders to simply combine different components of the model in order to develop the new CI platforms (irrespective of their domains) more effectively and efficiently.

The proposed ‘Silver Economy’ platform is designed based on the ‘generic’ CI framework proposed by Suran et al.. The CI model is based on four components: Staffing i.e., *Who is Performing the Task?*, Goals i.e., *What is Being Accomplished?*, Processes i.e., *How is It Being Done?*, and Motivation i.e., *Why They are Doing It?*; and these are again divided into *types, properties, and interactions*.

- The *staffing* of the ‘generic’ CI framework, are the users of CI platforms. Based on their roles and responsibilities, they can be divided into two categories namely, *contributors* and *beneficiaries*. Contributors are the individuals who use their knowledge and expertise in order to solve problems and generate new solutions. In CI platforms like InnoCentive and OpenIDEO, users of different countries collaborate with each other and propose novel solutions. Such as modifying engine oil to reduce transport to combustion chamber or how might businesses of all kinds rapidly adapt to support the immediate needs of the COVID-19 response, and enable a more just and resilient future? The contributors on CI platforms can also be further categorized as *hierarchy* and *crowd*. The members of the hierarchy are mainly experts and administrators who manage work allocation, whereas members of the crowd are the active contributors who contribute new artefacts or information. These two type of contributors can be seen in Kaggle: crowd submit new machine learning solutions or optimize the existing ones; whereas the hierarchy allocate the resources or select the best solution. Based on the ‘generic’ CI model, there are some key properties of the crowd: the users should belong to diverse backgrounds i.e., the users should belong to different cultures, economic, and social backgrounds; the users should be independent of each other i.e., they should not influence each other opinions, and the crowd should have a “critical mass”. An ideal example of such properties can be seen in Climate CoLab: users are from different countries and have different expertise, and they can work independently or in a group but need to follow some rules. Furthermore, crowd should trust and respect each other to promote co-creation among the members of the crowd; and should follow the SECI (socialization, externalization, combination, and internalization) to convert tacit knowledge into explicit.
- As proposed by Suran et al., the goals can be categorized as: *individual goals* and *community goals*. Furthermore, goals should be *objective* and

well defined. These type can be seen in InnoCentive: individuals with novel ideas participate in challenges to present their ideas (or artefacts) to the members of the community and learn from other’s feedback (comments, votes and like/dislike) and finally earn reward; whereas the community’s goal is to select the most innovative idea based on the feedback and their expertise.

- The ‘generic’ CI framework, categorizes processes into types and interactions. Integrating these types and interactions, processes can be classify as *collection*, *collaboration*, *group decisions*, and *individual decisions*. Collection are the independent activities, in such activities an individual create new innovative solutions and solve problems without being a part of any community. While group tasks are the part of collaboration activities, in such activities individuals come together on the platform and then create new knowledge and solutions. An example of such collection and collaboration activities can be seen in Kaggle: an individual user post the solution and different communities can evaluate and improve it. Similar to collection and collaboration activities decisions can also be independent (individual decisions) and dependent (group decisions). For example, in Threadless users can take individual decisions like a user can independently select or reject the T-shirt designs submitted by other users; whereas in group decisions multiple users as a community select or reject the designs, and the end result of the group decisions affect the entire community.
- *Intrinsic motivations* such as *passion* and *interest* (like in Reddit and Stack Overflow, users provide new information on specific topics), and *social cause* (like in HackAir and Climate CoLab, users provide new innovative solutions to tackle the global climate issues) encourage users to collaborate for the betterment of the society. *Extrinsic motivations* such as *tangible* (like in InnoCentive and Goldcorp, users win cash prizes for submitting novel solutions) and *intangible* (like in WikiCrimes and Kaggle, users earn a reputation based on their continuous contributions) encourage users to contribute in chance of obtaining incentives.

3 Related Work

3.1 Silver Economy

In the present century, demographic change has led to a higher population of the elderly in society all around the globe including the European Union. According to Popescu et al., a couple of decades ago, the ageing population was considered as a minority and economists and governments devised decent plans to manage them [58], however, lately, this population segment has been growing exponentially and raised concerns to structurally update policies.

Silver economy is defined as the specific needs of the ageing population and the goods and services targeted to the people over the age of 50 years old leading to economic opportunities³. According to Cornet, the silver economy

³Growing the European Silver Economy

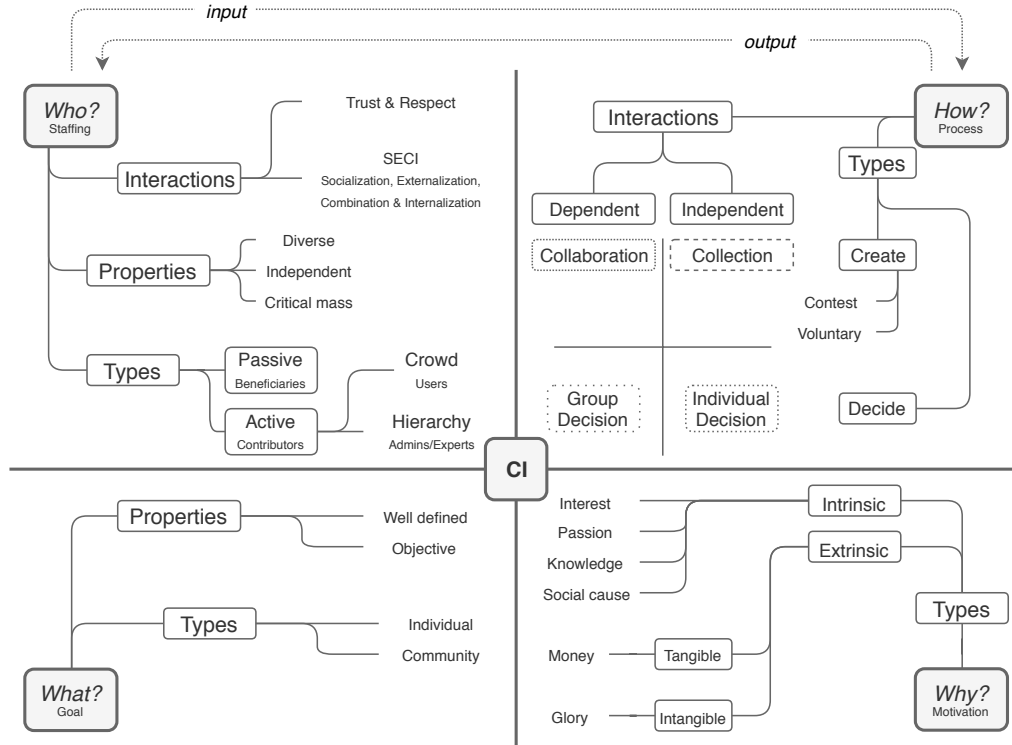


Figure 3: ‘Generic’ CI Model of Suran et al.

encompasses “a great diversity of individuals concerning status, income, health, social and cultural context.” He further suggests that it includes the “50+ markets for wealthy baby boomers, active retirees, as well as poor and frail older adults, mostly lonely women at risk of dependency and social isolation” [16]. For this paper, we use the definition from OECD that suggests that silver economy is “an environment in which the over-60 interact and thrive in the workplace, engage in innovative enterprise, help drive the marketplace as consumers and lead healthy, active and productive lives”⁴. This silver economy is a result of an increase in longevity and a decrease in the birthrate which consequently increases aggregate demand against supply. In 2013, it was found out that 1:4 of the population were over 60 years old and therefore, intensive measures were required to manage the change [36]. Subsequently, this puts a burden on the state budget as 25% of it is used on the welfare of the silver economy which totals \$7 trillion per year worldwide. Specific economic sectors like health care systems, senior tourism, social protection systems and innovation for healthy ageing etc. are being enhanced and designed to build a more sustainable silver economy [7].

This change in population trend can lead to immense opportunities in silver innovation [41]. When the demand is increased, a market is created and opens an avenue for entrepreneurs to exploit through innovative activities however,

⁴The Silver Economy as a Pathway for Growth

further research is required on how the supply in the silver economy can be met or benefit from the increased demand [43]. At one end, an increase in the elderly population may pose a threat to society [15] however, it may serve as a great entrepreneurial opportunity [76] [40]. According to Zsarnoczky’s study on silver tourism in Hungary, it was found out that it is highly imperative to understand the needs of the ageing group, how to alter the business model accordingly and how Europe will be the leading actor in this sector in the future [76]. ICT is considered as one of the solutions for satisfying the needs of senior citizens by developing innovative solutions to help them live independent life. “*The sector of AHA (active and healthy ageing), wellbeing, eHealth, senior tourism, age-friendly housing, health and social care and their ICT-related sub-sectors are facing huge development processes in the near future*” [75]. In a silver economy study conducted by Technopolis Group and Oxford Economics among other ideas concerning of potential solutions for older people, it was pointed out: “*development of an interactive platform connecting people that are working on developing new solutions with older people that want to support and/or invest in business development and share experience with the younger generation or be involved in test-bed activity*”⁵. Thus, innovation plays a key role in the development of the products and services that meet the ageing group’s demands as well as helps in achieving the competitive advantage in the market [75]. According to Neven, governments, entrepreneurs and senior citizens should gain an advantage from the rapid advancement in technologies and this was referred to as the ‘triple-win narrative’ [51]. Moreover, the great surge is anticipated in the current century where elderly people will have a better quality of life, improved healthcare systems and be more independent because of the combination of different technologies “*(nanotechnologies, biotechnologies, additive technologies, information technology robotics and cognitive technologies)*” [31]. There has been immense research and literature carried out on how these technologies will be adopted by elderly people and eventually lead to a better quality of life. However, there is limited research on the supply side of the silver economy [43].

According to Felix, governments need to explore the potential of the silver economy and support them by developing a model that adapts to their needs instead of fitting them to an already existing model [29]. There is a need to create awareness regarding the rapidly growing silver economy, economic systems have to be integrated and also special instructions should be developed to cater to this specific economy⁶.

3.2 Digital Platforms for the Silver Economy

ICT has played a vital role in helping the silver economy achieve digital inclusion as the ageing population may perceive that digital technologies are valuable, makes them self-efficient and also fulfil their needs⁷. This has eventually led to more digital and ICT based platforms and eventually revolutionized the way people socialize, search for information and avail themselves services [28]. According to Thomas et al., digital platforms is a hot topic in recent times and discussed widely at both, organizational and educational level [68]. Digital platforms can be considered a one-size-fits-all solution because of the flexibility and

⁵Silver Economy Study

⁶Active and Healthy Living in the Digital World

⁷Fostering solidarity and responsibility between generations

dynamism of the platforms that they can be used for any product and service [32]. Platform-based business models are being designed to transform even the healthcare industry [35].

Boudreau and Hagiu elaborate on the significance of a multi-sided digital platform that allows interactions from different user groups enabling knowledge exchange and collaboration [6]. The value created through these platforms is interdependent on the size of the group, where one group gains value when the size of the other group enlarges [23]. According to Ardolino et al., the infrastructure of such platforms should be designed in a way that allows two-way interaction as well as the transaction between the user groups however this is only possible when ICT is in place [1]. ICT allows online communication, therefore, devices like mobile phones, the internet, laptops and tablets etc. are imperative for the platform to fulfil its function [27]. In order to foster user involvement, online communication tools are required to organize communication and interaction which eventually also help in collecting data that helps in streamlining users' preferences and efficient use of resources [20].

Digital platforms have been defined based on the different points of view as some literature focuses on the technological aspect where the technical core is offered by the platform owner to develop products/services [69]; while on the contrary, non-technological view defines platform as a commercial network or market [55] [74]. The digital platform is defined by Spagnoletti et al. as “*a building block that provides an essential function to a technological system and serves as a foundation upon which complementary products, technologies, or services can be developed*” [63]. While Koh and Fichman define digital platforms as “*two-sided network... that facilitate interactions between distinct but interdependent groups of users, such as buyers and suppliers*” [39]. For this study, we use the definition by Staub et al. as he defined the digital platform as a “*software-based system that: a) consist of a modular technological architecture, b) coordinate external actors that innovate and/or compete and c) can function as a central hub of an ecosystem, in which peripheral firms or individuals facilitate complements and are connected via boundary resources*” [64].

There are several EU funded projects and initiatives that work to identify the technology readiness of the elderly, explore the market and develop technological solutions to their problems. Various attempts are in progress to enable active ageing in society and one such framework was designed by Camarinha-Matos et al. that incorporated ICT and a roadmap was devised to enable the desirable level of active ageing by involving the appropriate stakeholders [14]. It was suggested by Ahtonen (2019) in a policy brief by the European Policy Centre that effective solutions to the problems faced by the ageing population lie in the collaborative approach that involves the senior citizens as well the policymakers⁸. Some examples are AGE Platform Europe⁹ that targets 50+ to cater to their routine problems and a European network for NGOs and Ho-Care2.0 network¹⁰ that provides home care solutions that are tailor-made for customers by using co-creation techniques.

OSIRIS ‘Supporting the Smart Specialization Approach in the Silver Economy to Increase Regional Innovation Capacity and Sustainable Growth’¹¹ is

⁸Active and Healthy Living in the Digital World

⁹AGE Platform

¹⁰HoCare2.0

¹¹OSIRIS - Smart Silver Economy

also one such EU funded project that responds to the changing needs of the ageing population of the BSR. It aims to develop a digital collaborative platform referred to as the Digital Silver Hub (DSH) to serve as an environment to develop innovative and technological solutions to help the elderly live a comfortable and independent life and eventually, in return become capable to contribute back to the economy. The project seeks the growing silver economy as an entrepreneurial opportunity instead of a threat. The quadruple helix actors which include the private sector, public sector, academic sector and senior citizens from each region are involved throughout the project in order to unite expertise and knowledge from all walks of life to help contribute to the development of the DSH. It aims to involve smart specialization approaches and collaboration and co-creation techniques to tackle the challenges faced by the silver economy [12]. The project also undertakes the development of the Smart Silver Labs¹² for each region that will serve as incubation centers for innovative products and services and the DSH can serve as a platform to enable these labs to function and communicate with each other. Therefore the following vision and mission statements for the DSH were developed:

Vision Statement: “To support the life cycle of innovative solutions to tackle ageing challenges and to enhance silver economy growth opportunities in the Baltic Sea Region.”

Mission Statement: “To have a collaborative virtual hub that supports the creation, deployment and publishing of innovative solutions to generate economic growth by using a smart specialization approach.” [13]

Keeping in mind, the vision and mission statement, initial concept of the DSH was realized where it was identified that DSH will serve as a knowledge hub allowing interaction and sharing of information regarding the challenges faced by the elderly and how these can be deciphered through innovative solutions. Moreover, it was also identified as the virtual marketplace and social media platform that *“innovation actors could create their personal or business presence on the platform to facilitate communication between them where they could share and publicize their interests and could create a unique community for honest peer to peer conversations and crowdsourcing.”* [13] Stakeholders identified were the quadruple helix actors and the focus areas were to build collaborative communities, a unified repository and an ecosystem to enable knowledge exchange and enhance capacity of the innovation actors to exploit opportunities arising from the increasing silver economy in the BSR [13]. With the initial concept and basic requirements on the table, this paper seeks to dig deeper into functionalities and features of the DSH in the attempt of creating a collective intelligence hub.

4 Methodology

In order for the research to be effective and valuable, the methodology has to be devised in accordance with the research objectives. This paper focuses on devising the functionalities for a digital collaborative platform built to facilitate independent living for the elderly population of the BSR. The chosen research method is qualitative research since the platform under discussion seeks to address the problem of the demographic shift in this region.

¹²Smart Silver Labs

Mohajan explained qualitative research as a type of social science research that seeks to interpret meaning from non-numerical data that helps us to make sense of social phenomenon through the study of targeted populations or places [48]. Such qualitative approaches undertake a comprehensive and in-depth outlook to analyze the situation at hand from various perspectives. A primary feature of this method is its flexibility to incorporate varying “world-views” of the actors involved¹³. Bryman associated qualitative research with “*participant observation, semi- and unstructured interviewing, focus groups, the qualitative examination of texts, and various language-based techniques like conversation and discourse analysis*” [11].

For this research, the qualitative data was collected with informed consent through interviews from 30 participants. These participants included the quadruple helix actors (businesses, academia, government, and senior citizens) as well as the Project Heads of the OSIRIS project. They represented all of the countries taking part in the OSIRIS project. The interviews were conducted in face-to-face settings, where the participants were presented with a predetermined set of questions based on the generic CI model of Suran et al.. However, the approach to the interviews was semi-structured as the questions were kept open-ended and the individuals were allowed to expand on their responses to the questions. The interviews were then transcribed to generate a vast amount of raw qualitative data/content that had to go through a rigorous process of analysis using NVivo. This study employed a deductive thematic analysis in order to sift and interpret all the data derived from the 30 interview participants. The interview questions were designed based on Suran et al. generic CI model to follow the deductive approach. NVivo is a software tool created by QSR international for qualitative data analysis and facilitates researchers to classify, interpret and analyze large amounts of unstructured non-numerical data [37].

Thematic analysis is a method of analysis for qualitative data that seeks to identify and categorize common or shared meanings within the given data [8]. Elo and Kyngäs suggest that qualitative analysis aims to come up with a model that evaluates the phenomenon under observation in a conceptual and practical form. Researchers can utilize either an inductive or a deductive approach for theme generation [25]. For the inductive approach, the themes are derived from the researcher’s raw data and may not reflect the exact questions asked off the participants. Moreover, they may not mirror the researcher’s stance. However, deductive approaches employ an already devised theory, framework, or other researcher-driven focal points to identify themes of interest [38]. Deductive content analysis helps operationalize the structure of analysis on the basis of pre-existing knowledge or frameworks [25]. In this case, the generic CI framework devised by Suran et al. was employed to explore the functionalities of the DSH, as a deductive approach towards thematic analysis. Pope et al. state that the deductive approach of data analysis in qualitative research is less common, yet is becoming more popular with time [57]. It presents the possibility of analyzing the vast amounts of raw data according to a pre-existing framework that the researcher aims to explore in context to a certain phenomenon.

The preliminary data for the study was collected by transcribing all 30 interviews to provide a descriptive record of the research. In order to derive meaningful and relevant information from the data collected several codes were

¹³Taylor & Francis Group

generated through thematic analysis using the software NVivo. According to Braun et al., the process of thematic analysis involves several phases. The first phase pertains to the researcher familiarizing with the data during the data collection process [9]. The second phase involves the generation of codes from the data that later on form the building blocks of analysis. This is the phase where the similarities and patterns start appearing and the researcher gets the opportunity to deeply reflect on them. Once several codes are generated throughout the whole data set, the next phase of the analysis sets in. The third phase is characterized by the generation of preliminary themes based on the codes. In the fourth phase, the themes are reviewed and updated based on their relevance and utility. The fifth phase involves the process of defining and naming the themes. In the case of this research where the deductive analysis is applied, the themes are based on the generic CI model of Suran et al.. The sixth and final phase is all about the systemic and coherent presentation of the in-depth analysis of the themes.

Thus, the process of thematic analysis of qualitative data using the deductive approach helped the research by providing an in-depth evaluation and analysis of the first-hand responses of the actors involved in the DSH.

5 Thematic Analysis

The DSH is currently in the system design phase of development and the CI model provides strong foundations to create a roadmap for developing effective functionalities for the DSH. For research purposes, 30 interviews were conducted. The interviewees comprised of participants belonging to the quadruple helix innovation actors (academia, business organizations, public sector authorities, and senior citizens) as well as the Project Heads of the DSH. Participants belonged to the five countries of the BSR involved in the development of the DSH; Finland, Latvia, Estonia, Lithuania, and Denmark.

Thematic analysis is a method of evaluating patterns and themes within qualitative data. It is a very effective tool for data analysis that is becoming increasingly popular due to its flexibility and accessibility [8]. The six essential steps for a thematic analysis including familiarization, generation of codes, themes application, themes reviewing, theme definition, and report generation were put in place. It is to be noted that during the analysis of the in-depth interviews several codes were identified and applied using the open-source tool, NVivo. The recognized codes from the transcripts were then further categorized into themes to analyze the research conducted which are as follows:

Staffing
Goals
Processes
Motivation
Addition Requisites

Table 1: Themes found during thematic analysis.

5.1 Staffing

The first theme generated through the NVivo analysis of the qualitative interview data is the ‘staffing’ of the DSH. For any platform to run effectively, staffing is an important consideration as it determines the *who* dimension which includes the individuals and groups that are directly or indirectly involved in the activities executed on the platform. The key actors are the Project Heads as they are paramount in determining the resources required to create, operate, manage and utilize the platform. Given that, several other stakeholders participate in the project referred to as the quadruple helix actors (Fig 1) that ensure that the platform is used for the intended purpose and goals and activities are successfully achieved and executed.

The very first step to initiate any project is to conduct market research and to ensure if the targeted stakeholders will be willing to use and adopt the outcome of it. Keeping this in mind, all participants were questioned about their willingness to use the DSH, almost all of them acknowledged the utility of the platform and confirmed their readiness to use and participate in its functionalities. The public sector authority rep from Finland mentioned; *“there are more and more elderly people in our region. And there’s a need for developing better services. It would be very good to have a platform that would provide information for the funding opportunities, seeking partners, already existing services, and for developing innovations.”* However, a few participants also highlighted that they would only be willing to use the platform if it serves a specific purpose of their business and belonged to their focus area, for instance, the business rep from Denmark stated: *“if this whole part of having retired teachers or retired professionals, being a bigger part of the core servicing of what we’re doing, I think it’s a great place to find sort of very concentrated access to a specific target audience and services related to that.”* On the other hand, the majority of the senior citizens were very delighted by the idea of a platform that was focused on their well-being and looked forward to its inception however, only one senior citizen rep who was from Denmark showed unwillingness saying; *“I probably use some other platforms, or maybe just google what I need as usually, these platforms are very complicated and hard to understand.”*

Contributors are the active actors who participate in different activities on the platform and help build innovative solutions to the problems faced by the elderly by bringing their knowledge and expertise to the system while beneficiaries are passive actors who only aim to benefit from the outcomes of the system. The triple helix (academia, business organizations in the private sector and public sector authorities) and the project heads; all were very interested in playing their roles as both contributors and beneficiaries of the ecosystem created through the DSH. The majority of the senior citizens were also very ecstatic about contributing to the platform and being part of the innovation processes as the representative of senior citizens from Latvia mentioned, *“So I could be actually giving my contribution as a mentor, helping elderly people, even though I’m eager, and also willing to do my contribution, with no financial benefits out of this. So I can do mentorship for maybe one to two hours per month on a social basis as my social input.”* However, a few of the senior citizens appeared reluctant to comprehend their part as contributors to the platform, though they did not seem to mind using it for their benefit. The representatives belonging to the academic sector were interested in both using and contributing to the DSH

for their research, testing products, sharing their ideas, receiving feedback and finding partners. As one of them mentioned that it was “*a great opportunity that I would utilize as both a contributor and a user.*” Another participant from the private sector identified that “*the platform provides very concentrated access to a specific target audience and services related to that.*” He saw business organizations as contributors to the DSH, offering services to the silver population. The public sector authority rep from Lithuania also stated:

“Sometimes, I’m a beneficiary when I need to do consultancy and advisory services for my clients, and on the other hand, there are a lot of projects, project opportunities, and maybe collaboration opportunities, when I can also make some kind of an input and maybe as an agency, we might not use this platform, but we always work with companies or some research institutions then we always need to give them information where they can share their ideas so I think we could use the platform as both; contributor as well as the beneficiary.”

The DSH will serve as a platform for all the innovation actors to screen and accelerate the uptake of innovations enabling the ageing population to live independently therefore, contributors to the platform will take different roles and execute activities that will eventually lead to innovative ideas. According to the responses from the interviews, the following areas were identified where stakeholders were willing to contribute:

- Idea sharing
- Providing feedback
- Testing
- Discussion forums
- Training/mentoring
- Market Research
- Updating/sharing information on new events and innovations

Another consideration regarding the staffing and possible options for contributors and beneficiaries of the DSH is determining the success of the ecosystem. Measurement of success for any platform eventually becomes its Key Performance Indicators (KPIs) which should be determined and tracked to be able to provide value to platform users. While some recommended gauging the success of the platform based on its number of users, others put forward the notion of determining the capacity of the platform to push a certain number of innovations in the market for the ageing population. As one interviewee suggested, “*it’s not about having a lot of users registered, but to have active users.*” A senior citizen said that he would consider the platform successful if it became a part of his everyday life just like Facebook. The success of the platform meant different things for different innovation actors. While one participant thought that “*1000 unique visitors every day*” should be the critical mass for the success of the platform, another one suggested a focus on “*active elders*”. One candidate posited that “*the centre of the value proposition for this platform is for companies to get access to active elders, and get feedback from them. So, the number of academic institutions and companies is less relevant because they’re*

usually easier to find. It would be more about the elderly people and getting in contact with them.” Senior citizens also gauged the success of the platform based on its degree of user-friendliness, though they were unsure how that could be measured. As the revenue generation is not directly involved, determining platform KPIs is not straightforward, however, according to the responses from the interviews, the main KPIs identified are:

- Newly published content per month
- Number of onboarded customers/users per week/month
- Degree of user-friendliness
- Activity on the platform per day/week
- Number of innovative solutions/ideas
- Number of reported bugs/errors
- Users’ attitude to published content (surveys, Net Promoter Score)

Interaction and socialization are imperative between actors in order to enable knowledge creation on the platform. For a smooth flow of knowledge, it is important that actors trust each other’s abilities and treat each other with respect. Organizational knowledge is a combination of tacit and explicit knowledge, therefore SECI: “*Socialization, Externalization, Combination, and Internalization*” dimensions from Nonaka and Takeuchi’s model were used to promote sustainable innovation and enable competency development in actors on the platform. When participants were asked if they will be willing to socialize with other innovation actors or senior citizens, the majority of them showed immense interest and found it to be necessary for the platform’s success. The public sector authority rep from Latvia stated; *“this ecosystem can be very fragmented as there are some different ministries and different organizations and all this experience is not linked together. That’s why interaction is very necessary. And perhaps, it was one of the main tasks in the near future, split together all actor groups and to cooperate.”* Interviewees highlighted the fact that this platform can serve as a very useful intermediary for different stakeholders to find people from the same field and collaborate using the different communication mediums. Moreover, this platform can be helpful especially for academicians working on the silver economy to find their target group for research as senior citizens representatives showed immense interest in interacting with other innovation actors to participate in useful contributions instead of using it for casual chitchat as mentioned by the senior citizen: *“I think that communication is necessary. Also, it should be very close to social networks to make it more social-able, sharing videos and information with each other, so that the people who are on this platform, also make their teams for the projects, they can use these communications for making real project teams like if they want to sell something, so they make these communities of similar interest.”*

Having said this, it is also important to identify the medium of interaction that is most efficient and suitable for such an innovation platform to function. There was a mixed response from the participants regarding the socialization function of the platform. Some of them considered it a good idea to include the chat function and video call options to socialize through the DSH. One

Medium	No. of Votes
Chat	6
Voice call	4
Video call	2
Combination of all three	6
Integrated system (Zoom, Skype etc.)	11
No socialization	1

Table 2: Number of votes for each medium of communication.

participant even expressed his preference for video calls over the chat function due to the personal nature of it. However, a considerable number of interviewees thought that these services were already being provided by many other platforms and applications. Academia rep from Estonia stated: *“like nowadays we have MS Teams, Zoom and Skype, maybe there is no need for special, inbuilt video chat systems, it’s an integration between the system or the chat option, it’s a good way to say hello or to have somebody online, it’s better to have a direct message to have somebody being online than just sending an email and actually wait maybe a month after at work, or maybe it goes to some junk mailbox or doesn’t know, and if you find some common ground, it could be video call or some other option.”* As a digital space for the elderly, some suggested socialization functions specific to the silver generation that included convenience and ease of use as their primary advantage and therefore, preferred video or voice call over chat as mentioned by the senior citizen rep from Lithuania: *“Socialization is always important because some elderly people, they have some health problems, they are not so active and they spend more time at home. And it would be a very good idea to have a possibility to socialize with others using video call or via voice call.”* Table 2 summarizes the responses from interviewees into a number of votes against each medium.

When users socialize amongst each other and disseminate their knowledge and expertise, tacit knowledge is turned into explicit knowledge which is then internalized and becomes tacit knowledge and could serve as an asset for the platform. For a CI platform to be successful, different actors should be attracted to the platform to enhance this process of competency development and what is a better way than word-of-mouth, therefore, participants were asked if they would recommend their peers to use this platform and why. There was a mixed response as the platform is still a work-in-progress and they would want to test it for themselves first and then decide if they would like to recommend it to others. However, some of the interviewees were ecstatic with the concept of such a platform that is targeted for the silver economy and their well-being and stated that they would ask their colleagues and peers to join if the platform serves as it promises. The public sector authority representative from Finland mentioned; *“We are a Regional Council and we are interested in funding base activities and enabling better projects, and if this platform would be beneficial for those purposes, so it would help us to generate better projects, better results, then I would be interested, and then I would recommend for others as well.”*

5.2 Goals

According to the generic CI model of Suran et al., it is important to identify accomplishments and desired results bound to objectives in a given time frame. During the first phases of the research, a list of goals was identified and a majority of the participants agreed that these goals matched their expectations regarding the DSH. According to them the major goals revolved around providing innovative solutions for the silver generation in the BSR countries, fostering a collaborative knowledge exchange across the innovation actors, knowledge sharing, and the generation of feedback through the involvement of the end-users of the platform. Following is the list of the goals identified:

- The DSH will support learning processes and knowledge diffusion between innovation actors and regions.
- The DSH will facilitate interaction between innovation actors and create specific co-creation and learning environments.
- The DSH will bridge companies and research organizations for generating new innovative solutions to tackle ageing challenges and to exploit silver economy opportunities.
- The DSH will enable both companies and research organizations to generate challenges, requests or innovation projects and to invite each other to co-create innovative solutions for tackling ageing challenges.
- The DSH aims to enable the involvement of end-users in the co-creation of innovative solutions
- The DSH will be used for launching invitations and for scheduling end-user participation in different product development phases or the product validation stage.
- The DSH aims to facilitate knowledge transfer.

Given these aims, participants were asked what they expected from the platform in terms of the eventual outcome. Various innovation actors had differing opinions related to the main focus of the hub. One of the partner heads stated that the DSH would just be concentrating on developing new ideas and he would expect it to be all about knowledge transfer from academia to the business sector as a response to the need of businesses to always concentrate on solutions, not problems. Another candidate explained, *“It’ll bring together companies and research organizations for generating new innovative solutions. There would be debates regarding funding schemes in order to respond to these innovation ecosystem needs. It will also facilitate knowledge transfer. You could share your ideas and, if you have a certain idea, you and your business organization can look for an academic person to help you with research. So that is how the partner searching could take place.”* An academia rep from Lithuania mentioned that this platform could serve as a one-stop-shop for all the information related to the elderly and serve as a repository for all the available services in the market targeted to the silver economy. While the business rep from Latvia perceived that the platform would serve as a hub where new ideas will be worked on by different teams across different borders. The business rep from Finland stated;

“I want to expect that it will be something that the end-users will want to use and, of course, service providers want one to sell their services from this platform. So when every user group knows that it’s benefiting them all and it’s easy to use then I think we are quite far off.” Therefore, a summary of the main expectations of the participants regarding the outcome of the DSH is as follows:

- Developing new ideas
- Knowledge transfer
- Funding mechanisms
- Information repository
- Team formation
- Reliable information source
- Socialization opportunity
- Collaborations between the different countries in the Baltic Sea region
- Collaboration between quadruple helix actors
- Networking
- Creation of welfare technology projects for elderly
- Updated information
- Availability of new and interesting content
- Social welfare opportunities
- Ability to conduct market research and test innovative ideas

Quite a few of the quadruple helix expected the hub to include *“updated information for all four of the innovation actors.”* Most of them believed that the utility of the platform could be compromised if there was no way to make sure that the information available on it was up-to-date. A concrete service of the DSH that many interviewees mentioned was *“mapping and keeping track of latest trends in the silver economy.”* It could be a digital space that provided information and the URLs of all the products and services related to the silver generation in the BSR.

Another interesting observation made by one of the participants regarding the goals of the DSH and the expectations related to it was its role to serve as a digital alternative to Yellow Pages for all the services and products related to the silver economy. An innovation actor explained that, *“The digital silver hub is going to be more like an information and communication platform where you can do some partner searching if you have an innovative idea, And you can also navigate through the DSH and find different types of information about different services already available in the market. And so basically, it’s an information and communication platform.”*

Participants from all helixes had some ideas about the concrete services that the DSH should provide not only for an individual but also for the community.

The senior citizen rep from Denmark mentioned; *“platform should provide information about healthcare and legislation, as in what are your rights and what way to go if one needs help.”* Most of the participants from the business, public sector and academia helixes were interested in services where they could conduct their research, test their findings, collaborate and partner search for team building for innovative solutions that will eventually be targeted to the elderly people and contribute to the overall society. The public sector authority rep from Finland stated; *“I think the short term for myself because I work at the Regional Council and we are funding these projects and we want to have good development projects in our field. But I would like this platform to generate an arena for encouraging us to do better in the field, which is very important for all of us. If I think of myself in a long term, I’ll be living in this world as an elderly person so I would hope that there would be better services. Good practices and benchmarking should be encouraged and development funds should be deployed towards the welfare of the society and then results should be shared across the BSR and the world and kind of little by little to make the world a little bit better place to live.”*

The policymaker from Estonia explained that they are interested in trying to understand the system of labour market services, services that fit the needs of middle-aged and older people. The focus is to try to help the unemployed or people at the high risk of unemployment. It is already evident that the biggest challenge this target group faces are outdated skills. These people very often participate less in lifelong learning and eventually face more social challenges. But tackling this problem means getting them to participate in skill-building to find employment or suitable skills to help them remain on their employment. *“If there are initiatives on the DSH that managed to overcome this, for instance from the labour market training perspective, have good training and skill-building workshops, it will be highly valuable.”*

A majority of the interviewees admitted that they had not used a similar platform before. However, a few partner heads, researchers, and policymakers had been involved in related projects that were not transnational yet supported some kind of collaborative efforts from the participants and users for idea generation and knowledge sharing (see Table 3). The public sector authority rep from Finland stated; *“Yes, I have actually, kind of intensively been working at Nokia Corporation. So we were creating idea platforms and different kinds of platforms, for all kinds of things, for learning, sharing and generating ideas for business development etc. There’s also a Finnish startup called Solved. And they provide a platform for experts to work together with related to circular economic problems.”*

The DSH serves society by addressing the needs of the ageing population. It would provide them with a digital space to acquire information regarding products and services to support their everyday living and improve their quality of life. By involving the end-users (senior citizens) in idea and feedback generation, the platform provides concrete opportunities to realize the individual goals of the quadruple helix actors as well as the societal goals of facilitating a more productive and independent silver generation.

Region	Existing projects
Finland	AGE platform Europe ACTIVAGE Project This is Finland Agingcare.com Axxess
Estonia	Caremate CARMA EUROcarers Tallinn.ee Estonian Chamber of Disabled People
Latvia	Carer+ Riga Active Seniors Alliance (RASA)
Lithuania	Fabijoniškės Social Service Home Lithuania – Long-term care
Denmark	Danish Assistive Technology Database Danish.Care Danish Life Science Cluster

Table 3: Existing services for elderly in BSR.

5.3 Processes

The third theme generated through the qualitative analysis of the interview data is the processes that govern the development, operations and management of the DSH. Understanding these processes provides insight into the nature of the DSH through the CI framework. The proposed model describes CI processes as types of activities (create/decide) and interactions (dependent/independent). From the data gathered from the interviews as well as previous workshops, it is evident that the DSH serves as a platform that aims to enhance the generation of new and innovative ideas through co-creation and collaboration (*create*). These ideas are then further enhanced by other innovation actors and/or experts who express their opinion in terms of likes/dislikes, loopholes, feasibility and other factors (*decide*).

When participants were asked if they would be willing to share their ideas with other innovation actors, the majority of them agreed however, they pointed out that the platform should provide protection and patent rights to their ideas so that they are not copied by others in the market. An academic rep from Denmark said; “*I would be a little afraid of sharing ideas as I have to be pretty sure that my idea or service will not be copied. But if there is copyright or if your ideas are protected then I would be willing to share it. I would find it quite beneficial to work together with other innovation actors because I see a lot of potential in the whole idea of this project.*” This is a good example of *Collection* (i.e., create plus independent) whereby actors contribute their independent work to the system. In addition to this, participants were asked if they do agree to share their ideas on the platform, would they be willing to work on the idea themselves after they have received their feedback or would they like to collaborate with other innovation actors and co-create? There was a ratio of 4:1 who agreed to *collaborate* (i.e., create plus dependent) instead of

independently working on their ideas as the academic rep from Latvia expressed; *“collaboration is the key for successful development of innovative solutions.”*

Although generating and sharing innovative ideas has emerged as an important function of the platform, there is a need to determine the process of how these ideas will be shared and further developed. The data from the interviews suggest that several methods could be employed to choose the best ideas. However, as one of the interviewees mentioned that it was an *“open innovation platform”* where nobody was forced to share or implement their ideas. There are no hierarchies for decision-making, as this would be an open ecosystem where all the stakeholders come together to co-create, test, and maybe fund their innovative ideas.

A practical solution that emerged through the interview data was the possibility of discussion forums, votes, and contests. While looking for ways to foster creativity and settle conflicting ideas amongst the quadruple helix, an interesting example surfaced pertaining to a T-shirt company, Threadless¹⁴ that organizes virtual contests, asking people to submit T-shirt designs related to a certain theme. Voting takes place on their website, where the best designs are chosen based on the number of votes and score ratings for each design. Interview participants were optimistic that a similar approach could be applied to the DSH to generate new ideas, choose the best ideas and encourage participation from the quadruple helix as experts from different fields could judge according to their expertise. However, it was also mentioned that despite the ideas of voting and score rating can come in hand, it is also imperative to add a comment section and further enhance the idea by taking it to the discussion forum as the business rep from Denmark suggested; *“That depends on what we’re evaluating so if you have a logo or sign design or subjectively relevant, I think voting is perfectly fine. Because it’s very quick to get an intuitive understanding you either like it or you don’t. Whereas, for example, what is the best wheelchair might require a little bit more detail with all the specifications and details and with the innovative ideas, it is always best to have discussions and critical debates.”*

While most of the candidates were willing to participate in score rating, voting, and discussion forums to resolve the conflict of ideas and identify the best ones, some were reluctant to give input in matters they thought they did not have *expertise* in. A majority of the end-users or the senior citizens wanted to pitch in their opinions and feedback on services and products that concerned them, but a few did not seem very excited about the possibility of discussion forums and votes. There were also concerns amongst some candidates regarding the relevance of the people participating in the voting and discussion forums to the product/service/idea in question. An interviewee implied that a large number of people in one region cannot make good decisions about products or services that would be most suitable for another region. The end-users, the researchers, the private and public sector, all would have to come together and collaborate for knowledge creation and decision making.

Gamification has been emerging as a successful strategy to encourage user engagement with a product/service [3]. Keeping this in mind, participants were asked if they would be willing to participate in different contests or competitions on the platform and surprisingly, the majority of them including the senior

¹⁴Threadless

citizens were very enthusiastic about it. Academic rep from Finland stated; *“All kinds of competitions, they are quite good hooks for the hubs, so that if people have a chance to win something and even if it is some small prize, there is a high probability that they will come back. If the DSH conducts such competitions frequently, for example, once a month then it will help to grow the user base.”* The partner head from Estonia also mentioned; *“I think, yes, there should be some kind of prize because then people will be more motivated to engage. They get the knowledge, build PR, opportunity to collaborate and even sometimes money as a prize like you have to have some kind of motivation; some gift card or some collaboration or some opportunity.”*

A majority of the participants seemed to endorse a democratic decision-making process [group decision (i.e., decide plus dependent)], eliminating the need for bureaucratic hierarchies. However, one of the interviewees highlighted the significance of experts and informed decisions. He suggested that *“decisions might be made, not by a majority of laymen, but by qualified people; not delegated by others, but by real experts, where we’ll be able to make qualified decisions.”* The decision-making process was very well described by the lead partner head from Finland as she explained that whatever information is on the platform should be accessible for everyone depending on what role they choose. Basically, it should be open and with open access comes the risk of losing information or giving out too much information. In this case, platform users will be trusted that they will make wise decisions and move their discussions to more private facilities when discussing intricate details. Another significant factor that was brought to notice by the majority of the quadruple helix actors was trust. They pointed out that people and businesses will willingly share their ideas for discussion and feedback only if they have trust in the platform. While innovation centres and researches related to the silver economy might be operating separately in different regions, a platform that brought together the BSR countries through collaboration would require sufficient efforts to build its credibility.

5.4 Motivation

This theme tends to investigate and understand the motive behind stakeholder engagement and usage of the DSH. In order to develop a platform that facilitates transnational knowledge sharing and co-creation for the lifestyle improvement of the silver generation, it is imperative to comprehend the motives each innovation actor has behind engaging with the platform.

Since the research aims to include multiple stakeholders and innovation actors, each actor of the helix may have varying reasons behind their involvement with the platform. It is important to understand here that the senior citizens are the ultimate end-users of the innovative services and products listed on the DSH while all the four quadruple helix actors are the users of the DSH. One of the main aims of the DSH is to provide opportunities for the silver generation to improve the quality of their everyday life. To shed light on why the users would use the platform in the first place, the data suggests that most of them were interested in the knowledge dissemination function. Some wanted to share their experiences and ideas with others for the overall well-being of society, while others wanted to help maintain their own self-esteem and feel like contributing members of society. A few also displayed an inclination towards the financial benefits of sharing their knowledge and experience through the digital space.

One of the participants belonging to the academic sector discussed his motivation for using and contributing to the platform as follows: *“As a researcher, I can use my writing to create some content for sharing ideas, for sharing my knowledge. I can contribute my knowledge of a combination of sociology, psychology, communication, business, management, as well as my experience and social network. Meanwhile, I can find something for myself too. Maybe it’s interesting to participate in some research, which I see as an opportunity as well.”*

Almost all of the quadruple helix and the partner heads identified dissemination of knowledge as a chief motivator for them. However, the private sector also considered money and profits as a very convincing reason for them to show interest in the DSH. A participant even declared that you need to make money to keep things running and without generating profits/revenues, it would be difficult to achieve sustainability for the platform.

The representative of the business sector from Denmark argued that money, fame or social welfare motives were not all mutually exclusive. While explaining his motivation behind engaging with the DSH, he said; *“I don’t see those three as mutually exclusive. I usually find that the more you can supply all three, the better. But I think when you’re talking about companies at heart, it is first a financial motivation. Otherwise, I don’t think anything is scalable. So the other motive would be to find other people who would be interested in teaching or have specialized knowledge, or if we somehow change our target audience, to be elderly people, then get access and validate a market potential. And I don’t necessarily see social welfare as being intertwined with age and pension. I think the big challenge today is not social welfare-related, it is realizing that elderly people are not useless. They still have a lot of activities they want to do. And they also have quite a lot of value to society. That’s a lot of work starting from adopting digital technologies, where physical challenges or maybe even slower reaction time is not a problem.”*

In order to attract a user base and encourage participation on the DSH, extrinsic motivational factors were considered more valuable as the majority of interviewees claimed that they will be more willing to contribute if they know that this platform will provide them with some kind of reward. Tangible and/or intangible rewards, both were chosen over social welfare.

The academic rep from Finland stated; *“It would save my time and effort for finding information related to the silver economy on this hub. I think that some people may have already covered the relevant information so that I don’t have to do it myself anymore. In this position where I’m now, it would be to gain and disseminate knowledge but if I would get an opportunity to earn money, that’s also good however, not so much for social welfare.”*

The participants were also asked about what should be done to ensure that the platform engages them for a longer period and keeps them coming back to the platform. It is very important for any CI platform’s success that it encourages participation and users’ active involvement however, not all platforms can do so. It was identified that several factors can impact such engagement levels such as the onboarding process optimization, customer support, regular updates, new content, feedback collection and convenient user interface. One of the participants suggested that he was interested in the content, interesting solutions, other people’s achievements, and success stories. The senior citizens were more concerned about the user-friendliness of the platform. One of them

agreed that he would continue using the platform if, *“if it’s working, if it’s easy, if it’s convenient, sort of efficient, offers an easy way to do things, and gets the answers I’m searching for.”* A senior citizen from Lithuania also said; *“the user interface if it’s interactive, it’s attractive. It’s interesting. That is something that would always encourage me to come back.”* On the other hand, the public sector authority rep from Denmark suggested that if the quality of the outcome is up to the mark and if desired results were achieved from the DSH, then user engagement will not be a problem. An academic rep from Estonia stated; *“it would be good to have some update mechanism to inform if there is something new going on in the market or if there is a technology presentation on the hub that I could attend or somehow bring me back to this environment.”* The business rep from Lithuania also mentioned on the same lines; *“it’s the constant update of information. If you do some subscriptions, we have resources to know that those can be quite useful. For example, many people don’t like email subscriptions. But for example, I do subscribe, because it’s the most informative way of getting to know people and other businesses. And those who are interested, they do read the subscriptions.”*

5.5 Additional Requisites

The DSH is a transnational collaborative framework that involves participation from the BSR countries. These countries are facing similar challenges pertaining to demographic change and hence a digital collaborative platform involving BSR countries can address the problem for all of them. However, it has already been established that idea generation and knowledge sharing are amongst the most important aims of the platform. Hence, it is important to investigate whether the platform users; contributors and beneficiaries both, would be interested in ideas generated elsewhere in the world. A vast majority of the research participants did not have any hesitation in accepting ideas from countries beyond the BSR. But a few of the policymakers identified a need to establish laws and procedures pertaining to such knowledge exchange such as security protocol and copyrights.

The Project Partner Heads were also concerned about the decision-making process and ways to establish trust amongst the users. Some suggested the use of ratings or review systems to ensure transparency and credibility both. Although it has already been established that the platform would be employing an open innovation system, there were some reservations amongst participants related to the degree of openness and transparency.

The business partners were also concerned about the financial mechanism and the marketing functionalities of the system as the DSH would serve as a platform for collaboration and co-creation for innovative solutions, most of the participants were concerned about how the funding will take place. Government, incubation centres and private sectors (sponsorship) should be interested in financing such a platform as an example from Lithuania came forward; GovTech Lab¹⁵ seeks to solve societal challenges using technology. It is powered by the Agency for Science, Innovation and Technology and has received funding from European Regional Development Fund. Other official partners include the Ministry of the Economy and Innovation of the Republic of Lithuania, Lithuanian

¹⁵GovTech Lab

Airport, Regulatory Authority of the Republic of Lithuania, Statistics Lithuania, Vilnius Sveikiau, Ministry of Social Security and Labour and many more.

Only a few of the participants were aware of any similar platforms in other countries such as IDEO; the open ID platform in California or the Finnish Startup Solved. But there wasn't any open innovation platform that supported transnational collaboration for the silver economy.

6 Evaluation and Discussion

Several functionalities were identified through the thematic analysis of the interviews conducted from the partner heads of the OSIRIS project as well as the quadruple helix actors from each region in the BSR. These functionalities had to be validated by experts in order to analyse which are the best fit to achieve the desired objectives of the DSH therefore several experts were approached working in different fields of technology and science targeted to the silver economy (see Table 4). These experts also served in the expert committee to the OSIRIS project for requirement evaluation and prototype testing. Evaluation of the functionalities was gathered using an evaluation form whereby they had to go through each feature and they could agree/disagree and also state the reason for their preference. Building on the aforementioned motivations, this section highlights the main functionalities and their evaluation from the experts which is then further translated to an illustration of the components of the DSH using the Generic CI model in Fig 5.

Expert Name	Role	Organization
Leena Lemola	Project Manager	Riihimäki Business Development Company
Eglė Brezgytė	Head of Project department	Klaipėda State University of Applied Sciences
Taivo kangilaski	Senior Researcher	Laboratory for Proactive Technologies
Michael Smærup	PhD and Associate Professor	VIA University College
Marina Weck	Principal Research Scientist	Häme University of Applied Sciences
Kirsten Maibom	Research Manager	Research Centre in Health and Welfare Technology
Egils Rupeks	Member of Social Enterprise Commission	Ministry of Welfare of Latvia
Søren Aalykke	Project Manager	Center for Assisted Living Technology
Erik kangilaski	Software Developer	Tallinn University of Technology
Syed Hammad Hassan	Financial Crime Investigator	Wise PLC

Table 4: Expert Names with their roles and organizations

The DSH functionalities are developed based on the generic CI model of

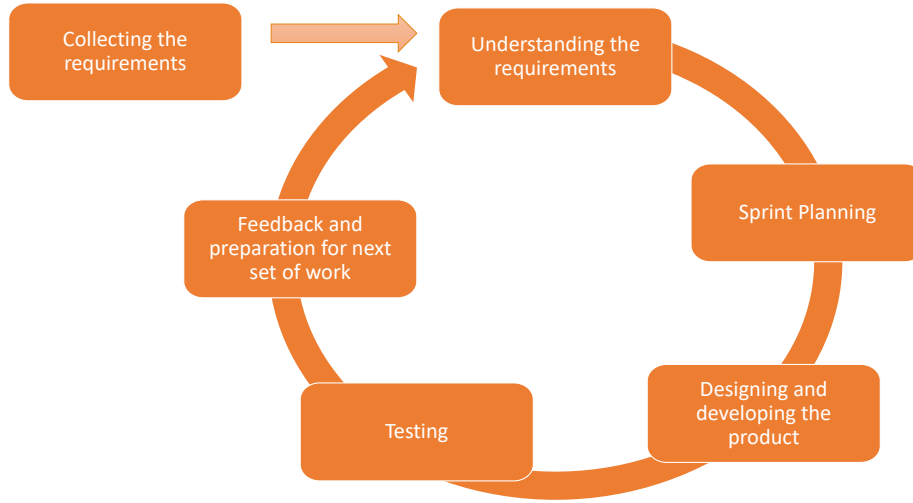


Figure 4: Agile Life Cycle [13]

Suran et al., which means that an environment has to be conditioned to enable quadruple helix actors (*who*) to develop innovative ideas and solutions (*what*) with the help of resources and knowledge exchange and co-creation techniques (*how*) to help silver economy live an independent and active life (*why*). In order to develop the DSH, agile methodology (See Fig 4) has been adopted due to its flexible nature whereby a web developer works on small chunks of the project. This is extremely useful especially when multiple iterations of the project are accessible and work is being reviewed at each stage. It allows to implement changes constantly and receive feedback which results in continuous delivery of semantically structured outcomes.

The first step of the agile lifecycle is to collect a part of the information about the project which means that required functionalities are collected from the project partners and the quadruple helix actors. The next step is to understand these requirements which are then prioritized and necessary resources are allocated. We need to create a backlog where we have functionalities which software developers can start to use and for this, we need to have the data for the system.

6.1 The ‘Who’ Dimension

The key actors on the platform are not the project heads but stakeholders or innovation actors. Project heads like other stakeholders participate in collaboration using the DSH collaborative platform. This platform serves as a virtual environment where all stakeholders can collaborate in innovation processes using a methodology based on knowledge exchange, co-creation/production techniques, and participatory methods. At the beginning of the project, it was considered that all stakeholders including the partner heads will contribute as well as benefit from the DSH in order to ensure sustainability of the system. However, from the interview responses and expert evaluations, it was identified

that the role of the project heads is limited and they are only important till the implementation phase. After that, it will be the quadruple helix actors including businesses, public sector authorities, educational institutions and senior citizens who will ensure that the platform is used for the intended purpose and goals and activities are successfully achieved and executed. Triple helix actors that include businesses, public sector authorities and academicians can use the platform as the beneficiary as well as the contributor. They may use the platform to extend their own research, market their products/services or help contribute toward the silver economy by participating in different collaborations for innovative solutions for the elderly independent living. However, the majority of senior citizens may be reluctant to comprehend their part as contributors to the platform, though they would not seem to mind using it for their benefit. However, the senior citizens may not perceive DSH as directly useful to them but they are very important for all the other helixes and their representatives. Therefore, they need to be convinced to participate in some manner as consultants on senior needs. On the contrary, in some regions such as Finland, senior citizens are very active and are willing to use the platform in providing own contribution to the development of innovative product and service solutions that enable them to continue living a comfortable, independent, and active life.

There are several areas where actors can participate and contribute to the platform. It can be in the form of sharing innovative ideas and discussing their feasibility. An innovation actor may use the platform to discuss the idea, gain feedback and search for partners for joint collaboration. Feedback can be obtained on a certain innovation idea or a publication from experts on the platform who also happen to be stakeholders. These ideas can also be tested e.g. if an innovation actor wants to test how a certain technology will be accepted by the elderly, a pool of senior citizens on the platform can be approached and asked to participate in identifying perceived usefulness and perceived ease of use. Moreover, these ideas can be discussed and criticized at the discussion forum where innovation actors from all walks of life can participate and give their expert opinion. The DSH can also be used to organize training/mentoring programs not only to educate about the changing technology to innovation actors but also to create technology readiness amongst the elderly. Information on these training programs, along with other events and innovations have to be updated and shared on the platform. This is possible if stakeholders actively participate in the DSH and keep it up-to-date. In addition to this, the platform also serves as a ground for market research where quadruple helix actors are available if focus groups have to be arranged, interviews have to be conducted or questionnaires have to be filled out. Other areas where stakeholder can contribute is to give new perspectives to the political discussion, to share the end users' perspectives and needs, to market innovations, services, and products for other ecosystem members and to provide networks to larger companies that might be interested in purchasing or cooperating with smaller companies or innovators. It is also important to identify KPIs for any platform to gauge success and to ensure that the objectives are being met. However, measuring success can be very subjective as one factor might be important to one while the other completely discredits it. Therefore, a set of predetermined KPIs has to be deliberated and frequently measured to identify the loopholes and gaps which can then be worked on to improve the performance of the platform. According to the expert evaluation,

the number of loyal users should be the main KPI as they determine most of the activity on the platform and keep it running. Moreover, new content has to be published and kept updated. An example of Facebook came forward as it attracts its users and retains them by keeping its newsfeed fresh and crisp. It was also highlighted that the number of innovative ideas can be a viable KPI but it was contradicted by many as well. There should be some criteria set up first to evaluate an innovative idea that would qualify as successful.

The majority of participants are willing to socialize with other innovation actors or senior citizens on the platform and find it to be necessary for the platform's success. However, according to the experts' evaluation, socialization in isolation may not have any value unless it is translated into collaboration in innovation and business development. Moreover, it was also highlighted that there might be a problem of such 'cross-helix' communication, given the different backgrounds of participants and a more inclusive approach has to be put into practice which may require further research and understanding. The medium of communication also plays an important role in making participants comfortable with socialization. According to thematic analysis results, integrated systems like Zoom/Skype/Teams may play a vital role in ensuring smooth interaction between the innovation actors however, according to the experts, inbuilt chat systems should also be built to enable instant interaction with convenience. It was also suggested that the social media platforms like LinkedIn and Facebook should also be merged to channel networking and build public relations. Chatting is preferred over video and voice calls because it allows stakeholders to keep their privacy intact to some extent. The only problem is that if the communication is on a transnational level, some senior citizens do not trust themselves to participate in English.

6.2 The 'What' Dimension

The goals of the DSH are already listed in Section 5 which were finalized by the project team and cover all directions of the silver market growth. These goals were identified in the initial phases of the research and according to expert evaluation, these goals are comprehensive and truly ambitious. These goals are set by project heads and participants at different workshops in the earlier stages of research therefore, it was necessary to enquire from the quadruple helix actors from BSR about their own views of the outcome of the DSH to ensure that their expectations meet these goals. The main expectations from the platform identified were building innovative solutions to the problems faced by the elderly people in their everyday life and also enhancing knowledge transfer and exchange amongst the innovation actors. Moreover, the DSH provides an opportunity to build cooperation and collaborations between not only different actors from the different helixes but also from different countries in the BSR. The business, public sector and academia helixes are interested in services where they could conduct their research, test their findings, collaborate and partner search for teambuilding for innovative solutions that will eventually be targeted to the elderly people and contribute to the overall society. A concrete service of the DSH is identified as the "mapping and keeping track of latest trends and technology solutions in the silver economy". It could be a digital space that provided information and the URLs of all the products and services related to the silver generation in the BSR.

6.3 The ‘How’ Dimension

The DSH would serve as an ecosystem where innovative solutions are not only developed but also discussed, criticized, tested and also open for collaboration. With an open innovation approach, ideas are shared with all and/or chosen stakeholders at the platform, therefore, patent rights have to be provided to protect their ideas from being copied in the market. However, with such open innovation development, it is also imperative for the innovation actors to understand the risks and be aware of their own rights. Nonetheless, the platform will be able to achieve its objectives and goals, if an environment of trust has been established. Stakeholders need to feel protected to be able to share and work on their ideas on the DSH therefore patenting and copyrights have to be thoroughly incorporated.

As it is an open innovation platform, there will be a democratic structure with no hierarchies for decision making instead everyone will be trusted to make the right decisions for themselves and act responsibly on the platform. Such an open ecosystem usually allows more creativity and ingenuity. But when there are so many ideas, how can one decide which is better than the other? It is, therefore, necessary to have a system to foster inspiration, settle a dispute or choose the best ideas. It was recognized that when someone has an innovative idea, a proposal or a visual display could be drafted to present on the DSH, whereby other experts and innovation actors can vote or score rate them as the famous quote says; “Majority is authority.” Since technological solutions are more complicated and need more in-depth reviews, it is also imperative to add a comment section alongside it to be able to add detailed comments and also, if possible, further enhance the idea by taking it to the discussion forum. Furthermore, in order to attract new users or to encourage the existing users to let their creative juices flow and come up with innovative ideas, the expert evaluation also agreed that the contests should be held. These contests intrigue an element of competition and lay a positive impact on the process of idea generation. A contest can be arranged in a way that a certain theme e.g. healthcare for the elderly can be employed and contestants can be encouraged to come up with new ideas on how different healthcare problems can be solved. Winners can then be provided awarded with a reasonable amount of cash money or gift cards etc. According to the experts’ evaluation, senior citizens would also like to participate in the contests as they have time and resources and they want to be involved in community activities, product and service developments for themselves and feel useful for the society.

6.4 The ‘Why’ Dimension

Stakeholders and innovation actors need the motivation to participate on the platform and contribute to the development of innovative solutions for elderly people to help them live a more comfortable and independent life. It has been identified that extrinsic motivation factors play an utmost important role to drive their behaviour. External rewards including tangible such as money and intangible such as fame can prove to be very beneficial in encouraging the actors to make their contributions. Although intrinsic factors like social welfare cannot be completely ignored, these factors may play a little or no part in motivating the innovation actors to invest their efforts and help DSH achieve its objectives.

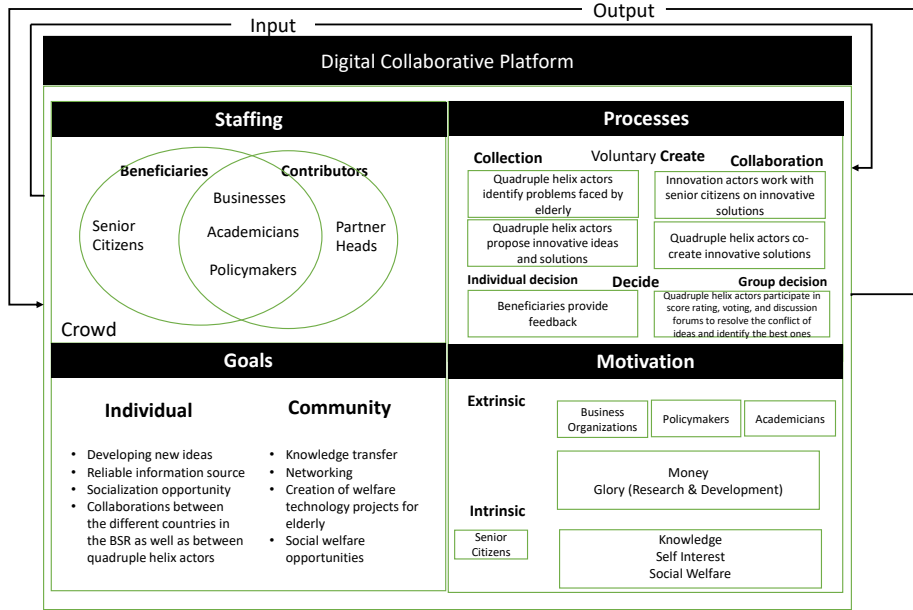


Figure 5: Components of DSH illustrated using the 'Generic' CI Model of Suran et al.

When an innovation actor is convinced to sign up for the DSH, it is imperative that the platform is engaging and helps in user retention. According to the experts' evaluation, users will be engaged if they feel or find the platform useful, i.e. platform can satisfy their needs and support their innovation development processes. It should also be convenient to sign up for, enter the DSH and navigate the system to impact user engagement levels positively. The platform includes interesting innovations and contacts that may interest financiers, enterprises, public stakeholders etc. To support innovation development processes and market uptake of innovative solutions and to tackle the social challenges, the government, incubation centres and private sectors (sponsorship) should be interested in financing such a platform.

7 Future Work

As mentioned earlier, DSH uses an agile methodology therefore the next step is to define sprint. In order to set targets, sprint duration is set which is the time duration required to complete the task. If the sprint is short, the working version becomes more flexible and frequent subsequently, requiring feedback on the regular basis. In our case, the data (functionalities) is collected and analysed and it will be provided to the developer to add it to the DSH. In this case, the sprint duration is one month.

Then the platform designing and development is done which includes incorporating the given functionalities to the website. This way a part of the website is ready for visualization that could provide a clearer picture of what the final

outcome will look like and in case of any bugs or errors, an immediate fix can be done. This is referred to as testing which includes the developer performing a small set of tasks on the platform, feedback is given and changes can be done constantly. When a reasonable amount of functionalities have been collected and incorporated on the DSH, project partners will then be invited to test the hub and give their feedback.

System requirements specification and system design document have to be prepared to outline the architecture components of the DSH. DSH will use the classical three-tier architecture, where the logic tier and data tier are used as a “Platform as a Service” (PaaS) approach. It is a well-established software application that composes of three tiers: Presentation tier, Application tier and Data tier. This architecture provides flexibility to the development teams as each tier is run by its infrastructure and development teams which means that it can be developed simultaneously and update a specific part of the tier independently without affecting other parts of the system. Based on the identified functionalities, the following architecture components have to be developed:

- User Management - request user rights, create user / update / deactivate user, user authentication functionality
- Menu / Category Management - create top menu element, category and/or category element
- Country and Role Management - create and activate countries and roles
- Information Content Management - create / update / remove content (services), including overall and technical information
- Custom Page management - create custom pages and publish them. Publishing links (for events, terms etc.)
- Forum management - create a forum, administrate topics and moderate content
- Search Engine - find elements from pages and Information Content
- Chat Module - possibility to have online chat with other chat users
- Information publishing and dashboard - publish information into the front-end, display user right requests count, display forum compliance problems notifications.

8 Conclusion

Demographic change is a growing concern all over the world and several measures are in place to tackle the challenges that arise from the growing population of senior citizens. One such similar initiative is the development of the DSH which is a transnational collaborative digital platform to enhance the uptake of innovative ideas and ensure the exchange of technological solutions to the problems faced by the ageing population. The main aim of the DSH is to enable the ageing population to find solutions to their everyday problems and resolve them independently. In this way, it will be perceived as an entrepreneurial

opportunity instead of an economic burden and consequently, allow the silver economy to contribute back to society positively. This paper identifies the main functionalities based on the generic CI model and identifies the main actors, processes, goals and motivation that the DSH should fulfil to be accepted as a CI platform. These functionalities were validated and evaluated by different experts in the BSR working in different fields of science and technology in the silver economy. The DSH's novelty lies in the fact that it is a transnational digital platform that involves the quadruple helix actors and use their expertise and knowledge to develop technological solutions for the silver economy.

Acknowledgement

This work has been partially conducted in the project "ICT programme" which was supported by the European Union through the European Social Fund.

References

- [1] M. Ardolino, N. Saccani, F. Adrodegari, and M. Perona. A Business Model Framework to Characterize Digital Multisided Platforms. *Journal of Open Innovation: Technology, Market, and Complexity*, 6(1):1–23, 2020.
- [2] D. Bhatt, Ganesh. Knowledge management in organizations: examining the interaction between technologies, techniques, and people. *Journal of Knowledge Management*, 5:68–75, 2001.
- [3] P. Bitrián, I. Buil, and S. Catalán. Enhancing user engagement: The role of gamification in mobile apps. *Journal of Business Research*, 132:170–185, 2021.
- [4] A. Boder. Collective intelligence: A keystone in knowledge management. *Journal of Knowledge Management*, 10(1):81–93, 2006. doi: 10.1108/13673270610650120.
- [5] E. Bonabeau. Decisions 2.0: The power of collective intelligence. *MIT Sloan Management Review*, 50(2):45–52, 2009. ISSN 1532-9194.
- [6] K. J. Boudreau and A. Hagiu. Platform Rules: Multi-Sided Platforms as Regulators. In A. Gawer, editor, *Platforms, Markets and Innovation*, Chapters, chapter 7, page 29. Edward Elgar Publishing, United Kingdom, April 2009.
- [7] F. Bran, M.-L. Popescu, and P. Stanciu. Perspectives of Silver Economy in European Union. *Revista De Management Comparant International/Review of International Comparative Management*, 17:130–135, 2016.
- [8] V. Braun and V. Clarke. *Thematic Analysis*, pages 57–71. American Psychological Association, Washington, 2012.
- [9] V. Braun, V. Clarke, N. Hayfield, and G. Terry. *Thematic Analysis*, pages 843–860. Springer Singapore, Singapore, 2019.

- [10] A. Brooking. *Corporate Memory: Strategies for Knowledge Management*. Intellectual capital series. International Thomson Business Press, London ; New York, 1999.
- [11] A. Bryman. Quantitative and qualitative research: further reflections on their integration. In *Mixing methods: Qualitative and quantitative research*, page 22, London, 2017. Routledge.
- [12] S. Butt, I. Pappel, and E. Ounapuu. Potential for increasing the ict adaption and identifying technology readiness in the silver economy: Case of estonia. In *Electronic Governance and Open Society: Challenges in Eurasia (EGOSE 2020)*, pages 139–155, St. Petersburg, 01 2020. Springer International Publishing.
- [13] S. Butt, K. Rava, T. Kangilaski, I. Pappel, and D. Draheim. Designing A Digital Collaborative Platform for the Silver Economy: Inception and Conceptualization. In *Proceedings of ICEDEG 2021 - the 8th International Conference on eDemocracy & eGovernment*, pages 47–54, Quito, 07 2021. IEEE.
- [14] L. Camarinha-Matos, H. Afsarmanesh, F. Ferrada, A. Oliveira, and J. Rosas. A comprehensive research roadmap for ict and ageing. *Studies in Informatics and Control*, 22:233–254, 09 2013.
- [15] A. ConwayLenihan, N. Woods, K. K., A. Thummel, and R. M. The Implications of Regional and National Demographic Projections for future GMS costs in Ireland through to 2026. *BMC Health Services Research*, 14, 02 2015.
- [16] G. Cornet. Europe’s ‘silver economy’: A potential source for economic growth? *Gerontechnology*, 13:319–321, 01 2015.
- [17] K. Dampney, P. Busch, and D. Richards. The meaning of tacit knowledge. *Australasian Journal of Information Systems; Vol 10, No 1 (2002)*, 10, 01 2007. doi: 10.3127/ajis.v10i1.438.
- [18] T. Davenport and V. Grover. General Perspectives on Knowledge Management: Fostering a Research Agenda. *Journal of Management Information Systems*, 18:5–22, 06 2001.
- [19] S. Davis. *Connectionism: Theory and Practice*. Vancouver studies in cognitive science. Oxford University Press, USA, 1992. ISBN 9780195076660. URL <https://books.google.rw/books?id=aEtnDAAAQBAJ>.
- [20] R. Dendere, C. Slade, A. Burton-Jones, C. Sullivan, A. Staib, and M. Janda. Patient portals facilitating engagement with inpatient electronic medical records: A systematic review (Preprint). *Journal of Medical Internet Research*, 21, 11 2018.
- [21] L. Dore. Winning Through Knowledge: How to Succeed in the Knowledge Economy. Special Report by the Financial World; The Chartered Institute of Bankers in association with Xerox, 2001.

- [22] C. Doukas, V. Metsis, E. Becker, Z. Le, F. Makedon, and I. Maglogiannis. Digital cities of the future: Extending @home assistive technologies for the elderly and the disabled. *Telematics and Informatics*, 28(3):176–190, 2011. Digital Cities.
- [23] T. Eisenmann, G. Parker, and M. Van Alstyne. Strategies for two-sided markets. *Harvard Business Review*, 84:92–101+149, 10 2006.
- [24] G. Elia and A. Margherita. *A Collective Intelligence Platform for Developing Technology Entrepreneurship Ecosystems*, pages 195–220. Palgrave Macmillan, London, 01 2016.
- [25] S. Elo and H. Kyngäs. The qualitative content analysis process. *Journal of advanced nursing*, 62 1:107–15, 2008.
- [26] P. Ensign and L. Hebert. Knowledge sharing among r&d scientists. In *Proceedings of the Hawaii International Conference on System Sciences*, volume 37, page 7, USA, 01 2004. IEEE.
- [27] D. Evans and R. Schmalensee. *Matchmakers: The New Economics of Multisided Platforms*. Harvard Business Review Press, Massachusetts, 2016. ISBN 9781633691735. URL <https://books.google.ee/books?id=pIhZCwAAQBAJ>.
- [28] P. Evans and A. Gawer. The rise of the platform enterprise: A global survey, 2016.
- [29] J. Felix. Silver economy: opportunities and challenges to Brazil adopt the European Union’s strategy. *Innovation: The European Journal of Social Science Research*, 29:1–19, 04 2016.
- [30] J. Gamble. Tacit vs explicit knowledge as antecedents for organizational change. *Journal of Organizational Change Management*, ahead-of-print, 10 2020. doi: 10.1108/JOCM-04-2020-0121.
- [31] L. Grinin, A. Grinin, and A. Korotayev. Forthcoming Kondratieff wave, Cybernetic Revolution, and global ageing. *Technological Forecasting and Social Change*, 115, 10 2016.
- [32] A. Hagi and D. Yoffie. What’s Your Google Strategy? *Harvard Business Review*, April, 2009, 87:74–81, 04 2009.
- [33] R. Halonen and E. Laukkanen. Managing tacit and explicit knowledge in organisational teams. In *Third IEEE International Conference on Digital Information Management (ICDIM)*, pages 292–297, London, 11 2008. IEEE.
- [34] S. B. Hamid, A. A. Norman, Z. Abu Bakar, and J. Mohammad Nayan. NLM Knowledge Bank: A Framework of Managing Knowledge in the National Library of Malaysia. In *ICOLIS 2007, Kuala Lumpur: LISU, FCSIT, 2007*, pages 85–91, Selangor, 2007. Koleksi Persidangan.

- [35] S. Hermes, T. Riasanow, E. K. Clemons, M. Böhm, and H. Krcmar. The digital transformation of the healthcare industry: exploring the rise of emerging platform ecosystems and their influence on the role of patients. *Business Research*, 13(4):1–37, 2020.
- [36] N. Istudor and I. Petrescu. Sustainable business opportunities in rural areas. *Quality - Access to Success*, 17:14–19, 03 2016.
- [37] K. Jackson and P. Bazeley. *Qualitative Data Analysis with NVivo*. Sage Publications Ltd, Thousand Oaks, 2019.
- [38] M. Kiger and L. Varpio. Thematic analysis of qualitative data: Amee guide no. 131. *Medical Teacher*, 42:1–9, 05 2020.
- [39] T. K. Koh and M. Fichman. Multi-Homing Users’ Preferences for Two-Sided Exchange Networks. *MIS Quarterly*, 38:977–996, 12 2014.
- [40] F. Kohlbacher. *Caught in inaction?!? How do companies respond (or not) to the business implications of demographic change*, pages 101–108. Springer Fachmedien Wiesbaden, Germany, 01 2020.
- [41] F. Kohlbacher, C. Herstatt, and N. Levsen. Golden opportunities for silver innovation: How demographic changes give rise to entrepreneurial opportunities to meet the needs of older people. *Technovation*, 39-40:73–82, 2015.
- [42] H. Landemore and J. Elster. *Collective Wisdom: Principles and Mechanisms*. Cambridge University Press, Cambridge, 2012. doi: 10.1017/CBO9780511846427.
- [43] B. Laperche, S. Boutillier, F. Djellal, M. Ingham, Z. Liu, F. Picard, S. Reboud, C. Tanguy, and D. Uzunidis. Innovating for elderly people: the development of geront’innovations in the French silver economy. *Technology Analysis & Strategic Management*, 31(4):462–476, 2019.
- [44] P. Levy. *Collective Intelligence: Mankind’s emerging world in Cyberspace / Pierre Levy ; translated from French by Robert Bononno*. Plenum Trade New York, New York, 1997.
- [45] T. Malone and M. Bernstein. *Handbook of Collective Intelligence*. HANDBOOK OF COLLECTIVE INTELLI. MIT Press, Cambridge, 2015. ISBN 9780262029810. URL <https://books.google.ee/books?id=Px3iCgAAQBAJ>.
- [46] T. W. Malone and M. Klein. Harnessing collective intelligence to address global climate change. *Innovations: Technology, Governance, Globalization*, 2(3):15–26, 2007. ISSN 1558-2477. doi: 10.1162/itgg.2007.2.3.15.
- [47] T. W. Malone, R. Laubacher, and C. N. Dellarocas. Harnessing crowds: Mapping the genome of collective intelligence. *SSRN Electronic Journal*, 1(4732):9, 2009. doi: 10.2139/ssrn.1381502. URL <https://doi.org/10.2139/ssrn.1381502>.
- [48] H. Mohajan. Qualitative research methodology in social sciences and related subjects. *Journal of Economic Development, Environment and People*, 7:23–48, 03 2018.

- [49] G. Mulgan. *Big mind: How collective intelligence can change our world*. Princeton University Press, New Jersey, 2018.
- [50] Y. Nakamori. Knowledge Management. In: Knowledge Construction Methodology. *Translational Systems Sciences*, 20:63–91, 2020.
- [51] L. Neven. By any means? questioning the link between gerontechnological innovation and older people’s wish to live at home. *Technological Forecasting and Social Change*, 93:32–43, 2015. Science, Technology and the “Grand Challenge” of Ageing.
- [52] A. Newell. The knowledge level. *Artificial Intelligence*, 18(1):87–127, 1982. ISSN 0004-3702. doi: [https://doi.org/10.1016/0004-3702\(82\)90012-1](https://doi.org/10.1016/0004-3702(82)90012-1). URL <https://www.sciencedirect.com/science/article/pii/0004370282900121>.
- [53] I. Nonaka and H. Takeuchi. *The Knowledge-creating Company: How Japanese Companies Create the Dynamics of Innovation*. Everyman’s library. Oxford University Press, United Kingdom, 1995. ISBN 9780195092691. URL <https://books.google.ee/books?id=B-qxrPaU1-MC>.
- [54] I. Nonaka and R. Toyama. Strategic management as distributed practical wisdom (phronesis). *Industrial and Corporate Change*, 16:371–394, 05 2007.
- [55] M. Pagani. Digital business strategy and value creation: Framing the dynamic cycle of control points. *MIS Quarterly*, 37:617–632, 10 2013.
- [56] V. Pattanaik, S. Suran, and D. Draheim. Enabling social information exchange via dynamically robust annotations. In *Proceedings of the 21st International Conference on Information Integration and Web-Based Applications & Services*, iiWAS2019, page 176–184, New York, NY, USA, 2019. Association for Computing Machinery.
- [57] C. Pope, S. Ziebland, and N. Mays. Analysing qualitative data. *BMJ Clinical Research*, 320:114 – 116, 01 2000.
- [58] M. Popescu, A. Predescu, and D. Oancea. Economic factors concerning development of Romania as future silver economy. *Quality - Access to Success*, 15:355–358, 01 2014.
- [59] G. Pór. Collective intelligence and collective leadership: Twin paths to beyond chaos. *Sprouts: Working Papers on Information Systems*, 8(2), 01 2008.
- [60] B. Sarayreh, A. Mardawi, and R. Aldmour. Comparative Study: the Nonaka Model of Knowledge Management. *International Journal of Engineering and Advanced Technology*, 1(6):45–48, 2012.
- [61] M. Schrage. *Collaborative Tools: A First Look*. R.L. Ruggles III (ed.), Knowledge Management Tools. Butterworth-Heinemann, United Kingdom, 1997. URL <https://www.taylorfrancis.com/chapters/mono/10.4324/9780080509846-17/collaborative-tools-first-look-michael-schrage-rudy-ruggles?context=ubx&refId=65d5ecf1-8e5c-41d4-b542-fe9325aea891>.

- [62] T. Segaran. *Programming Collective Intelligence : Building Smart Web 2.0 Applications*. O'Reilly, California, 2007.
- [63] P. Spagnoletti, A. Resca, and G. Lee. A Design Theory for Digital Platforms Supporting Online Communities: A Multiple Case Study. *Journal of Information Technology*, 30:364, 02 2015.
- [64] N. Staub, K. Haki, S. Aier, and R. Winter. Taxonomy of Digital Platforms: A Business Model Perspective. In *Hawaii International Conference on System Sciences (HICSS 54)*, page 10, USA, 01 2021. IEEE Computer Society.
- [65] S. Suran, V. Pattanaik, S. B. Yahia, and D. Draheim. Exploratory analysis of collective intelligence projects developed within the EU Horizon 2020 framework. In N. T. Nguyen, R. Chbeir, E. Exposito, P. Anjorté, and B. Trawiński, editors, *Proceedings of ICCCI 2019 – the 11th International Conference on Computational Collective Intelligence*, Lecture Notes in Artificial Intelligence 11684, pages 285–296, France, 2019. Springer. doi: 10.1007/978-3-030-28374-2_25. URL https://doi.org/10.1007/978-3-030-28374-2_25.
- [66] S. Suran, V. Pattanaik, and D. Draheim. Frameworks for Collective Intelligence. *ACM Computing Surveys*, 53(1):1–36, may 2020. ISSN 0360-0300. doi: 10.1145/3368986. URL <https://dl.acm.org/doi/10.1145/3368986>.
- [67] F. Talebzadeh and M. Samkan. Happiness for our kids in schools: A conceptual model. *Procedia - Social and Behavioral Sciences*, 29:1462–1471, 12 2011. doi: 10.1016/j.sbspro.2011.11.386.
- [68] L. Thomas, E. Autio, and D. Gann. Architectural leverage: Putting platforms in context. *Academy of Management Executive*, 28:198–219, 06 2014. doi: 10.5465/amp.2011.0105.
- [69] A. Tiwana, B. Konsynski, and A. Bush. Research Commentary —Platform Evolution: Coevolution of Platform Architecture, Governance, and Environmental Dynamics. *Information Systems Research*, 21:675–687, 12 2010.
- [70] United Nations: Department of Economic and Social Affairs - Population Division. World population ageing 2019, 2019.
- [71] V. Vafaie, E. Rahimi, N. Rostami, and F. Shad. The importance of knowledge management on innovation. *Applied mathematics in engineering, management and technology*, 5(1):68–73, 10 2016.
- [72] D. J. Vergados, I. Lykourantzou, and E. Kapetanios. A resource allocation framework for collective intelligence system engineering. In *Proceedings of MEDES'10 – the 2nd International Conference on Management of Emergent Digital EcoSystems*, pages 182–188, Thailand, 2010. ACM.
- [73] T. Wenginger. An exploration of submissions and discussions in social news: Mining collective intelligence of Reddit. *Social Network Analysis and Mining*, 4(1):173, 2014. doi: <https://doi.org/10.1007/s13278-014-0173-9>.

- [74] G. Ye, R. Priem, and A. Alshwer. Achieving Demand-Side Synergy from Strategic Diversification: How Combining Mundane Assets Can Leverage Consumer Utilities. *Organization Science*, 23, 02 2012.
- [75] M. Zsarnoczky. Innovation challenges of the silver economy. *Vadyba Journal of Management*, 28(1):105–109, 2016.
- [76] M. Zsarnoczky. Silver tourism. In *International Scientific Days 2016: The Agri-Food Value Chain: Challenges for Natural Resources Management and Society*, pages 556–563, Slovak Republic, 06 2016. Faculty of Economics and Management; Slovak University of Agriculture in Nitra.