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S H A P E S

Smart and **H**ealthy **A**geing
through **P**eople **E**ngaging in supportive **S**ystems

D1.3 – SHAPES Innovation and Knowledge Directory First Draft

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Revision History

Table 1 Revision History

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0.2	30/09/2021	Sonja Grigoleit, Simone Schmitz, Diana Freudendahl (FhG)	First draft version
0.3	05/10/2021	Sonja Grigoleit, Simone Schmitz, Diana Freudendahl (FhG)	Revised version
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1.0	31/10/2021	Michael Cooke (NUIM)	Contribution – IPR Management

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Table of Acronyms and Abbreviations

Table 3 Acronyms and Abbreviations

Acronym	Full Term
ACTIVAGE	ACTivating InnoVative IoT smart living environments for AGEing well
AIOTES	ACTIVAGE IoT Ecosystem Suite

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CAD	Computer-aided design
CoP	Community of Practice
CRM	Customer relationship management
ELSA	Ethical, legal and social aspects
FAITH	a Federated Artificial Intelligence solution for moniToring mental Health status after cancer treatment
FP7	7th Framework Programme
GA	Grand Assembly
GATEKEEPER	Smart Living Homes – Whole Interventions Demonstrator for People at Health and Social Risks
ICT	Information and communications technology
InteropEHRate	Interoperable EHRs at user edge
IoT	Internet of Things
IoT-AHA	Internet of Things for Active and Healthy Ageing
IPACSO	Innovation Framework for ICT Security
IPR	Intellectual property rights
KET	Key and Emerging Technologies
NUIM	Maynooth University
OECD	Organisation for Economic Co-operation and Development
OPEN DIE	Aligning Reference Architectures, Open Platforms and Large-Scale Pilots in Digitising European Industry
PHArA-ON	Pilots for Healthy and Active Ageing
PMB	Project Management Board
R&D	Research & Development
RRI	Responsible Research and Innovation
SECI	Socialization, Externalization, Combination, Internalization
S-EHR	Smart Electronic Health Records
SHAPES	Smart and Healthy Ageing through People Engaging in Supportive Systems
SMART4HEALTH	Citizen-centred EU-EHR exchange for personalised health
SMARTBEAR	Smart Big Data Platform to Offer Evidence-based Personalised Support for healthy and Independent Living at Home
SWOT	Strengths, Weaknesses, Opportunities, Threats
TRIZ	Theory of inventive problem solving

Keywords

SHAPES, Innovation Management, Knowledge Management, Knowledge Sharing

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Executive Summary

This deliverable presents an interim version of the **SHAPES Innovation and Knowledge Directory**. It describes a **literature review** on different innovation and knowledge management models and strategies as well as an overview how the innovation process was planned in similar healthcare project of the OPEN DEI initiative.

On this basis the SHAPES innovation and knowledge management strategy was developed. Specifically, the following steps were defined:

- Identification of **user requirements**
- Definition of the **context environment** (lifeworld of aging individuals; organisational, structural and sociotechnical factors; ELSA)
- Development and/or adaption of digital solutions and creation of the **SHAPES platform**
- **Evaluation of the SHAPES platform** in real life use cases
- Development of **Business models** and the broader SHAPES ecosystem
- **Dissemination and Exploitation** of SHAPES solutions

To foster knowledge sharing within SHAPES the following measure will be considered:

- **Face-to-face meetings** and workshops as well as (informal) knowledge sharing via IT mediated tools is of uttermost importance to build trust and commitment
- The barriers and challenges of knowledge sharing, such as **differences in culture, language and legal environment** have to been addressed
- SHAPES has to aim for a balance between o**pen research and the protection of intellectual property**
- The consortium members aim to create an environment which is **open to new ideas**
- During meetings **plain language** should be used and examples or stories should be used (when possible) to explain content
- All project partners should have **clear roles and expectations** (also part of D1.1)
- **MS Teams** is used as a helpful tool for knowledge sharing

The SHAPES knowledge management also includes the **publication of the SHAPES innovations and the results of the foresight exercises**.

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All SHAPES technological and non-technological innovations are made available to the consortium via the publication of this deliverable (and the final one due in M48) and also on a more regular basis in MS TEAMS.

Relevant innovations outside of SHAPES are published on Information Cards (Technology Cards and Influencing Factor Cards) on a regular basis and are available in TEAMS and also in the Annex of this deliverable.

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1 Introduction

This deliverable is the first of two versions of the SHAPES Innovation and Knowledge Directory. It describes a literature review on different innovation and knowledge management models and strategies as well as an overview how the innovation process was guided in similar European large-scale pilot projects. On this basis the SHAPES innovation and knowledge management strategy was developed and presented in this report.

In the second part of this report the different technological and non-technological innovations of SHAPES are shown. Additionally, the Information Cards (Technology Cards and Influencing Factor Cards) of the foresight exercises in WP9 are compiled in the Annex of this deliverable.

This version of the deliverable presents the current state of the art of the SHAPES innovations. The final version in M48 will deliver the final version of all SHAPES innovations.

1.1 Rationale and purpose of the deliverable

1.1.1 Deliverable Objectives

This deliverable outlines the innovation and knowledge management strategy of SHAPES, informs about the current status of the SHAPES innovations and compiles the results of the foresight exercises.

1.1.2 Key inputs and outputs

This report is based on a literature review regarding innovation and knowledge management models and strategies.

Additionally, a questionnaire was sent to all SHAPES partners to collect the status of the innovations within this project.

Furthermore, the results of the foresight exercises in WP9 (Information Cards: Technology Cards and Influencing Factor Cards) are presented in this report.

The main output of this deliverable is the final innovation and knowledge management strategy for SHAPES as well as an overview about the broad bandwidth of different innovations of the project.

1.2 Structure of the document

This document is divided into six main sections:

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- Section 1 contains an introduction to this report
- Section 2 describes the literature review about innovation and knowledge management models and strategies.
- Section 3 outlines the SHAPES innovation and knowledge management strategy.
- Section 4 compiles the different technological and non-technological innovations of SHAPES.
- Section 5 describes the results of the SHAPES foresight exercises - the innovations and trends in pan-European care.
- Section 6 concludes this report.

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2 Background: innovation and knowledge management

2.1 Definition – what is innovation and knowledge management?

2.1.1 Innovation

The term innovation has **multiple definitions** and involves different approaches. For some authors, innovation is a process wherein knowledge is acquired, shared, and assimilated to create new knowledge that embodies products and services (Harkema 2003) methods and processes (Brewer and Tierney 2012), and social and environmental contexts (Harrington et al. 2016). Characteristic of innovations is the creation of value (Castaneda and Cuellar 2020).

(Du Plessis 2007) delineated innovation as a **formation of new knowledge** which helps the new business returns, which has purpose to make organization internal business process and structure more sophisticated that produce the market acceptable products and services (Akram et al. 2011).

(Akram et al. 2011) suggested a more overarching definition: "Activities and processes of **creation and implementation of new knowledge** in order to produce distinctive products, services and processes to meet the customers' needs and preferences in different ways as well as to make process, structure and technology more sophisticated that can bring prosperity among individuals, groups and into the entire society.

On a more general level innovation is broadly understood as a **transformation of knowledge into new products, processes and services** (Filippov and Mooi 2009).

The following box contains definitions from several authors and organizations (Figure 1).

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- "Innovation (Latin – innovare): to make something new. (Oxford English Dictionary)"
- "Innovation is the successful exploitation of new ideas. (Department Trade & Industry (DTI) 2003)."
- "Successful innovation is the creation and implementation of new processes, products, services and methods of delivery which result in significant improvements in outcomes, efficiency, effectiveness or quality" (Albury 2005).
- Innovation is "the successful development, implementation and use of new or structurally improved products, processes, services or organisational forms" (Hartley 2006).
- "Innovation is the successful exploitation of new ideas" (Utterback 2006).
- "Innovation is a process that turns new ideas into opportunities and puts these into widely used practices (Tidd und Bessant 2011)"
- The European Commission Green Paper on Innovation (European Commission 1995) indicates that the term innovation is commonly used in two different ways:
    - To refer to the innovation process itself (i.e. the process of bringing any new, problem solving idea into use)

  And
    - To refer to the result of the innovation process (i.e. a new product, process, service or work practice). An innovation in this sense may be a radical innovation/breakthrough or a product, process or service improvement or an adaptation."

Figure 1: Selected definitions of "innovation".

There are also **different taxonomies of innovation**. According to the (OECD 2007) there are four types of innovation: product, process, marketing, and organizational. Other classifications of innovation are technological or not (Archibugi; Nelson 2010), incremental or radical (Henderson and Clark 1990), disruptive (Christensen and Raynor 2013), and open innovation (Chesbrough 2012; Castaneda and Cuellar 2020).

Also Higgins (1996) - similar to the OECD report - suggests **four types of innovation** (Likar et al. 2013; Die Merkhilfe Wirtschaft 2020):

- **Product innovation** (which results in new products or services or enhancements to old products or services, e.g. the electric car)
- **Process innovation** (which results in improved processes within the organization – for example business process re-engineering, e.g. introduction of the assembly line in the production of motor vehicles)
- **Management innovation** (which improves the way the organization is managed)

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- **Marketing innovation** (including the functions of product promotion, pricing and distribution, e.g. streaming services like Netflix or Spotify)

Other dimensions which are in use to classify innovations are: **type and degree of novelty** of the innovation (Jacobs and Snijders 2008). There is also a fuzzy approach to novelty in which all innovations can be assigned along an axis from incremental to radical. In a similar way (Mulgan and Albury 2003) distinguish, incremental, radical and systemic innovation. Another dimension is the type and **size of the organisation** in which the innovation project took place and furthermore the environment/sector in which the innovation was developed (Eveleens 2010).

Other authors make a distinction between innovations that took place in **a private firm or in a public organisation**. (Eveleens 2010).

2.1.2 Innovation process models

(Eveleens 2010) compared in his study 12 **innovation process models** from various sources – management literature, policy papers and scientific handbooks. He concluded that all innovation models distinguish between certain phase, stages or building blocks.

All models start with some form of **idea generation** or searching for ideas for innovation. The next step is for a majority of authors to narrow the options down, to take a decision, and to **select which projects are pursued** and which are not pursued. The next step is then to turn the (selected) idea into some **tangible product**, process or service. Here words such as development, prototyping or manufacturing are used. This **prototype is then tested** with first users. The fifth general step is the one in which the newly developed product, process or service is going to be implemented in “the real world”. This phase is called **implementation/launch**. However, some models include a **post launch phase**. This entails the sustaining and supporting of the innovation or even re-innovating it and scaling it up. At last, a few models also include a phase for explicit learning. Not only learning about the innovation itself, but also about how the innovation process went (Eveleens 2010; Die Merkhilfe Wirtschaft 2020).

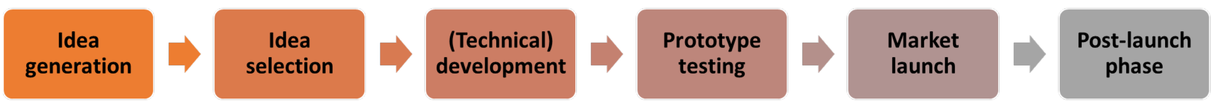

Figure 2: Most important steps of an innovation process (Eveleens 2010; Die Merkhilfe Wirtschaft 2020)

For each of these phases of the innovation process (Eveleens 2010) has composed routines or activities from the different models. His selected list is presented in Table 4.

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Table 4: Selected list of tools, routines and activities for the different phase of the innovation process (Eveleens 2010).

Idea generation	Idea Selection	Develop-ment and Testing	Implemen-tation/ Launch	Post-Launch	Learning
Away-days; give people time away to come up with new ideas.	SWOT analysis to determine strategic position	Operating tests: tests to check the functionality/ reliability of the product under real-life working conditions.	A detailed financial analysis, involving a return or profitability assessment.	Designate “idea evangelists”	Value Analysis
Quality Function Deployment; analyse how to deliver value to the customer	Risk Assessment Matrix	Let users try the product and let them give feedback	Trade literature, trade shows, and trade advertising but no special promotion or training for the sales force.	Organise places where professionals meet: ‘collaboratives’ in the health service or Talking Heads (school heads)	Brainstorming
Review of competitors' products	Portfolio management	Rapid prototyping technologies and approaches	use alfa, beta gamma versions of products		Benchmarking
Invite artists or trend-spotters	Payback period and/or break- even analysis	Try out different approaches	apply a stage- gate model		
Build cross-unit networks		Create safe havens			
Role-playing					

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What can we learn from it for the SHAPES project?

Include the **different steps of an innovation process**
- Idea generation, Idea selection, Technical development, Prototype testing, Market launch, Post-launch phase

Use **validated tools and activitites** in the different innovation process steps
- e.g. brainstorming, prototyping, cross-organisational networking

2.1.3 Innovation management models

Similar to the term "innovation" itself there are also many definitions for innovation management.

According to an **early definition**, innovation management is the discipline of managing processes in innovation. Innovation management can be used to develop both product and organisational innovation. The focus of innovation management is to allow the organisation to respond to an external or internal opportunity, and use its creative efforts to introduce new ideas, processes or products (Kelly and Rossini 1978).

It is also described as a field of discipline that deals with issue relating to **how the innovation process could be managed effectively** (Harkema and Browrys 2002). With innovations as the mainstay of today's business, innovation management is seen as an organisation's core function (Kyriazopoulos and Samanta 2009; Lee 2016)

By utilizing **innovation management tools**, management can trigger and deploy the creative capabilities of the work force for the continuous development of an organization (Clark 1980). Common tools include brainstorming, prototyping, product lifecycle management, idea management, design thinking, TRIZ, Phase–gate model, project management, product line planning and portfolio management (Aas et al. 2017; Wikipedia 2021)

The table below contains a list of different **innovation management methodologies and tools** (Hidalgo and Albors 2008).

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Table 5: Innovation management typologies and associated methodologies (Hidalgo and Albors 2008)

Innovation Management technique	Methodologies and tools
Knowledge management tools	Knowledge audits Knowledge mapping Document management IPR management
Market intelligence techniques	Technology watch/ Technology Scan Patents Analysis Business Intelligence CRM: Customer relationship management Geo-marketing
Cooperative and networking tools	Groupware Team-building Supply Chain Management Industrial Clustering
Human resources management techniques	Teleworking Corporate intranets Online recruiting e-Learning Competence Management
Interface management approaches	R&D - Marketing Interface Management Concurrent Engineering
Creativity development techniques	Brainstorming Lateral Thinking TRIZ Scamper Method Mind Mapping
Process improvement techniques	Benchmarking Workflow Business process re-engineering Just in Time
Innovation project management techniques	Project Management Project appraisal Project portfolio management
Design and product development management tools	CAD systems Rapid Prototyping Usability approaches Quality Function Deployment Value analysis
Business creation tools	Business simulation Business Plan Spin-off from research to market

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Apart from the single tools and methodologies themselves there are also overarching **models of innovation.**

(Rothwell 1994) documented **five shifts or generations of innovation models**, demonstrating that the complexity and integration of the models increases with each subsequent generation as new practices emerge to adapt to changing contexts and address the limitations of earlier generations (Ortt and van der Duin 2008; IPACSO - Innovation framework for ICT security).

Rothwell found that each new generation was in fact a response to a significant change in the market such as economic growth, industrial expansion, more intense competition, inflation, stagflation, economic recovery, unemployment and resource constraints. (Buyse 2012).

2.1.3.1 1st generation Innovation model – Technology push

The 1st generation technology push era of innovation models represents a **simple linear structure** which maps innovation as a sequential process performed across discrete stages. Technology push is based on the assumption that new technological advances 'push' technological innovation via applied research, engineering, manufacturing and marketing towards successful products or inventions as outputs (IPACSO - Innovation framework for ICT security). This means that push-based models to innovation are more internally and **technologically oriented** (Nieminen 2018).

This first generation model, however, incorporates market information very late in the process, so that commercial applications are often merely technical inventions and therefore often not adopted to the market (Buyse 2012; Berkhout et al. 2006). Another **disadvantage** is that these pushed innovations don't give enough attention to the transformation process of existing products or the needs of the market place and the consumers (Ceravolo et al. 2016; Rothwell and Wissema 1986).

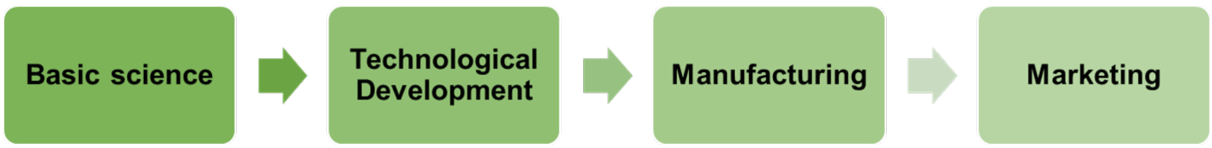

Figure 3: Technology push innovation model (Du Preez and Louw 2008; Varjonen 2006).

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2.1.3.2 2nd generation Innovation Models – Market Pull

In the 1960s mid, the approach shifted from Technological push to Market pull. The **focus began on responding to market needs**. Factors ignored during the first generation are considered now in the second generation (Alcor AF Bureau 2020).

The second-generation model is also a **linear** one, but this time prioritizing the importance of market demand in driving innovation. What distinguishes this model from its predecessor is that rather than product development originating from scientific advances, new ideas originate in the marketplace, with R&D becoming reactive to these needs (IPACSO - Innovation framework for ICT security).

The model recognizes the fact that including the market/consumer needs will help drive performance and will be a source of ideas for new and better products/services (Hughes and Chafin 1996; Ceravolo et al. 2016).

A major **disadvantage** of the second generation models is that there is too much emphasis on market-driven improvements of existing products (optimisation), resulting in a large variety of short-term projects (Buyse 2012; Berkhout et al. 2006)

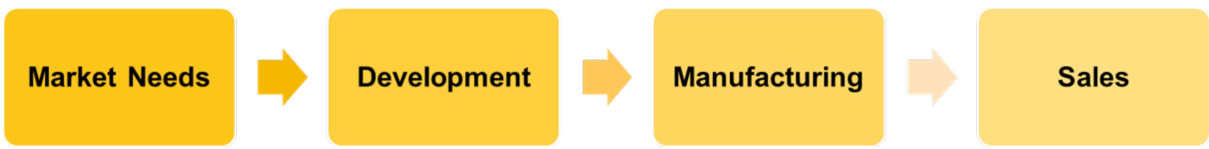

Figure 4: Market pull innovation model (IPACSO - Innovation framework for ICT security).

The first and second generation of innovation models are both still being used today, with minor modifications such as adding control elements between each phase to approve the transitioning from one phase to another like in the stage-gate model. The **stage-gate model** was predominantly used by NASA in the 1960's while trying to find creative innovative ideas to send a man on the Moon. This model, further simplified and suggested by (Cooper 2002) consists of five relevant phases or stages and the added controlling elements here are the gates positioned after each phase.

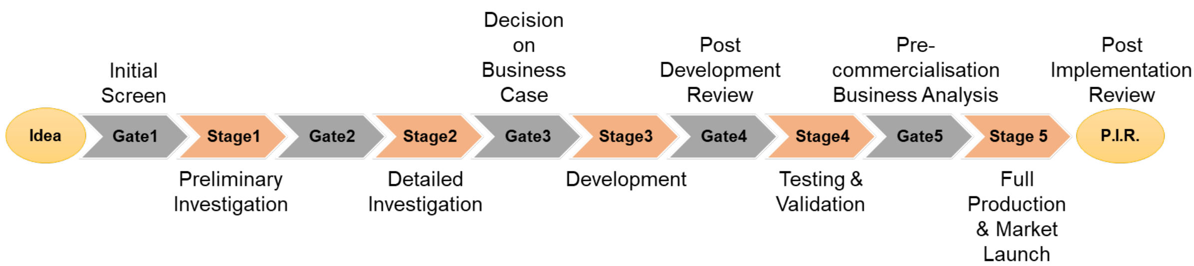

Figure 5: Cooper's Stage Gate Model (Cooper 2002; Ceravolo et al. 2016)

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2.1.3.3 3rd generation Innovation Model – Coupling Method:

The third generation Interactive, Coupling or Chain-linked models overcame many of the shortcomings of the previous linear models, by incorporating interaction and feedback loops to recognize that innovation is characterized by an interaction between science and technology and the marketplace (IPACSO - Innovation framework for ICT security). This means that in this 3rd model the **technology push and market pull models are "coupled"** (Nicolov and Badulescu 2012; Ceravolo et al. 2016)-

It is understood that innovation is rarely the result of pure technology push or market pull forces, but rather the result of the matching and combination of the two. The process is still sequential but with **feedback loops**. R&D and marketing play a balanced role. The emphasis is given to the interface between the two (Buyse 2012).

Third-generation models can be seen as 'open R&D models', emphasising product and process innovation (technical), and **neglecting organisational and market innovations (non-technical)** (Berkhout et al. 2006).

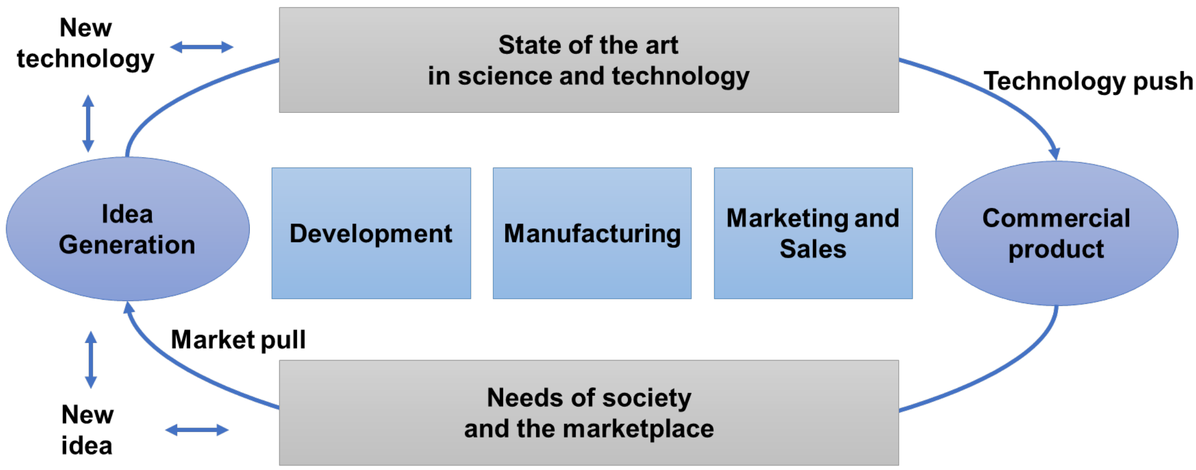

Figure 6: Third generation coupling model of innovation (Du Preez and Louw 2008; Rothwell 1995).

4th generation Innovation Model – Integrated Model:

In response, and aiming to reflect the high degree of cross functional integration within firms, fourth generation integrated or parallel models **reflect significant functional overlaps between departments and/or activities**. A further novel feature of this model is the **concept of external integration** in terms of alliances and linkages with suppliers, customers, universities and government agencies (IPACSO - Innovation framework for ICT security).

This model focuses essentially on the two primary internal features of the process, i.e. its parallel and integrated nature (Buyse 2012). It emphasises on the role of feedback and the **non-sequential character of the innovation process**. Innovation is also by definition, **cross functional**, and R&D is just one of the functions involved in the

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innovation process. The fourth generation integrated model also puts emphasis on the concurrent learning with customers and suppliers (Buyse 2012).

Fourth-generation innovation models can be characterised by the following properties (Berkhout et al. 2006):

1. Innovation is embedded in **partnerships**: 'open innovation'.
2. Attention is given to an **early interaction between science and business**.
3. **Hard knowledge of emerging technologies** is complemented by **soft knowledge of emerging markets**.
4. The need for new organisational concepts is acknowledged by emphasising **skills for managing networks** with specialised suppliers as well as early users.
5. **Entrepreneurship** plays a central role.

According to (Bochm and Fredericks 2010) the fourth innovation generation was driven by Simultaneous Engineering or New Product Simultaneous Engineering and the skill with which **Japanese companies were using these processes to generate disruptive innovations**, for example, automobile manufacturers' ability to introduce new cars within 30 months, while their rivals took from 48 to 60 months (Barbieri and Álvares 2016).

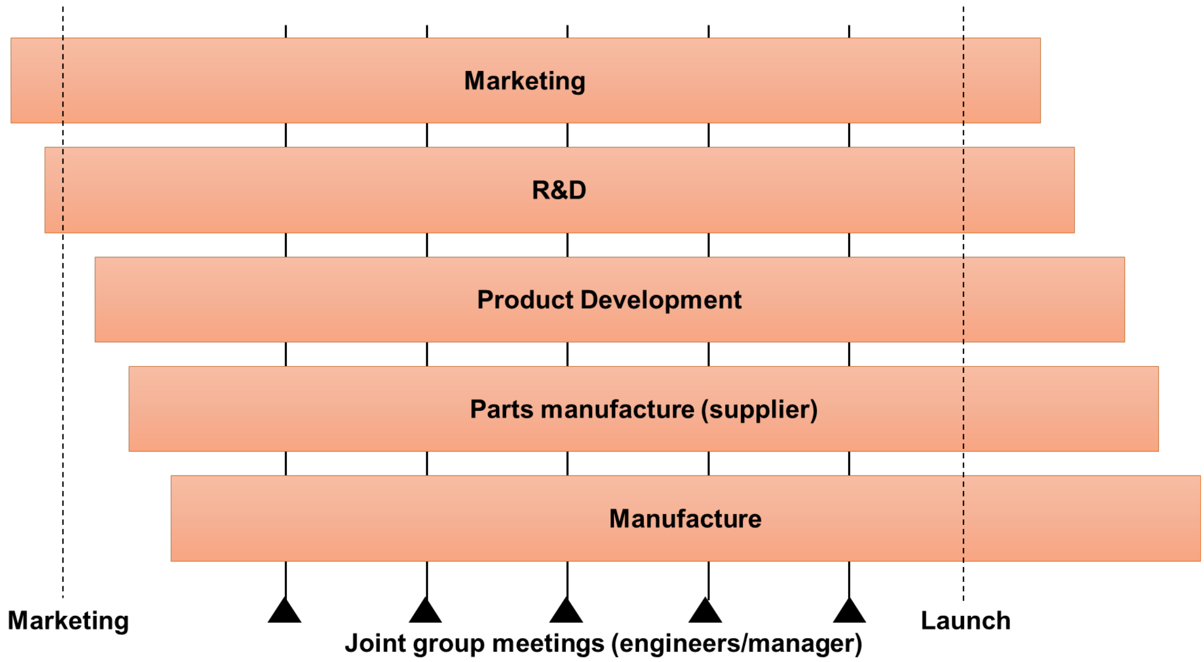

Figure 7: Forth generation model (Rothwell 1995; Du Preez and Louw 2008).

2.1.3.4 5th generation Innovation Model – Network Model

Extending from the previous generation of innovation models, fifth generation systems integration and networking models emphasize that innovation is a **distributed**

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networking process requiring continuous change occurring within and between firms, characterized by a range of external inputs encompassing suppliers, customers, competitors and universities. Reflecting a systems thinking approach, the dominant characteristics are the integration of a firm's **internal innovation ecosystem** and practices with *external factors in the National Innovation Environment* (Du Preez and Louw 2008). The fifth generation models are characterized by the introduction of **ICT systems** to accelerate the innovation processes and communications across the networking systems in terms of raising both development efficiency and speed-to-market through strategic alliances (IPACSO - Innovation framework for ICT security).

The fifth generation innovation models are bases for the intensive and flexible use of integrated networks and systems for implementing innovations quickly and continually (Barbieri and Álvares 2016). The focus was on gaining **flexibility and increasing the development speed** (Alcor AF Bureau 2020).

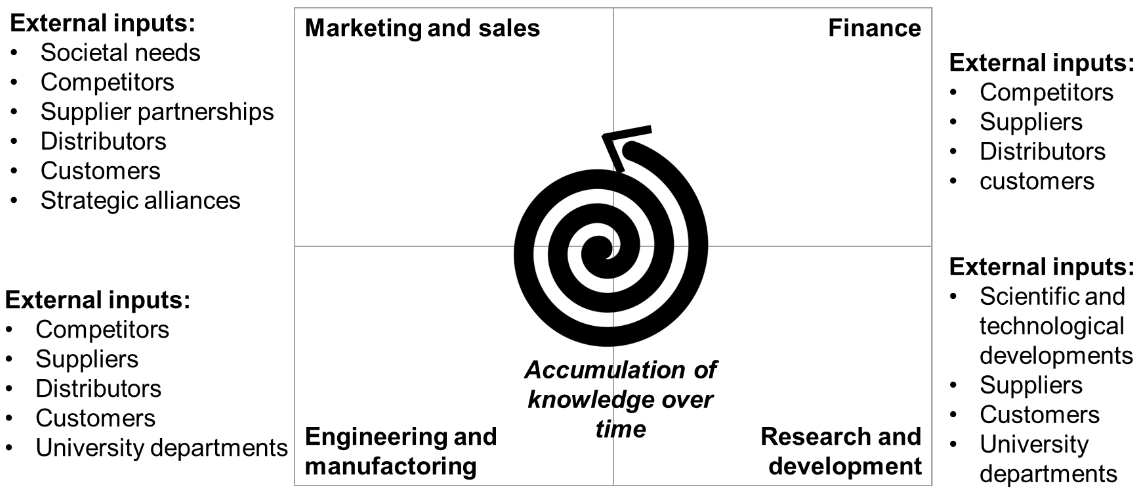

Figure 8: A network model of innovation (5th generation) (Du Preez and Louw 2008; Trott 2012).

2.1.3.5 6th generation Innovation Model – Open Innovation Model

Reflecting the preceding network models of innovation, the open innovation approach is **not limited to internal idea generation and development** (IPACSO - Innovation framework for ICT security).

Introduced by (Chesbrough 2010) this model underlines **idea management** also **with other organizations**. R&D is being done by outside partners, if it is not possible to be handled by the company itself. Additionally, ideas can occur while developing a new product/service, which can change the course of the process. This model promotes using outside knowledge, such as suppliers, competition, entrepreneurs, scientists etc. (Ceravolo et al. 2016).

(Enkel et al. 2009) identified three core processes in open innovation (IPACSO - Innovation framework for ICT security):

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1. **The outside-in process:** which involves enhancing and extending an enterprise's own knowledge base through the integration of suppliers, customers, and external knowledge sourcing.
2. **The inside-out process:** which refers to securing commercial/revenue benefits by bringing ideas to market faster than internal development via licensing IP and/or multiplying technology, joint ventures, and spin-offs.
3. **The coupled process:** which combines co-creation with partners through alliances, cooperation, and reciprocal joint ventures with the outside-in process (to gain external knowledge) and the inside-out process (to bring ideas to market).

As (Chesbrough et al. 2006) defines, "Open innovation is the use of purposive inflows and outflows of knowledge to accelerate internal innovation, and expand the markets for external use of innovation, respectively." It looks out for technological advancements by **combining internal and external ideas** (Alcor AF Bureau 2020).

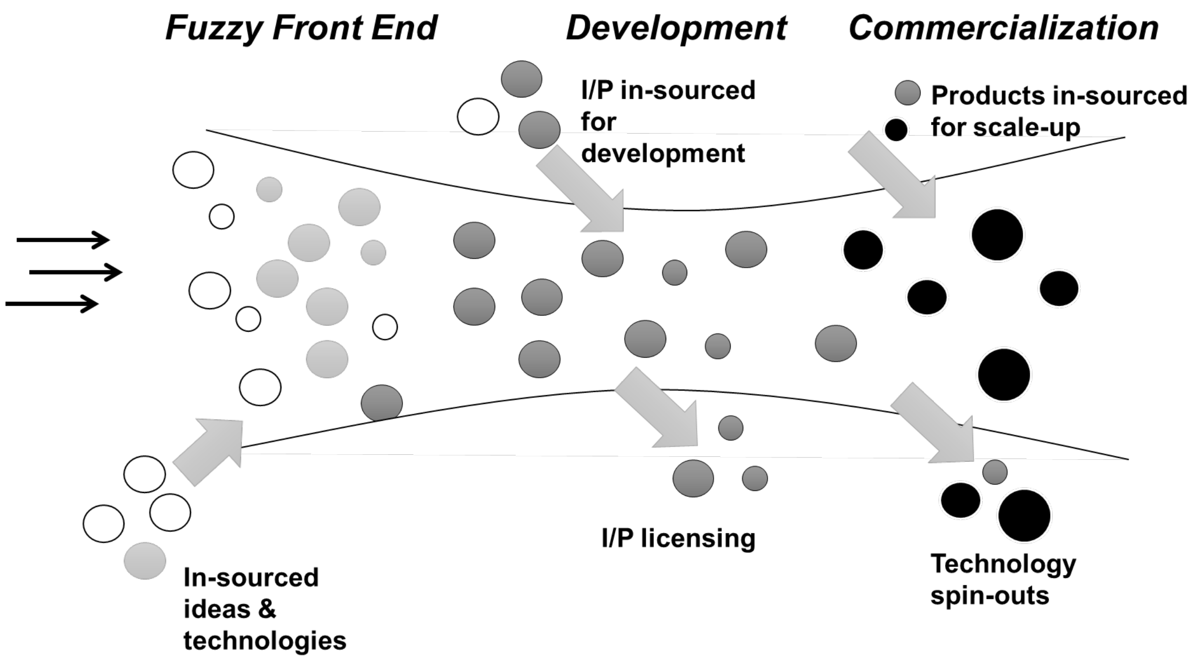

Figure 9: Open innovation model (Du Preez and Louw 2008; Docherty 2006)

2.1.3.6 Summary of the different innovation models

The FP7 project IPACSO has composed an overview of the different generations of innovation models (see Table 6).

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Table 6: Generations of Innovation Framework Model ((Du Preez and Louw 2008; IPACSO - Innovation framework for ICT security; Rothwell 1992)).

Model	Generation	Characteristic	Strengths	Weaknesses
Technology Push	First	Simple linear sequential process, emphasis on R&D and science	Simple, radical innovation	Lack of feedbacks, no market attention, no networked interactions, no technical instruments
Market Pull	Second	Simple linear sequential process, emphasis on marketing, the market is the source of new ideas for R&D	Simple, incremental innovation	Lack of feedback, no technology research, no networked interactions, no technological instruments
Coupling	Third	Recognizing interaction between different elements and feedback loops between them, emphasis on integrating R&D and marketing	Simple, radical and incremental innovation, feedbacks between phases	No networked interactions yet, no technological instruments
Interactive	Fourth	Combination of push and pull models, integration within firm, emphasis on external linkages	Actor networking, parallel phases	Complexity increment of reliability, no technological instruments
Network	Fifth	Emphasis on knowledge accumulation and external linkages, systems integration and	Pervasive innovation, use of sophisticated technological instruments, networking to	Complexity increment of reliability

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		extensive networking	pursue innovation	
Open	Sixth	Internal and external ideas as well as internal and external paths to market can be combined to advance the development of new technologies	Internal and external ideas as well as internal and external paths to market can be combined	Assumes capacity and willingness to collaborate and network, risks of external collaboration

The linear **first- and second-generation models** have been widely criticized for their **overly simplistic** linear, discrete and sequential nature of the innovation process. In response, the third generation of models demonstrates how the various business functions interact during the innovation process in addition to integrating the importance of technology push and market pull dimensions. Nonetheless, the main criticism of **third generation models** for is that they **do not detail sufficiently mechanisms for interacting with environmental factors** (IPACSO - Innovation framework for ICT security).

Contrasted to closed innovation, where innovation activities take place entirely within one firm, open innovation processes are characterized as spanning firm boundaries presenting **opportunities to reduce risk and commercialize both external ideas and internal ideas externally** (IPACSO - Innovation framework for ICT security).

There is no one size fits all solution to designing and implementing a successful innovation process as innovation engagement and management is **unique to its respective organisational context**. Nonetheless, there is an ever increasing general body of information around innovation practice and modelling (Rothwell 1994; IPACSO - Innovation framework for ICT security) which can help to select a suitable innovation model for each respective case.

However, due to the organisation of the Horizon 2020 projects the **SHAPES project** fits best to the **innovation model of the 3rd generation**. It has a clear market pull, which is the H2020-SC1-FA-DTS-2018-2 call of the European Commission. On the other hand, it also has a clear technology push part, which are all the different digital solutions under development of the SHAPES consortium. Already in the proposal phase of the SHAPES project these two parts (**market pull and technology push**) have been coupled to propose the best solution for the society on the basis of the available technologies.

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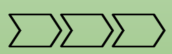
To overcome the disadvantages of the somewhat simplistic **innovation model of the 3rd generation it has to be adapted** to include some of the characteristics of the later model:

- Interaction with end-users and the market environment
- Including external input (society, competitors, universities)
- Using ICT system to accelerate the innovation process
- Inclusion of external ideas (open innovation)

What can we learn from it for the SHAPES project?

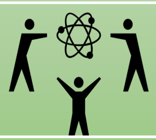


Follow the **3rd generation innovation model** (technology-push/ market-pull)

Ensure interaction with **end-users** and the market environment

Include **external input** (society, competitors, universities)

Use an **ICT system** to accelerate the innovation process



Include external ideas (open innovation)

2.1.4 Knowledge

In a famous definition of **knowledge** it is distinguished from information and information from data on the basis of a value-adding process, which transforms collected facts and figures into communicable messages and then into knowledge (Davenport and Prusak 2010).

Data is a set of objective facts about events or activities, and within an organisation is normally structured in some form or another. As well as being quantitative, data can

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be qualitative. There is no meaning in data – it is simply a collection of facts (Likar et al. 2013).

Information can be considered a message (Davenport and Prusak 2010) usually in the form of an audible or written statement. It has a sender and a receiver and is meant to change the way that the receiver perceives something. Either hard or soft networks can disseminate information. A hard network has a solid infrastructure such as delivery vans, post offices and e-mail. A soft network is informal and can consist of a message left on a voice mail system or a note pinned to a wall. Information has meaning and data can be transferred into information in a number of ways (Likar et al. 2013).

Knowledge can be seen as having a broader, deeper and richer meaning than data of information. It comes about as a result of people's experiences, values, insight and contexts. It can be stored in formal systems such as libraries, documents and electronic media. It is stored also in the routines and process practices and norms of an organisation. Most importantly it is stored in the heads of the individuals who work for the organisation (Likar et al. 2013).

According to (Nonaka 1994) knowledge is created through dialogue between possessors of **explicit and tacit knowledge** (Castaneda and Cuellar 2020).

Tacit knowledge is the kind of knowledge that is difficult to transfer to another person by means of writing it down or verbalizing it. For example, the ability to speak a language or knead dough requires sorts of knowledge which are difficult or impossible to explicitly transfer to other users. Since tacit knowledge is highly individualised, the degree and facility by which it can be shared depends to a great extent on the ability and willingness of the person possessing it to convey it to others. **Explicit knowledge** is knowledge that has been articulated, codified and stored in certain media like writing. It can therefore be readily transmitted to others. The information contained in encyclopaedias and textbooks are typical examples of explicit knowledge (Nonaka and Takeuchi 1995; Collins 2001; Polanyi and Nye 2015).

Some authors also mention a third type of knowledge – **embedded knowledge**. This type of knowledge has been less examined and exists in codes of conduct, processes, products, corporate culture, ethical principles, rules, and routines. An example is drawing lessons learned from routines. (Medina 2019)

The two mentioned conceptualisations of knowledge seem to have been developed relatively independently of each other. It is, however, a reasonable position that “all knowledge is tacit” with the corollary that explicit knowledge is information (Zeleny 2005).

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2.1.5 Knowledge sharing

(Helmstädter 2003) defined knowledge sharing as **interactions between human actors where the raw material is knowledge**. Knowledge sharing is the exchange of experience, skills, and tacit and explicit knowledge among employees (Hoegl et al. 2003). (Bartol and Srivastava 2002) defined knowledge sharing as individuals sharing **organisationally relevant information, ideas, suggestions, and expertise** with one another.

Knowledge sharing **encourages innovation**. Knowledge sharing-related behaviours positive influence the innovativeness of the sharers of knowledge in terms of propensity and capacity to promote and implement new ideas (Castaneda and Cuellar 2020). It is unlikely that innovation occurs in the absence of knowledge sharing (Kremer et al. 2019). (Wang and Hu 2020) claimed that knowledge sharing is a mediator between collaborative innovation and organizational performance (Castaneda and Cuellar 2020). Knowledge sharing has been identified as positive force in creating innovative organisations especially when there is **more positive social interaction culture** (Chyi Lee and Yang 2000; Lee 2016)

Although the **sharing of tacit knowledge is a great challenge**, there are various helpful activities and mechanisms. They traditionally involve face-to-face interaction like conversations or workshops. Arguably also some information technology tools can be conducive to tacit knowledge sharing such as email, groupware, instant messaging and related technologies (Eriksson and Grigoleit 2015).

What can we learn from it for the SHAPES project?

Knowledge sharing is of uttermost importance for innovation

- examples are: face-to face-meetings or workshops as well as knowledge sharing via IT mediated tools like videoconfernces, instant messages, emails, etc.

2.1.6 Knowledge sharing in inter-organisational teams

Although there are many reports about knowledge sharing in teams or within organisations or companies, there are only few studies available about inter-organisational knowledge sharing or **knowledge sharing in interdisciplinary networks**. To be able to learn from the experience of other networks or multi-organisational settings literature review was conducted about inter-organisational knowledge sharing to learn about possible barriers and promoters of knowledge sharing as well as about best practices in other domains (Eriksson and Grigoleit 2015)

2.1.6.1 What are the barriers and promoters for knowledge sharing?

In a study about knowledge sharing among the different stakeholders involved in the health sector (researcher, policymaker, end-user) it was reported about several barriers due to the different backgrounds and work conditions (Tsui et al. 2006).

Firstly, academic **researchers** receive only few incentives from universities to participate in non-research activities beyond publishing in peer-reviewed academic journals and presenting at conferences. As knowledge sharing is often seen as something that occurs after the research is concluded, when resources may be exhausted, the knowledge-sharing component is often lost.

Secondly, **policymakers** and their supporting analysts are constantly faced with the daunting task of sorting through a mountain of information to create effective understanding of the situation they are facing. Research evidence is only one source of information among many and may conflict with policymakers' values and the current political climate.

Thirdly, **end-users** face a number of challenges that limit their participation in knowledge sharing. Often, time and resources are not available to engage in knowledge sharing. End-user may also see research evidence as contradictory with their practice experiences. Given that research evidence may be perceived as inaccessible or difficult to understand, it is not surprising that research evidence may be rejected in favour of professional experience.

In another study about knowledge sharing among industrial research scientists (Ensign 2009) takes up the task of understanding tacit knowledge transmission within the context of a multinational, multidivisional company. The main finding of Ensign's research is that **reputation**[1] matters a great deal in knowledge sharing among scientists, with a favourable reputation of the scientist asking for information resulting in a greater likelihood that the information will be shared. However, contrary to expectation, sharing was less among closer colleagues in terms of reputation component past favourable behaviour – perhaps because of issues of competition. The results are summarised in Table 7.

Table 7: Summary of results of (Ensign 2009) study

Influencing factor	Effect on knowledge sharing

[1] **Reputation** is defined as an assessment of past behaviour and the expectation of future behaviour. Past behaviour is further decomposed into the nature of the interaction between two scientists (personal/ professional interactions, and co-work or co-location interactions), duration of the interaction, and frequency of interaction. Future behaviour is conceptualised as predictability in the interaction, reciprocity, and obligation (or ‘‘debt’’ in information exchange).

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Past favourable behaviour – (personal/ professional relationship)	Negative
Past favourable behaviour – (Co-work/ Co-locate relationship	Negative
Duration of interaction	Positive
Frequency of interaction	Not significant
Predictability of behaviour	Positive
Reciprocity (expectation that the recipient would give help back to the source)	Positive
Obligation (imbalance of exchange)	Negative
Physical distance	Negative
Expertise of recipient	Positive
Organisational connection	Positive
(Substantial) Contribution and Uniqueness of Sharing (knowledge cannot be obtained readily from another source	Positive
Time and effort required for sharing	negative

A study conducted by DG Research in 2006 regarding the transnational research cooperation and knowledge transfer between public research organisations and industry highlighted a number of key issues that should be addressed if closer linking between research and industry should be achieved (European Commission 2006, 2007)

- The alignment of interests between a research organisation and a private company within a given Member State is not always straightforward due to the **different agendas and expertise** of the parties;
- Transnational collaboration is additionally hampered by three main factors: **cultural differences (including language), legal differences, and difficulties in finding partners.**
- Research organisations find it difficult to balance their researchers' desire for **open access** to research results with the need to protect them if they are to become commercially viable products.

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- Although not being the sole factor, the differences between existing **legal frameworks** has a strong disincentive effect on transnational collaboration. The main research related barriers are the differences in IPR ownership regimes and joint ownership.

According to (McDermott 1999) four key challenges must be overcome in knowledge sharing communities:

- The **technical challenge**. Human and information systems must be designed to help community members think together, in addition to simply making information available.
- The **social challenge**. Communities must maintain enough diversity to encourage innovative thinking, yet still have common goals and interests.
- The **management challenge**. Environments that truly value knowledge sharing must be created and maintained.
- The **personal challenge**. Community members must be open to the ideas of others, be willing to share ideas, and maintain a thirst for new knowledge.

When these challenges are addressed, knowledge-sharing communities can provide opportunities for researchers, policymakers, and end-users to work together and learn from one another.

(Lawson et al. 2009) reported about knowledge sharing in inter-organisational product development teams. He concluded that **informal**, rather than formal, **socialisation mechanisms** are the most important means of facilitating knowledge sharing within the teams. Although formal approaches (like cross-functional teams, matrix reporting structures) provide the structure for interaction, informal social interactions define the roles and processes that underlie knowledge sharing. Knowledge sharing requires the development of trust and shared understandings built up over time and through experience. Informal socialisation tactics help create and maintain this “bank” of goodwill, which enables further collaboration (Lawson et al. 2009; Cousins et al. 2006; Cousins and Menguc 2006).

In another study of (Fey and Furu 2008) about knowledge transfer in multinational corporations it was also stressed that the transfer of tacit knowledge depends on **informal interactions among individuals and organisations**. It was also reported that even highly sophisticated expert data-bases which have been used in consulting companies as well as in industrial companies do not have the desired effect.

2.1.6.2 Lessons-learned regarding knowledge sharing in inter-organisational teams

The Handbook of Knowledge Sharing from the University of Alberta (Tsui et al. 2006) formulated three main strategies to overcome common obstacles in knowledge sharing between different sectors:

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1. **Consider the audience**

Knowledge sharing is a process that requires guiding the audience in a particular way of thinking. To do so requires an understanding of the problems they face, the level of detail they need, and the style of thinking they use (McDermott 1999). The message must be one that is valuable to an audience based on their needs, delivered by a messenger they can trust, in a language they are comfortable with (CHSRF 2002a).

2. **Use plain language**

If a community of people sharing knowledge spans several disciplines and contexts a common language is needed (McDermott 1999). Thus, the use of plain language is highly recommended whenever possible in knowledge sharing.

3. **Tell stories**

Evidence itself is not sufficient; it must be communicated in ways that make it compelling. Telling stories may be one way to present research and other forms of knowledge in a way that is appealing to diverse audiences (CHSRF 2002a).

The Knowledge Handbook further points out six characteristics of successful partnerships in research collaborations of partners with different backgrounds (CHSRF 2002b):

- **Cultural sensitivity**. Differences between partners are respected.
- **Trust.** The investments researchers, policymakers and end-users make to engage in a partnership are recognised; disagreements are expected; and ways to resolve conflict are established prior to disagreements.
- **Commitment.** Partners are committed to solving a problem and see research projects as single steps towards the solution.
- **Clear roles and expectations.** All parties are clear about their intentions, assumptions, and limitations at the start of the process. In particular, written partnership agreements can be helpful in ensuring clarity.
- **Partner with the organisation, not the individual.** Partnerships should be between organisations rather than individuals to protect against staff turnover and to increase the likelihood that project outcomes will be used.
- **Organisational support.** Resources such as time and money may be more accessible if employers are supportive of the partnership.

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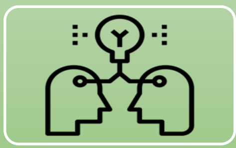
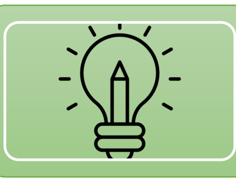
What can we learn from it for the SHAPES project?



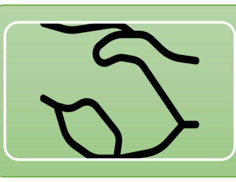
Adress the barriers and challenges of knowledege sharing

- such as differences in culture, language and legal environment

Aim for a **balance between open research and protection of intelectual property**



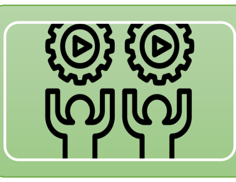
Create an environment which is **open to new ideas**



Plan for informal interactions to build **trust and commitment** to the project

During meetings use **plain language** and consider the audience

- tell stories to explain the content



Ensure that within the projects the partners have **clear roles and expectations**

Implement a helpful **ICT system** for knowledge sharing

2.1.7 Knowledge Management

(Marakas 2003) argued that knowledge management is the **process established to capture and use knowledge** in an organisation for the purpose of improving organisation performance and organisational capabilities are based on knowledge (Khalfan et al. 2010; Lee 2016).

(Gloet and Terziovski 2004) describe knowledge management as the **formalization of and access to experience, knowledge, and expertise that create new capabilities**, enable superior performance, encourage innovation, and enhance

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customer value. The authors also describe knowledge management as an umbrella term for a variety of interlocking terms, such as knowledge creation, knowledge valuation and metrics, knowledge mapping and indexing, knowledge transport, storage and distribution and knowledge sharing (Du Plessis 2007).

Knowledge management is also described as an organizational process that **aims to create centralize knowledge source** within the organization that acquire, assimilate, distribute, integrate, share, retrieve and reuse the internal and external, explicit and tacit to bring innovation in the organization in the form of the product, people and organizational process (Akram et al. 2011).

The **SECI model of knowledge** creation is one of the basic constructs of knowledge management. It can be used to explain the process of knowledge creation in organisations on the basis of knowledge transfer activities. While it has been developed for the business sector, it can also be used to understand how knowledge creation could work in broader networks including different sectors and disciplines. In particular SECI is built on a subtle understanding of the relationship between tacit and explicit knowledge. Figure 10 shows the four modes of knowledge conversion according to the model: socialisation (from individual tacit knowledge to group tacit knowledge), externalisation (from tacit knowledge to explicit knowledge), combination (from separate explicit knowledge to systemic explicit knowledge), and internalisation (from explicit knowledge to tacit knowledge) (Nonaka and Takeuchi 1995; Nonaka et al. 1998):

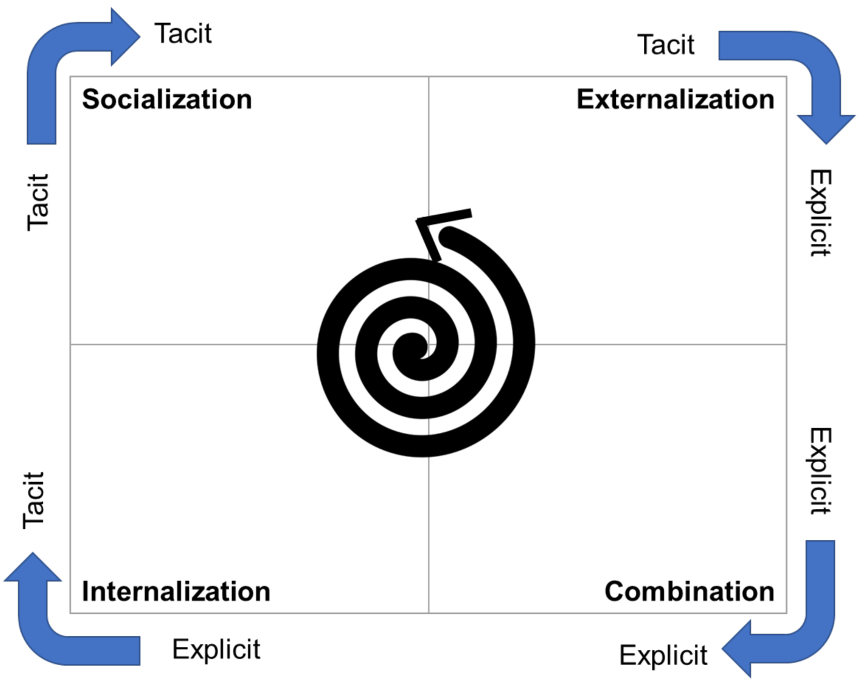

Figure 10: SECI Model of knowledge dimensions (Nonaka 1994; Nonaka and Takeuchi 1995; Nonaka et al. 1998).

Socialisation is the process of sharing tacit knowledge of individuals. Sharing experiences is a key to understanding others' ways of thinking and feeling.

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Externalisation requires the articulation of tacit knowledge and its translation into forms that can be understood by others. Dialogue supports externalisation. In practice, externalisation is supported by the use of metaphors and analogies.

Combination involves the conversion of explicit knowledge into more complex sets of explicit knowledge. Editing and systematising explicit knowledge are keys to this conversion mode.

Internalisation means the conversion of newly created explicit into tacit knowledge of individuals. Learning by doing, training and exercises are important to embody explicit knowledge. Thus, on the-job training (OJT) as well as games and simulations are used to induce internalisation of new knowledge.

In the current digital era, an increasing number of companies worldwide are exploring how knowledge management can support efficiency and innovation in their business. Knowledge management is applied in many industries and consists of a set of **procedures and practices** aimed at identifying relevant knowledge to create valued (Medina 2019).

Knowledge management systems refer to a class of information systems applied to **managing organisational knowledge**, which is an IT-based system developed to support the organisational knowledge management behaviour: acquisition, generation, codification, storage, transfer, retrieval (Alavi and Leidner 2001; Lee 2016).

There are a lot of **knowledge sharing tools** available on the market, which are in use both for companies as well as for research projects and similar. Examples are:

- Newsletters
- Media Releases
- Electronic mailing lists
- Knowledge Portals
- Websites
- Expert interviews
- Conferences
- Discussion forums
- Collaboration tools
- Wiki and crowdsourcing
- Communities of Practice (CoPs)
- Workshop based knowledge sharing methods (like Brainstorming, World Café, Serious Gaming or Scenario-based planning)

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What can we learn from it for the SHAPES project?

Use **IT tools** to manage the knowledge of the project and support knowledge sharing

2.2 Innovation management in other European research projects

This subchapter contains a short description of the other healthcare project, which are part of the OPEN DEI (Aligning Reference Architectures, Open Platforms and Large-Scale Pilots in Digitising European Industry) initiative of the Horizon 2020 programme. As far as available also the innovation management strategy of these projects are described (OPENDEI project 2021).

2.2.1 ACTIVAGE

The ACTIVAGE project is one of the European projects which are focused on the utilization of the **Internet of Things (IoT) technology in the treatment of the elderly** (Turku University of Applied Sciences 2016)

The project aims to prolong and support the independent living of older adults in their living environments and responding to the needs of caregivers, service providers and public authorities, through the deployment of innovative and user-led large-scale pilots across nine Deployment Sites in seven European countries based on the IoT technologies (Turku University of Applied Sciences 2016).

ACTIVAGE describes in its deliverables **five innovation phases**: Build, Demonstrate, Expand, Growth and Sustain. (Activage Project 2017)

1. At the end of the **Build Phase**, where the digital solutions have defined their experiment plan, the tool allows to collect “static” information of each digital solution, such as study objectives and endpoints, Local KPIs and contextual information about the solutions deployed (e.g. geographical context, architecture, end-users, stakeholders, etc.).
2. At the end of the **Demonstration Phase**, information about the preliminary evidence that each digital solution has generated separately is going to be provided. Additionally, according to the evolution of the Data Model, Analytics and Services that will be provided by AIOTES (ACTIVAGE IoT Ecosystem Suite) new hypotheses and means of verifications are expected to be defined (and demonstrated in the Expand Phase) and therefore these new elements will be included in the Evaluation tool.

3. At the end of the **Expand Phase**, evaluations will show how the replicability and interoperability elements have effect on the outcomes of each digital solution.
4. At the end of the **Sustainability Phase**, a complete picture of the project results will allow to have a clear map of how the IoT-AHA ecosystems defined in each DS have been successful towards solutions for Ageing well.

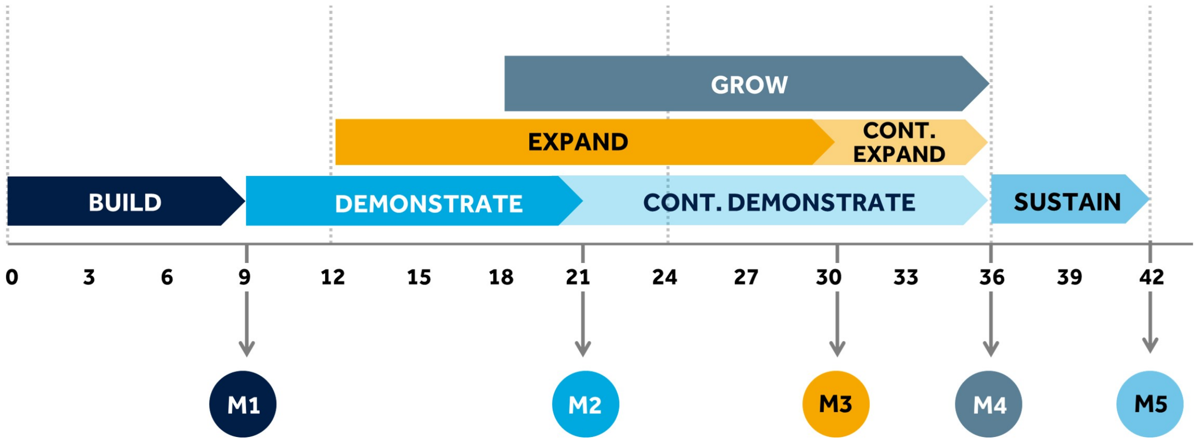

Figure 11: The ACTIVAGE life cycle

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BUILD	DEMONSTRATE	EXPAND	GROW	SUSTAIN
1. IoT Technology				
Development of the AIOTES layer	Interoperability, Standardization, Privacy, Data protection. Contribute to standardisation associated with IoT especially to SDO and alliances related with interoperability, trust, security and privacy; definition of APIs and methodologies; and use of IoT in AHA		APIs, Tools and Methodology. Contribution to standards. Market Place Delivered	Federation of Platforms enabling AHA and ecosystem sustainability. Promotion and sustainability of ACTIVAGE results and standards
2. Interconnected Deployment Sites, Use cases and Business Cases for AHA				
Set up Smart living environment	Deploy and Service Delivery		Deploy external Use Cases. Inbound entrepreneurs, business investors, new stakeholders	Host new use cases from third parties: start-ups, Reference Sites, other projects, cross LSPs
3. Generation of evidence and value				
Set up of tools and methods of the ACTIVAGE reference evaluation framework	Local & inter DS evaluation KPIs. Evaluation methodologies roll out. Attraction of other best practice and pilots to exploit the ACTIVAGE evaluation framework		Evaluate interoperability, and vendor un-lock. Inter DS evaluation. AH-Advisor Delivered	Evaluation Framework Delivered and Evaluated (Reference sites, other Demand Sites)
4. The user bound co-creation				
User needs and stakeholders requisites	User experience evaluation and KPI	Cross - User experience evaluation and KPI	External validation with new users, new use cases and needs	Users' community. White book (chapter)
5. Communication, dissemination, cross actions with relevant initiatives and channels				
Set up Communication & Dissemination platform; Set up programs, agreements and fora for collaboration	Disseminate through channels: Local, international, Living Labs network, Publications, workshops, fairs. EIT-Health: Share Living Lab network for demonstration and showcase. EIP-AHA: Participate in working groups. LSP and IOT projects: contribute to a universal IoT ecosystem		Call for applicants, Investors and Pitch competition. EIT-Health: Synergise start up program. EIP-AHA: Incorporate Reference Sites. IoT: cross LSP business cases	White Book. Maintain SD network as EIP-AHA networked reference site. Federate Platform Foundations for AHA enabling
6. Fast Innovation, Open Calls, Business Models and Exploitation				
Legacy business models	New Business Models baseline	Pivoting Business Models	Open Market validation of Business Models	Adoption & Business plans for exploitation

Figure 12: Description of the main activities of the innovation path for each innovation track

2.2.2 ADLIFE

ADLIFE seeks to support and improve the quality of life of **patients with advanced chronic diseases**. The toolbox of the ADLIFE project will contain a **personalised care management platform**, clinical decision support services and a patient empowerment platform. The integration of therapies and approaches in supportive care aims to reduce suffering and speed-up patients' recovery. This system will be tested on hundreds of patients in 75 hospitals across Europe (Adlife project 2020).

The innovation management strategy is (at least not publicly) available.

2.2.3 FAITH

The FAITH project aims to provide an **Artificial Intelligence application that remotely identifies depression markers in people that have undergone cancer treatment.** Therefore, FAITH is collecting and monitoring a range of health indicators, allowing data gathering and analysis of patients' mental status in a non-intrusive way (FAITH project 2021).

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The FAITH project undergoes the following phases (FAITH project 2021):

- **Requirement's gathering**: initial assessment of needs and requirements from the end-users (hospitals, doctors and patients). Preparation and approval of the clinical trial protocol.
- **Prototyping:** drafting the architecture specifications, data reference models, and use case scenarios. Building the platform and feeding data to the framework. Developing use acceptance criteria and users' feedback questionnaires. Developing validation criteria from the doctors' perspective. The concept is prototyped for a real-life situation trial.
- **Trials:** iterative trials at the hospital pilot sites. Doctors and patients validate FAITH. Then, feedback form these trials it is evaluated in further rounds to improve the requirements gathering and concept refinement.
- **Delivery:** final testing and validation to assess the healthcare, societal and business impact of the deployed FAITH solution. Exploration of market deployment activities.

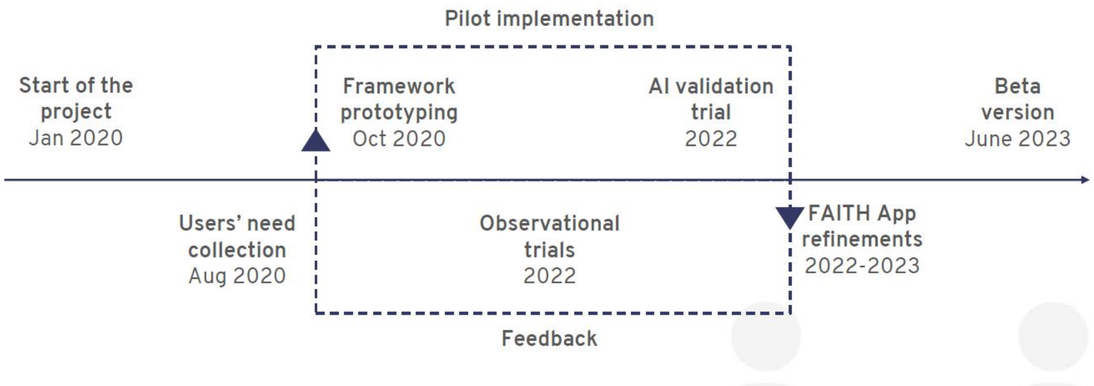

Figure 13: Implementation phases of FAITH (FAITH project 2021).

2.2.4 GATEKEEPER

The GATEKEEPER project has the primary objective **connecting healthcare providers, businesses, entrepreneurs, elderly citizens and the communities** they live in. It aims to create an open, trust-based arena for matching ideas, technologies, user needs and processes, aimed at ensuring healthier independent lives for the ageing population in Europe (The GATEKEEPER project 2021).

GATEKEEPER includes **open calls** to provide an opportunity to technological SMEs and start-ups to locate their innovative solutions in their market (The GATEKEEPER project 2021).

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2.2.5 InteropEHRate

InteropEHRate aims to support peoples' health by opening them up to new ways to **make health data available whenever and wherever needed**. To make this possible, key health data is managed in "patients' hands", i.e. through **Smart Electronic Health Records** (S-EHR) on mobile devices. Data is always transferred via highly secure channels including a direct device-to-device (D2D) communication. Patients are in full control of their data and its routes (The InteropEHRate project 2021).

The InteropeEHRate project has developed a **knowledge management and data mapping tool** which was shortlisted by the Horizon 2020 Innovation Radar under the Tech Ready category. These artefacts enable healthcare providers legacy systems to securely exchange health data with secure patients Electronic Health Records. InteropEHRate combines innovative multilingual knowledge extraction methods with an agile and interactive methodology for defining the rules that govern data transformations for cross-border health data exchanges. (The InteropEHRate project 2021).

2.2.6 SMARTBEAR

The aim of the SMART-BEAR platform is to integrate heterogeneous sensors, assistive medical and mobile devices to enable the **continuous data collection** from the everyday life of the elderly, which will be analysed to obtain the evidence needed in order to offer personalised interventions **promoting their healthy and independent living**. The platform will also be connected to hospital and other health care service systems to obtain data of the end users (e.g., medical history) that will need to be considered in making decisions for interventions (SMART-BEAR project 2021).

SMART-BEAR will leverage **big data analytics and learning capabilities**, allowing for large scale analysis of the above mentioned collected data, to generate the evidence required for making decisions about personalised interventions. Privacy-preserving and secure by design data handling capabilities, covering data at rest, in processing, and in transit, will cover comprehensively all the components and connections utilized by the SMART-BEAR platform (SMART-BEAR project 2021).

The SMART-BEAR project has an **Innovation Manager (IM)**, who is responsible for supporting the innovation-driven research and amplifying the project's impact (SMART-BEAR project 2020).

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2.2.7 SMART4HEALTH

The Horizon 2020 research consortium "Smart4Health" aims to develop prototype applications that allow users to **collect, manage, share and donate their health-related data throughout the EU** (SMART4HEALTH 2021).

The Smart4Health project **involves citizens and stakeholders** such as experts in the fields of health data and related issues into the processes of innovation as well as co-creation processes and challenges. The involvement of stakeholders also on project level aims is according to the guidelines of **Responsible Research and Innovation** (RRI), to ensure that both the process and outcome of research and innovation are acceptable and socially desirable (SMART4HEALTH 2021).

Responsible Research and Innovation (RRI) implies that societal actors (researchers, citizens, policy makers, business, third sector organisations, etc.) work together during the whole research and innovation process in order to better align both the process and its outcomes with the values, needs and expectations of society (European Commission 2021).

In practice, RRI is implemented as a package that includes multi-actor and public engagement in research and innovation, enabling easier access to scientific results, the take up of gender and ethics in the research and innovation content and process, and formal and informal science education (European Commission 2021).

In general terms, RRI **implies anticipating and assessing potential implications and societal expectations** with regard to research and innovation. In practice, RRI consists of designing and implementing R&I policy that will (European Commission 2021):

- engage society more broadly in its research and innovation activities,
- increase access to scientific results,
- ensure gender equality, in both the research process and research content,
- take into account the ethical dimension, and
- promote formal and informal science education.

2.2.8 PHArA-ON

The overall objective of the PHArA-ON project is to provide support for Europe's ageing population by integrating **digital services, devices, and tools into open platforms** that can be readily deployed while maintaining the dignity of older adults and **enhancing their independence, safety, and capabilities**. The project will utilise a range of digital tools including connected devices (e.g., the Internet of Things, IoT), artificial intelligence, robotics, cloud and edge computing, smart wearables, big data,

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and intelligent analytics that will be integrated to provide personalised and optimised health care delivery (PHARAON project 2021).

The innovation management strategy is (at least not publicly) available.

What can we learn from it for the SHAPES project?

- Include the **different phases of an innovation process**
- Include **feedback** from the end-users
- Include **open calls** into the project
- Nominate a **innovation manager**
- Take care **of Responsible Research and Innovation** (RRI) guidelines
  - e.g. include the society, take care of gender equality, take into account the ethical dimension

2.3 IPR Management in research projects

The main basis for the IPR legal framework in the H2020 is the project Grant Agreement which delineates the rights and responsibilities of partners concerning background IP and results. The GA includes rules and regulations pertaining to key issues, ranging from the requirement to ensure implementation of the Commission Recommendation on the management of IP in knowledge transfer activities, to the rights and obligations related to background, and the rights and obligations related to the results The articles on IP contained in the GA form the main legal obligations that the SHAPES beneficiaries have towards each other and the European Commission.

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The GA underscores the principle that each project partner maintains ownership of intellectual property rights for the innovations that they bring to the project. Where innovations are developed jointly the IPR is shared between the concerned partners. Partners will also have a need to access intellectual property belonging to others to achieve project objectives and exploit innovations from the project. In this situation such access will be granted on a reasonable and agreed basis. The details of how IPR and innovation is to be handled are outlined in the consortium agreement.

The GA takes precedence over the CA with the former establishing the legal obligations between the consortium and the European Commission and the latter governing the relationship and agreements between the partners in the consortium with respect to IPR and innovation.

The management of IP in H2020 projects is guided by the Guide to IP in H2020[2] published by the European Union IP Helpdesk. This guide includes the following principles for managing IPR during the implementation phase of the project, following the signing of the grant agreement and consortium agreement:

1. Carefully review the IP-related provisions in the GA;
2. Detail and agree on central IPR provisions in the consortium agreement;
3. Establish an efficient knowledge management process for the project;
4. Grant access rights to background and results to consortium partners;
5. Manage ownership and transfer of ownership of results;
6. Ensure the protection of project results;
7. Disseminate results with due respect to confidentiality provision;
8. Review and monitor the process for dissemination and exploitation of results;
9. Have a dispute-resolution process based on the provisions of the GA and CA.

The Guide also advises about the need for monitoring and respecting obligations post-project.

Fig.14 below outlines the phases and steps involved in the management of IPR in EU research projects.

[2] https://op.europa.eu/en/publication-detail/-/publication/e20da012-ec16-11e9-9c4e-01aa75ed71a1/language-en/format-PDF/source-164620712

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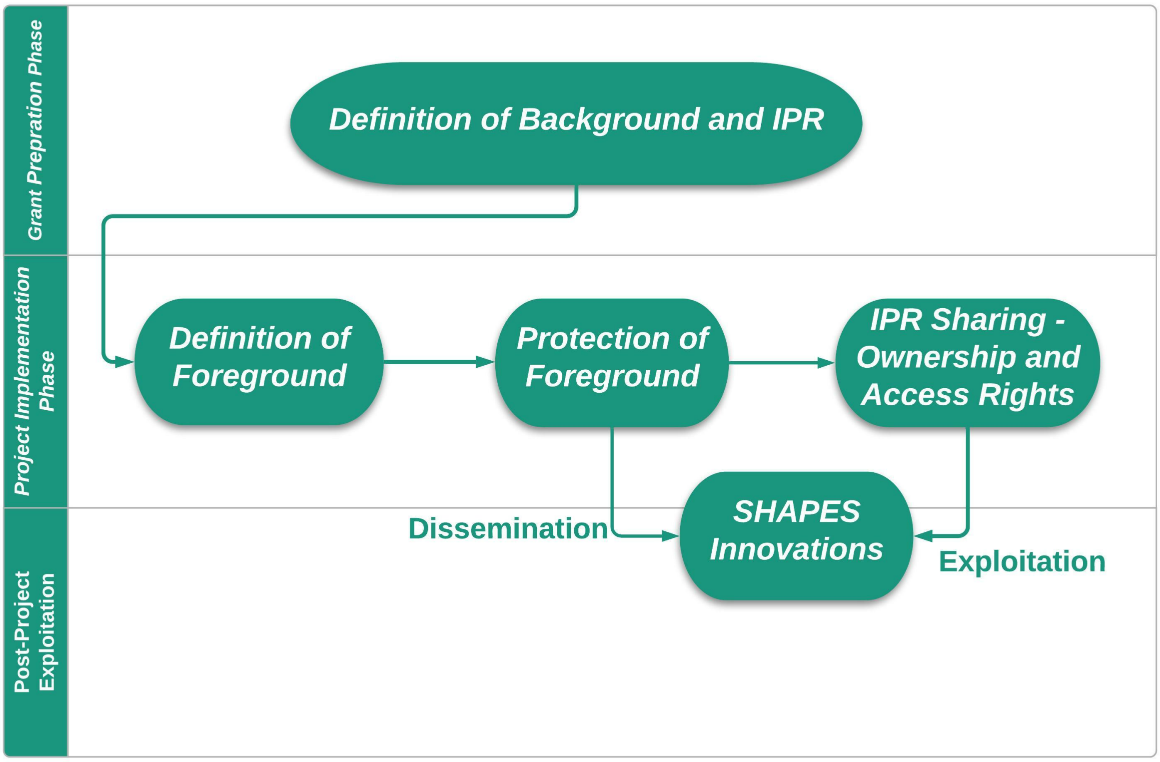

Figure 14 IPR Management Phases and Steps

- SHAPES IP mapping identifies the SHAPES IP innovations and their owners, including joint ownership where applicable.
- SHAPES IP Protection defines what the most appropriate IP protection approach is for the foreground IP developed in the SHAPES project.
- SHAPES IP Exploitation relates to consortium partners directly or indirectly (e.g., through licencing) exploiting the foreground IP developed in the SHAPES project.
- SHAPES IP Dissemination refers to any dissemination activities of the SHAPES consortium members such as publication in scientific journals and conference proceedings, social media, the SHAPES website and others, etc.

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3 Innovation and knowledge management within SHAPES

3.1 The SHAPES Innovation management strategy

On the basis of the literature review in chapter 2 an innovation management strategy was developed for the SHAPES project.

First it was shown in chapter 2 that it is necessary to follow an innovation process with different subsequent steps. Within SHAPES the following steps were defined:

- Identification of user requirements
- Definition of the context environment (lifeworld of aging individuals; organisational, structural and sociotechnical factors; ELSA)
- Development and/or adaption of digital solutions and creation of the SHAPES platform
- Evaluation of the SHAPES platform in real life use cases
- Development of Business models and the broader SHAPES ecosystem
- Dissemination and Exploitation of SHAPES solutions

Additionally, it was shown that it is suitable for an innovation action like SHAPES to follow the **innovation model of the 3rd generation** and find a balance between technology push and market pull factors.

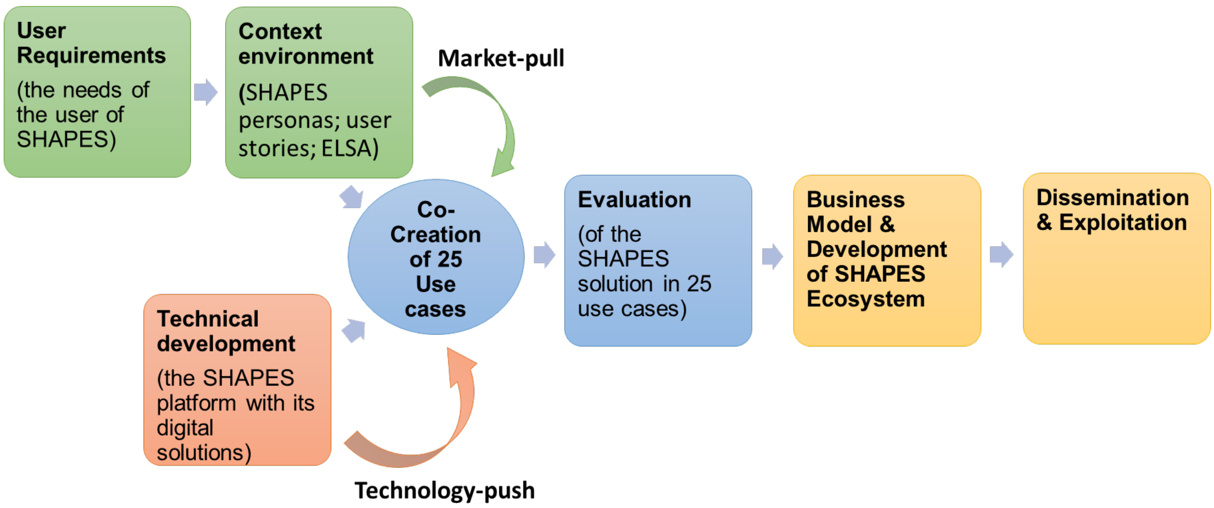

Figure 15: The innovation process steps of SHAPES with a balance of technology-push and market-pull aspects.

This general innovation model of the 3rd generation was adapted to include critical activities which have been shown to be necessary for the success of the project:

- Inclusion of the interaction with end-users and the market environment

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- Inclusion of external input (e.g. society, competitors, universities)
- Inclusion of external ideas (open innovation)

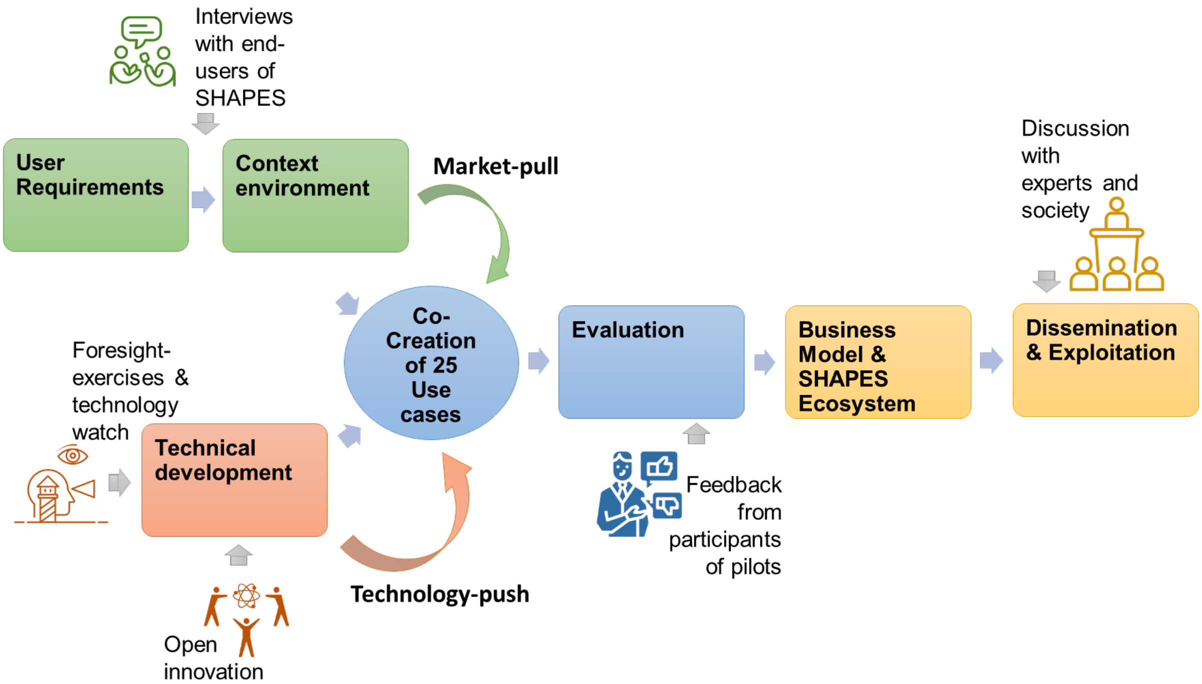

Figure 16: Innovation model of SHAPES.

In the literature mentioned in chapter 2 it has also proven useful to work in each of this innovation steps with validated tools and activities and also to use a common ICT tool to accelerate the innovation process.

The following **methodologies and tools** are in use in the different innovation steps (work packages of SHAPES):

- In-depth **interviews**
- Different **participatory workshop formats**
- **Co-creation elements** (co-development of use cases)
- **Feedback-loops** with end-users (mock-up tests, prototype testing)
- (Online) **conferences with participatory elements**
- **Dissemination** via several channels/media to invite feedback
- **Risk assessment**

As an ICT tool SHAPES uses **Microsoft Teams** as the primary means of managing and sharing project documents. This has also the benefit of maintaining version control.

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Additionally, MS Teams is used for scheduling meetings, videoconferences, chats and co-working with other partners in the same document (see D1.1 - Project Handbook for more details).

3.2 The SHAPES knowledge management strategy

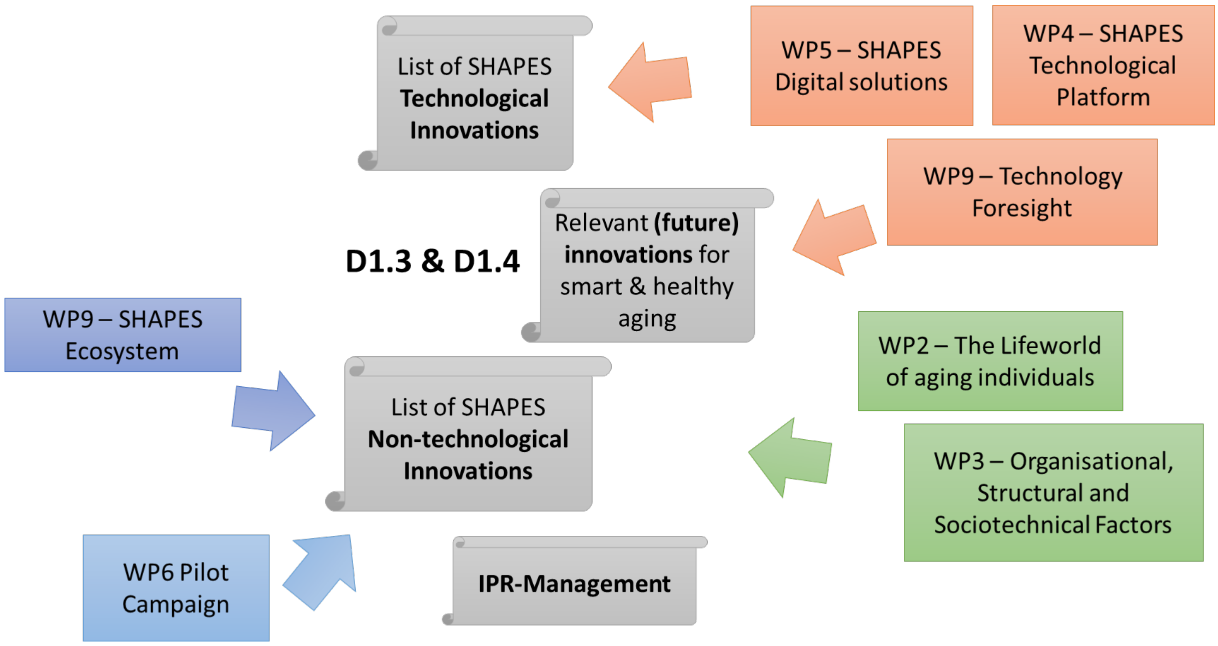

Figure 17: Knowledge Management within SHAPES

All SHAPES technological and non-technological innovations are made available to the consortium via the publication of Deliverable D1.3 and D1.4 and also on a more regular basis in MS TEAMS.

Relevant innovations outside of SHAPES are published on Information Cards (Technology Cards and Influencing Factor Cards) on a regular basis in work package 9 and are also available in the Annex 1.

On the basis of the literature research in chapter 2 the following **processes and methods** have been identified to be helpful to support the knowledge sharing and knowledge management within SHAPES:

3.2.1 Trust and commitment

At the beginning of the project SHAPES planned for several **face-to-face meetings**, such as plenary meetings, project management board (PMB) meetings, general assembly (GA) meetings, dialogue workshops with the greater public and further work package meetings.

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However, already in the fourth month the SHAPES project was hit by the effect of the **COVID-19 pandemic**, so that all further face-to-face meetings until now were cancelled and substituted by online formats.

Although the online formats got more sophisticated from meeting to meeting and workshop to workshop, the **social component** of these gatherings was still rather low.

The social effect of common coffee breaks, lunch breaks and conference dinner can hardly be substituted by online-format, so that SHAPES has to live without the trust-building and commitment triggering effect of **informal gatherings.**

However, the consortium is still looking forward to later stages of the project, in which hopefully face-to-face gathering will be possible.

To communicate on all working levels the project management has created a schedule for regular (online) meetings (more details can be found in D1.1 - Project Handbook):

- General Assembly decision-related teleconferences at least every 3 months;
- PMB take place monthly
- WP work related teleconferences also usually take place on a monthly basis
- Task related teleconferences are organized according to the respective work load in the project
- Each pilot theme and use case defines its own schedule of teleconferences – both technical meetings as well as for management issues

For the **videoconferences** SHAPES uses mainly Microsoft TEAMS or Zoom (see D1.1 - Project Handbook).

3.2.2 Clear roles and expectations

The **consortium** consists of 36 partners from 14 countries. For an innovation action it is a large consortium with a broad range of competencies and roles and also substantial end-user representation. The **general structure** of the consortium reflects a clear distribution of roles and responsibilities:

NUIM is the **coordinating organisation** and is responsible for the financial and administrative management of the project and deals directly with the project officer (PO).

The **General Assembly (**GA) is the ultimate decision-making body of the consortium and will consist of one representative from each SHAPES partner.

The **Project Management Board** (PMB) is the **supervisory body** for the execution of the project and shall report and be accountable to the General Assembly (GA). The SHAPES PMB consists of the

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- SHAPES Project Coordinator Mac MacLachlan (NUIM);
- Deputy Coordinator Michael Cooke (NUIM)
- The SHAPES Project Manager,
- All work package leaders;
- And nominated key thematic function managers.

Within SHAPES Fraunhofer INT is responsible for **innovation management** and for collecting and publishing the new SHAPES innovations within the consortium

The **work package leaders** are responsible for the detailed coordination, planning, monitoring and reporting of the deliverables within their work package. They are in continuous and detailed contact with the project coordinator, with whom they also provide the input for the various periodic reports to the EC.

The **task leaders (and pilot theme leaders)** are responsible for the coordination, planning, monitoring and reporting of the deliverables within their task.

The **use case leaders** are responsible for the coordination, planning, monitoring and reporting of the use case activities of their respective use case.

3.2.3 Overcome barriers and challenges of knowledge sharing

On the basis of the literature research it becomes evident that the atmosphere and language during the SHAPES meetings is also of high importance.

The respective moderator of the meeting is therefore encouraged to ensure that the different speakers use **plain language**, which is also understandable by participants with other professional backgrounds. One way to further support the mutual understanding is the usage of example or to explain the content by **telling stories**.

Especially for the **accessibility** for persons with visual or hearing impairments the SHAPES accessibility team has prepared an accessibility report to be able to prepare fully inclusive meetings and workshops (see SHAPES Accessibility Report for more details).

3.2.4 Openness to new ideas

To be aware of new developments in the research and innovation community SHAPES does foresight exercises on a regular basis to stay informed about **new innovations** relevant for the area of active aging (the results a summarized in chapter 5).

Additionally, SHAPES includes **open calls** to be able to include further innovations into the use cases of SHAPES. In total SHAPES has three Open Calls to extend the scope of the digital solutions integrated in the SHAPES Platform in support of active and healthy ageing and independent living. Selected innovative SME players may

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present valuable applications and/or services on top of the SHAPES Platform (first Open Call) and may conduct additional small-scale pilots, validating their digital platforms and prototypes (Second Open Call). These pilot activities will allow user validation and acceptance of the new digital solutions and represent a true market opportunity for new entrants.

The already published **first open call** had the aim to include value-added solutions as important complementary enablers for the SHAPES platform that are not currently available within the consortium, for example, new sensing or medical devices, novel functionalities required for running early trials by end users or medical standard-based procedures and technologies supporting evaluation and validation of inter-operability mechanisms designed and implemented in the SHAPES Platform.

3.2.5 Responsible Research and Innovation

Within SHAPES Sari Sarlio-Siintola from LAUREA is the **ethics manager** and with this the appointed person who will report of the status of the project monthly with respect to ethical compliance and also the ethical implications of innovation.

Additionally, SHAPES has created an **Ethical Advisory Board** (EAB) with independent expert advisors. The EAB is responsible for providing consultation and suggested rulings in any circumstance that project activities might potentially involve Ethics, Privacy and relevant Regulation implications. The EAB will help define the project baseline for research ethics and ethics by design against which all project activities and deliverables will be checked to ensure compliance with all relevant standards for responsible research.

3.3 IPR Management in SHAPES

The results attained by SHAPES activities involve Intellectual Property Rights (IPR) protection issues. These IPR issues which specifically include the ownership of the knowledge and innovation created by the Action (foreground knowledge) and the guidance for the successful exploitation of the Action's results by each partner, necessitate that rules be agreed for IPR and that provisions be taken for the IPR access rights, as per the consortium agreement.

SHAPES Management activity (WP1) has dedicated a specific task to innovation and knowledge management that addresses the SHAPES IPR aspects. The exploitation of intellectual property arising from SHAPES is considered under the following terms:

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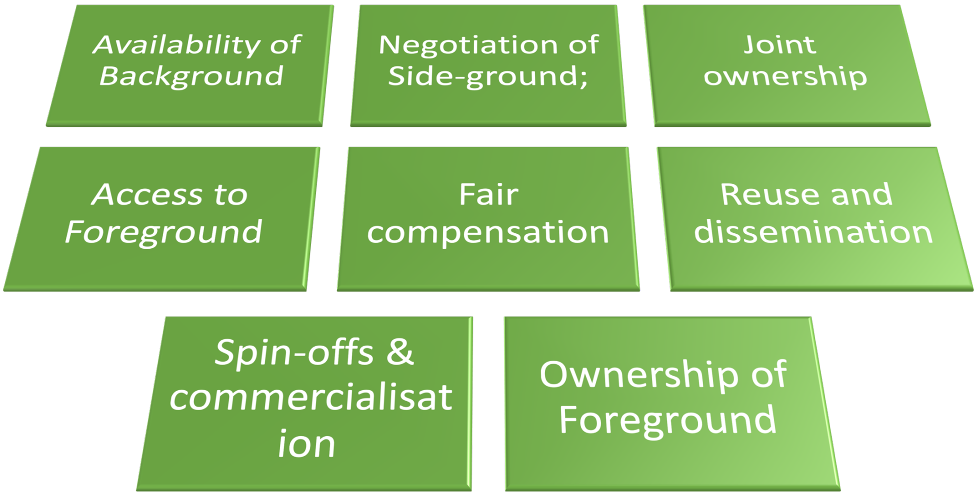

- Ownership of background knowledge is not altered by participation in the project and where it is of relevance to the Action it will be made available to the Consortium free of charge where necessary to perform the Action's work;
- Side-ground knowledge (information acquired in parallel to the contract) is negotiated between partners on a case-by-case basis, if access is needed for the project;
- Foreground knowledge is owned by the partner involved in generating it or the results. Each partner shall make available their foreground knowledge on a royalty-free basis, unless otherwise agreed, where it is necessary for the production of their own foreground knowledge within SHAPES;
- Where joint work by several partners leads to generated IP and the respective work share cannot be ascertained, they shall have joint ownership of that intellectual property (as per the GA);
- Pre-existing know-how and foreground knowledge will be made available to Action partners for exploitation purposes at favourable conditions;
- Research partners will be granted a fair compensation in the form of royalties by partners exploiting the foreground knowledge in which the research partners have contributed to;
- Research partners are entitled to freely reuse internally their foreground knowledge and to freely disseminate such foreground knowledge in academic papers, which must include all contributing partners as co-authors;
- Research partners are entitled to create spin-offs for the commercialisation of their foreground knowledge, in which case the same conditions apply as to any other SHAPES partner.

SHAPES partners are agreed on specific rules with regards to IP ownership, access rights to background and foreground IP for the execution of the project and the protection of IPRs and confidential information. This has been established with the

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joint signature of the Consortium Agreement formalising the project's management procedures, IPR issues and the exploitation of results. The CA describes the rules for sharing access rights to IPR, upon the principle that each partner has the required information to achieve their tasks in the project and to subsequently exploit the project's results. To ensure this goal is always upheld, the description is updated as required during the course of the project. If needed, specific agreements can be made and signed between SHAPES partners to secure the individual or joint exploitation of results.

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4 The innovations of SHAPES

SHAPES's **overall innovation** has the objective to effectively support healthy and independent living of older individuals within and outside the home.

SHAPES develops a **new platform**, based on existing open platforms, application programming interfaces and heterogeneous digital solutions and services ranging from assistive robots to eHealth wearables, IoT devices and Apps, built upon previous European and national IoT- and smart care-based innovations.

SHAPES innovative functionalities and services include motivational engines, medication management and control, medical appointments, calendar events and educational resources. These components' functions are enriched by accessing data generated by wearables, healthcare devices, sensors at home and external IoT-based informational sources.

In summary SHAPES introduces four innovative developments based on the expertise of the SHAPES partners:

- The **SHAPES Healthy Lifestyle and Wellbeing Assessment**, that gather the monitoring data of multiple health and fitness parameters, as well as data from home sensors, social activity apps, emotion analytics and nutrition recorders for individual guidance on healthy lifestyle and disease prevention.
- The **SHAPES Risk Assessment and Prediction Module**, which assess the risk of deterioration of an individual's health and wellbeing condition with the aim to adjust, alter or increase the level of care at home to safely postpone the need for institutionalisation.
- The **SHAPES Social Participation**, a function incorporating rich communications and social networking tools allowing older individuals to contact their friends and families and to be informed of the local social events agenda. The SHAPES Platform's emotion detection algorithms allow for the early identification of precursor signs of loneliness or isolation for proactive decision-making.
- **The SHAPES User Profiles**, derived from the processing and analysis of large datasets using big data analytics and AI techniques to extract commonalities, specificities, patterns and trends that allow the creation of user stereotypes, in which specific health and care conditions or settings are associated with appropriate care pathways, treatment plans and medicine prescriptions.

This chapter gives an overview about the specific SHAPES technological and non-technological innovations, which are currently developed by the 36 SHAPES partners and which all support the SHAPES platform as overall innovation of this project.

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Until now 71 individual innovations have been reported by the SHAPES partners. The final list of innovations will be reported in second version of this deliverable in M48 (October 2023).

4.1 Technical innovations

The technical innovations of SHAPES are all in the area of digital health. Digital health refers to the use of information and communications technologies in medicine and other health professions to manage illnesses and health risks and to promote wellness (Ronquillo et al. 2021).

Ronquillo et. al. defined the main subcategories of digital health:

1. Remote sensing and wearables
2. Telemedicine and health information
3. Data analytics and intelligence, predictive modeling
4. Health and wellness behavior modification tools
5. Bioinformatics tools (-omics)
6. Medical social media
7. Digitized health record platforms
8. Patient -physician-patient portals
9. DIY diagnostics, compliance, and treatments
10. Decision support systems
11. Imaging

The SHAPES digital innovations have been categorized according to these 11 categories. However, several of the SHAPES innovations have several functions and features and can be categorized in more than one category. Here is the list of the SHAPES technological innovations:

4.1.1 Remote sensing and wearables

- 3D depth cameras, smart bands, and other wearables: Development of an interactive caregiving platform aiming at the physical rehabilitation, integration and communication established between the different sensors

4.1.2 Telemedicine and health information

- COVIDshield: COVIDshield is a post lockdown solution to manage patients in quarantine, chronic disease patients and the general public during and after the pandemic.

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4.1.3 Data analytics and intelligence, predictive modeling

- SymbIoTe CIM compliant with FHIR: Support for interoperability among Digital Solutions for IoT-related e-Health monitoring data.
- Virtual Patients Scenarios: Addressed to formal healthcare caregivers aiming to develop decision making, reasoning and training skills in their workplace competency and provide sufficient day care and support to older adults with Neurodegenerative diseases, including Alzheimer's, Parkinson's disease and mild cognitive impairment.
- Anomaly detection (DAML): Individual models to monitor various health and fitness parameters and to detect anomalous situations in the health state of users. Heart Failure Prediction (HFPRED): Data analysis and machine learning for cardiac decompensation. User's cardiac decompensation risk estimation.
- Model-driven decision support system (CWDSS): Data analysis and model-driven decision support system. Allows to generate personalized wellbeing recommendations through alert system.

4.1.4 Health and wellness behavior modification tools

- DanceMove: Adaptation of the original Stepmania interface to the elder population. Clear interface, intuitive interaction, cognitive and physical activity adequate to elder participants.
- Talk and play/ Talk and play marketplace: Tool for people with cerebral palsy for Communication/ Entertainment/ Serious Games - customization to the needs of the individual, automatically taking into account the user's profile. Talk and Play App is mostly targeted towards the elderly user group (after a set up by the carers), while the Talk and Play marketplace is targeted towards the health professionals, the carers, and the community in general.
- Memor-i/ Memor-i Studio: Memory Game/ match identical items - use of the platform in 3 languages, easy expansion to other languages, easy creation of new games in many languages. SciFY will create a Memory Marketplace component so that its contributors can offer their games publicly. Memor-i is targeted towards the elderly user group, while the Memor-i Studio is targeted towards the health professionals, the carers, and the community in general.

4.1.5 Medical social media

- NewSum: News summarization App - new category for elderly.
- Video consultation/ communication software: video communication between older people and their relatives and friends

4.1.6 Digitized health record platforms

- eCare:

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- Development of a personalized care intelligence platform allowing
  - older individuals to monitor their health and wellbeing condition and create living ambient promoting improved quality of care.
  - care professionals to remotely monitor the health and wellbeing condition of the older individuals they are caring for.
- Development of augmented data analysis capabilities focusing on
  - physical activity
  - sleep quality
  - the prediction of heart failure

- SHAPES Gateway: Facilitates the collection and management of the IoT data that are generated by various IoT devices and forward them to the SHAPES core platform. There they can be utilized by the SHAPES solutions and services for providing personalized services, solutions and information to the care receivers and care givers that are part of the SHAPES Intelligent Living and Care Environment.
- ONE: Development of a platform to perform the remote monitoring of the symptoms of COVID-19 patients being treated at home.
- Medical database system (eHR): capture, storage and sharing of the required participant data.
- eHealthPass™: An online platform that is able to integrate and analyze several health parameters collected by different digital and technical devices, such as smartphone, smart bracelet, smart pillbox, but also parameters provided by the end-users. It's also an App and a Web Interface.

4.1.7 Patient -physician-patient portals

- Survey system: a questionnaire integration for periodic surveys
- diAnia/ diAnia marketplace: A smartphone app for carers of people at the early stages of dementia - offering diAnoia in 3 languages & adapt the code so that the app is easily translated in more languages. diAnoia App is targeted at the carers as direct users and the elderly as indirect users, while the diAnoia marketplace is targeted towards the health professionals, the carers, and the community in general.
- Chatbot: Interface for patient interaction with chatbot and health professional.
- eHealthPass™ mobile application: Patients can use the application to self-manage their condition, collaborate with their HCP and receive critical information and alerts when abnormal activity is detected.
- Digital Voice Assistance: empowered by a Smart Speaker and a Caregiver Administration Panel (Web Interface) with four skills from base: reminders; follow-ups; how-to; and questionnaires.
- eHealthPass™ clinical dashboard: eHealthPass™ clinical dashboard for Health Care Professionals (HCP). HCPs can prescribe shared care plans to the patients, monitor their progress, be presented with aggregated information and rich analytics and interfere with follow up activities /questionnaires for the patient when required.

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4.1.8 DIY diagnostics, compliance, and treatments

- ADILIB: Natural Language Processing and artificial intelligence to build Chatbots. Allows the consortium to build chatbots/ assistants to accompany the end-user in their daily duties and activities.
- RAPID Contact Tracing App: RAPID is a contacts tracing app that makes a log of the contacts made by the user through the day. RAPID can log the contacts made in a nursing home or in-home care. And support the creation and the implementation of preventive policies at healthcare institutions. RAPID can support the management of health issues related to persons with positive COVID-19 test.

4.1.9 Decision support systems

- eHealthPass™ clinical dashboard: eHealthPass™ clinical dashboard for Health Care Professionals (HCP). HCPs can prescribe shared care plans to the patients, monitor their progress, be presented with aggregated information and rich analytics and interfere with follow up activities /questionnaires for the patient when required.
- Shared care plan: Shared Care Plan to enable collaboration between patients and Health Care Professionals (HCPs) and promote self-management of a condition from the patients.
- Online Training Program: Program designed by WHO: 23 sessions, distributed over five thematic modules that address different aspects of care delivery, and caregivers (or end-user) can create their own personalized plan.

4.1.10 Imaging

- ICSee: A smartphone app for citizens with low vision, which processes the image/ video of the device's camera in real time.
- FACECOG: Computer vision and machine learning for image analysis and encryption techniques for biometric data management. User's facial recognition to support the user authentication process and for user identification at a distance.
- OROFACE: Computer vision and machine learning for image analysis. User's orofacial gestures analysis in sessions for training of orofacial musculature.

4.1.11 Other non-digital innovations

- A walking assistance bar that equips a personal service robot
- Automatic disinfection: Adaptation of KOMPAÏ robot for performing disinfection activities. Automatic disinfection task: making the robot navigate autonomously through this path while stopping at each point of interest for the time necessary to ensure the disinfection of each elementary zone.

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- Production of Project Management Matrix: AELTD developed the SHAPES Interdependency matrix to assist in illustrating to the consortium the links between all tasks and WPs within SHAPES.

4.2 Non-technical innovations

SHAPES is also generating a lot of non-technical innovations. These innovations work as influencing factor and support the technical innovations to maximise the positive impact on the life of the older persons.

Some of these innovations give insights into the lifeworld and needs of the older persons (like the personas created within SHAPES) to help adapt the final SHAPES solutions to the specific requirements of the users. Other innovations are in the area of methodology development, like for example the Delphi study to establish good practices and guide the procedures for evaluating usability within the pilots.

The full list of non-technical innovations (influencing factors) is the following:

- Formal Caregiver Persona: Development of a new formal caregiver persona aiming at reflecting the UC-PT5-004 and pilot scenario in a more inclusive and effective way.
- Dialogue frame: Supervisor, companion in cognitive activities and in gait rehabilitation.
- Information Cards: Informs the reader, gives new impulses. Cards are divided in "Technology Cards" or "Innovation Cards" and "Influencing Factors".
- Ethics toolkit: Ethical requirements for the SHAPES technology, user support, business and governance.
- Further Personas: Development of scenario for three interconnected personas aiming to approach the data collection's overlapping among the different pilot activities. The main objective is to enhance the collected data's quantity along all the pilot activities to generate more accurate results.
- Find an external/ third partner to apply SHAPES Open Calls: Search external/ third partner to apply SHAPES Open Call (OC1-Enablers-ST5 Speech-enabled chatbots), especially for Portuguese and Greece Languages.
- Case Study on a Local Health Unit: Documental collection and Interview to Administrative Council.
- Production and development of SHAPES Stories to project webpage: An alternative approach to publicly disseminating ethnographic research for all SHAPES stakeholders to read. The aim of the webpage is to provide an insight into the lives of the older people involved in SHAPES, through easy-to-read accessible vignettes.
- Literature Review about Evaluation Methodologies for Large-scale Pilots: Participation in an International Congress and Literature Review.
- Literature Review about Integrated Care Models

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- Consolidated knowledge on the terms and procedures for usability evaluation: Delphi study to establish good practices and guide the procedures for evaluating usability within the pilots.
- Consolidated recommendations on user interface design: Delphi study to establish good practices and guide the user interface design within SHAPES digital solutions.
- DanceMove: Study protocol including clinical, social, economic and technological evaluation of outcomes, under a SHAPES Pilot plan, improve psycho-social and cognitive stimulation through a technological solution that engages older adults in a ludic activity (dance).
- Ethnographic Fieldwork: 5 case studies of older individuals (the goal is 10 case studies), translation of ethnographic toolkit to Portuguese and deploying cases
- Production of a guide for organizing a virtual conference: Helpful instructive manual on how to organize a successful virtual workshop. The guide has been disseminated across all partners in the Health and Care Cluster.
- Activity-Centred Concept of Operations (CONOPS): This approach to the development of CONOPS is based partly on the IEEE (1998) standard for CONOPS development but enacted with the Activity System framework based on Engestrom (1987) and applied to the healthcare domain.

5 Innovations and trends in pan-European integrated care

Apart from the innovations within SHAPES this project is also monitoring innovations around SHAPES – key and emerging technologies as well as further influencing factors to support smart and healthy aging.

These monitoring activities are mainly done within the foresight exercises within WP9. The results of this exercises are presented in this deliverable as far as they inform about relevant innovations and trends in pan-European integrated care.

The foresight exercises take into account the impact on three different groups of people – the older people themselves, the informal caregiver, the health and care provider and also the academia in this area.

Older people are at the centre of the SHAPES ecosystem. They are the most common users and are mostly direct beneficiaries of both the SHAPES technical solutions and influencing factors. Additionally, in some cases, they will be the future customers of these solutions as well. SHAPES aims to provide helpful and supportive technical solutions and influencing factors to promote active and healthy ageing, through constructive activities.

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SHAPES is also committed to understand how older people would like to use the technical solutions, how these solutions should look, feel and operate as well as how best to ensure accessibility for older people in their use of the digital solutions.

Along with older people, SHAPES also aims to consider the view of **informal caregivers** of older people, such as family and friends. This means that SHAPES technical solutions and influencing factors also aim to assist informal caregivers by allowing them to gain better and more detailed insights into the health and mental status of their loved ones, and eventually understand them better. Additionally, SHAPES aims to provide guiding information, beneficial activities, and knowledge for informal care givers.

The technical solutions and influencing factors tested during the SHAPES pilots will empower users via improved self-management. At the same time, the solutions and services provide valuable insights into the health status (both mental and physical) of older people to assist health and care service providers with their work. Additionally, the increasing number of SHAPES services will broaden the portfolio of **health and care providers** and enlarge their capabilities to overcome the gap between preventing and treating diseases of older people. This approach enables better management of and delays the onset of illness by monitoring and analysing vital signs and mental data, daily routine and medication in a holistic real-time manner. Ultimately, data analysis will lead to improved preventive or intervening measures. Thus, health and care providers are a key stakeholder for SHAPES to consider and involve in the projects´ actions and activities throughout the project lifetime.

Academia is an integral part of SHAPES, as with its research it provides the basis for understanding the life-worlds of older people, exploring and establishing the framework for ethics, legal aspects and governance, and for defining requirements and recommendations for future applications that foster active and healthy ageing. In return, SHAPES seeks to inform academia to improve teaching and training of future experts and workforce ensuring the right skillsets that are necessary for efficient eHealth applications. This includes both soft skills and e-Literacy. Additionally, SHAPES regularly provides public deliverables that summarize the results of each task and work package that also enable civil society, companies and governmental organisations to benefit from the projects´ knowledge, insights, and accumulated data.

5.1 Relevant innovations and key and emerging technologies

This section contains a summary of the foresight exercises and a summary of its results – the key and emerging technologies as well as the influencing factors that facilitate active and healthy aging.

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5.1.1 Introduction to the SHAPES Foresight Exercises

In the course of the SHAPES project, Fraunhofer INT (FhG) carries out 8 Foresight Exercises in task 9.2. Until M24 (October 2021), three Foresight Exercises are completed, while the 4th is ongoing.

Foresight comprises the exploration of possible futures using specific scientific methodological approaches, e. g. scenarios, roadmaps. Foresight can be used to:

- identify **emerging technologies**, **future impacts** as well as new *societal demands and challenges*,
- **anticipate future developments**, disruptive events, risks and opportunities,
- **evaluate the impact of (upcoming) decisions** (in combination with other developments),
- help to **evaluate priorities** and potential new directions in decision making.

The SHAPES foresight process starts by gathering information about future technologies and anticipating influencing factors.

This information is gathered:

- by evaluation of current research and foresight studies. This search for early signs of important changes in society, science and technology is also called **Horizon Scanning**.
- and through the exchange with participants in **foresight exercises**, e. g. in workshops.

An important factor for such foresight exercises is also how far in the future we look. For the SHAPES project we decided to aim for the year 2030. Future-Influencing Factors and Technologies can be gathered by numerous sources:

- By studying **foresight and current research studies** (mostly, but not only related to smart and healthy aging),
- Through **exchanges** with scientists and researchers in the fields,
- Among discussions with all affected persons (elderly, caregivers, …).

In order to make sure, that all gathered information is consumable and useful for the project, FhG developed two templates. These templates are called "**Technology Cards**" and "**Influencing Factor Cards**" and they aim to provide starting points for interested actors for more in-depth analysis into specific topics. The Technology Cards inform about a new or an emerging technology, which probably is or will be relevant for the area of smart and healthy aging (examples are smart textiles or anomaly detection). Influencing Factors describe a possible/probable future environment condition or context for this area. Examples might be drug shortage of multitude of unsecure devices. Figure 18 is an example for a technology card and Figure 19for an influencing factor.

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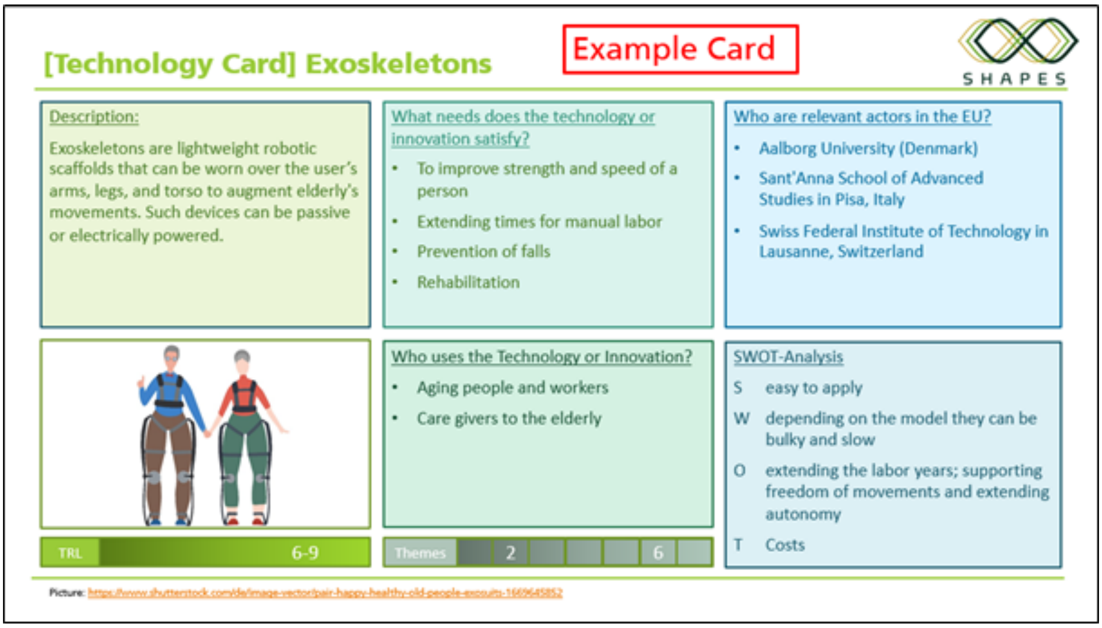

Figure 18: Example of a Technology Card

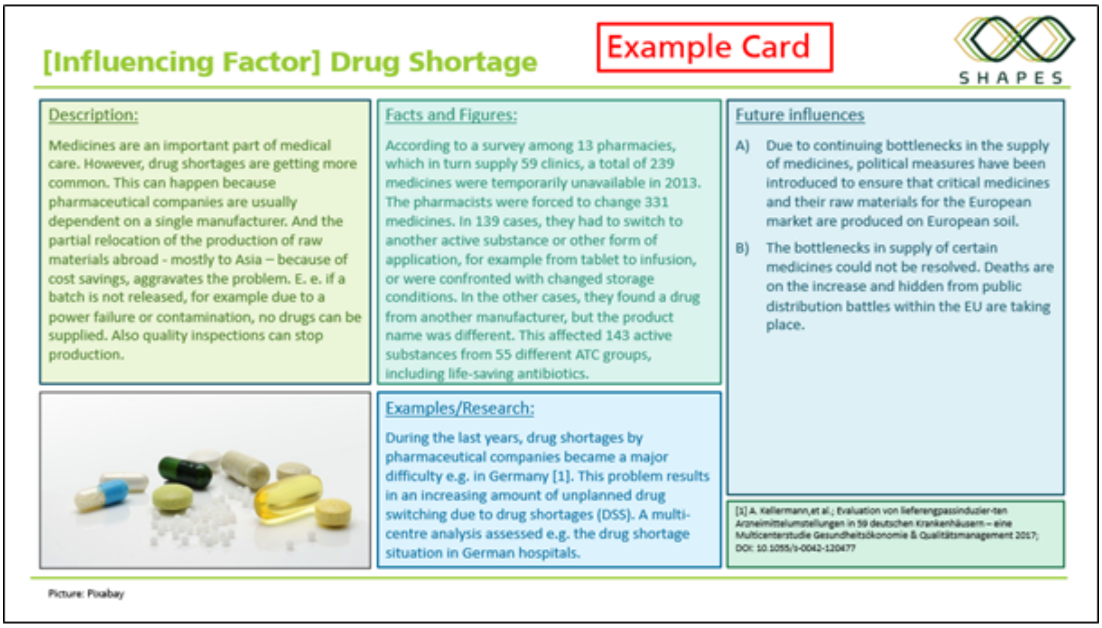

Figure 19: Example of an Influencing Factor Card

These Information Cards can and should be used at various points during the project:

- as **input for other work packages**, e. g. technical work packages.
- as **inspiration for work in pilot themes** and highlight solutions for SHAPES personas.
- as **information source** for people which are not directly involved in SHAPES but are interested in future technologies concerning smart and healthy ageing.

The gathered ideas of technologies can help to satisfy current and upcoming needs of the older persons and caregivers. Starting from current needs, for example it is possible to investigate new technological developments which are not yet developed

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or which are used in other areas, such as the aerospace industry. These technologies could be adapted to be used also in the area of smart and digital health.

During the awareness campaign Fraunhofer INT provided already some first studies, which are published by research institutes, governmental bodies, industry and so on. Such foresight studies can provide hints for relevant trends and innovations as well as of changing environments for current and future SHAPES solutions.

The seven pilot themes (PT) and personas in SHAPES were used as a guideline for the analysis. The seven PT together, are the basis to provide a clear understanding of the reality of European health and care systems and enable the validation of innovations capable of effectively supporting healthy and independent living of older individuals within and outside the home.

The following to subsections give a summary of the foresight exercises which have been the basis for the list of key and emerging technologies as well as influencing factors presented in this deliverable.

5.1.2 1st Foresight Exercise

During the first Dialogue Workshop in SHAPES the foresight process was presented and explained to the SHAPES consortium. The aim was to lay a foundation for discussions during the upcoming workshop.

5.1.3 2nd and 3rd Foresight Exercise

The 2nd and 3rd Foresight Exercises were conducted as paperwork exercises by all contributing partners of Task 9.2. Each partner carried out an evaluation of current research and foresight studies using the following questions:

- **Gaps**: What are current needs of older people that are not yet properly addressed?
- **Influences**: What are critical current and possible future influences concerning the elderly?
- Possible **direct solutions**: Are there any future technologies which could help the elderly in smart and healthy aging and in the satisfaction of needs or the mitigation of negative influences?
- Possible **transferred solutions**: Are there any technologies in other areas (e. g. from industries such as automotive, space, production) which could be adapted to be used in the future for the elderly?

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5.1.4 Results

The following figures are the sum of the results of the first Foresight Exercise:

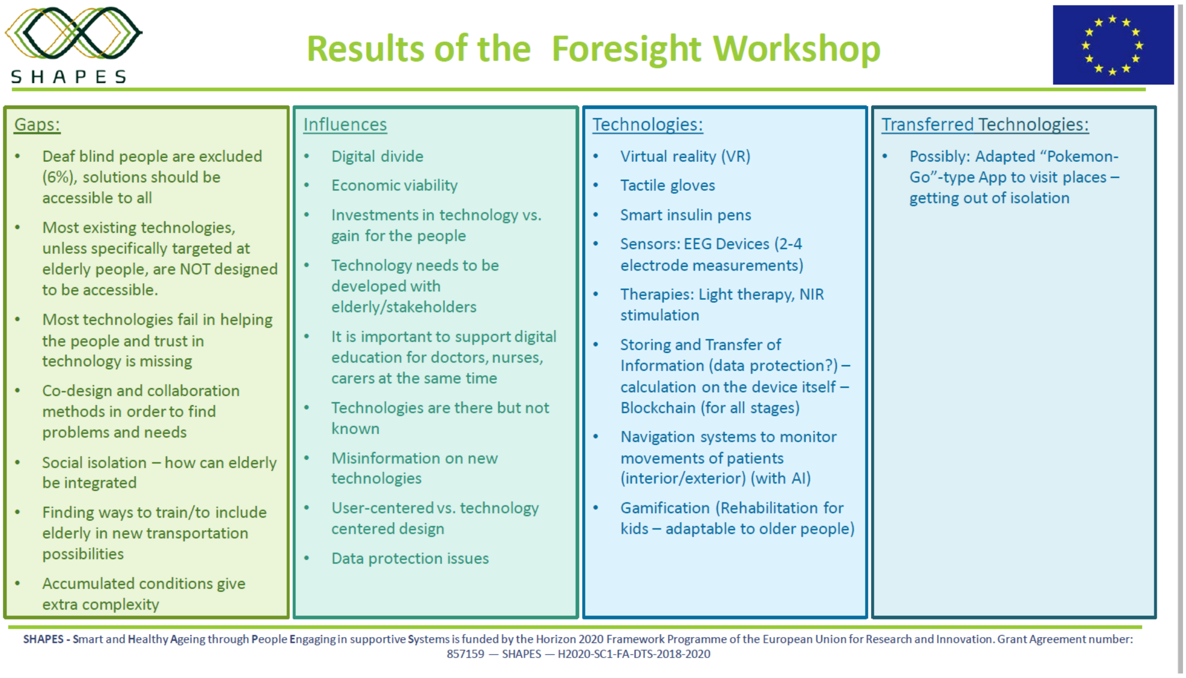

Figure 20: Results of the 1st Foresight Exercise

The results of the two following exercises are supplemented in Annex 1. The following figures shows some examples:

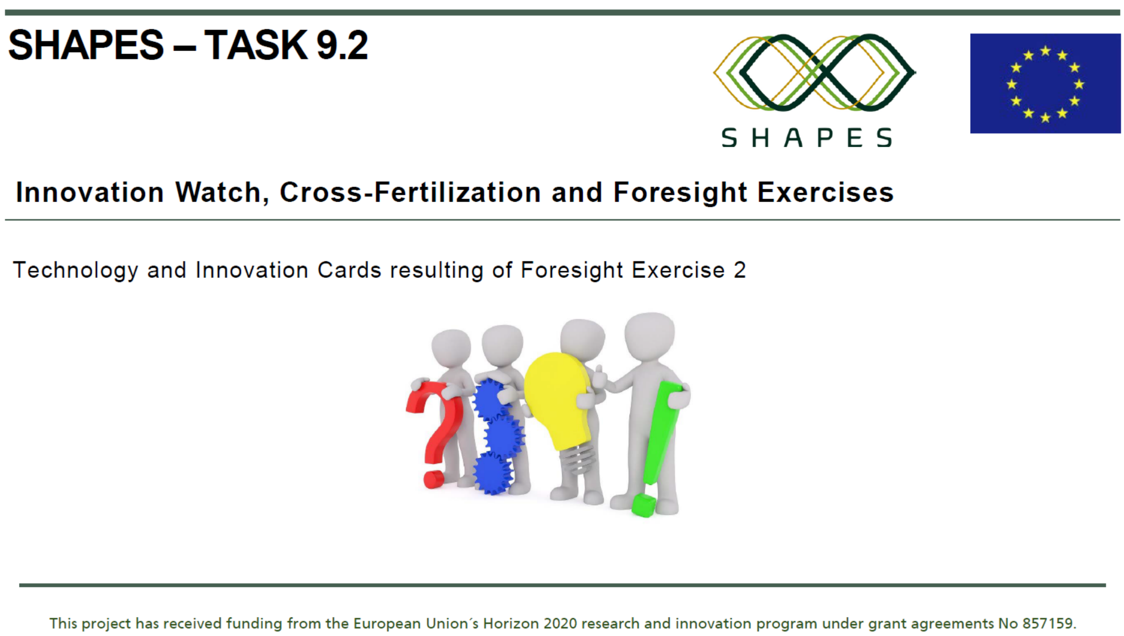

Figure 21: Exemplary individual results of the 2nd and 3rd Foresight Exercise_1

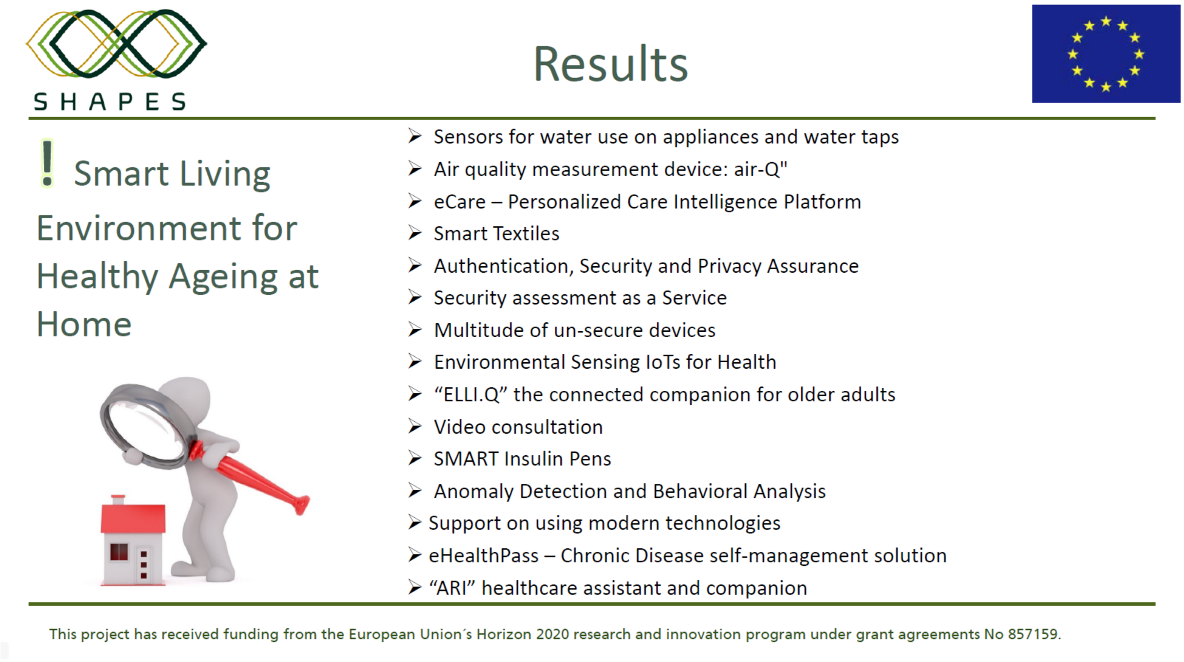

Figure 22: Exemplary individual results of the 2nd and 3rd Foresight Exercise_2

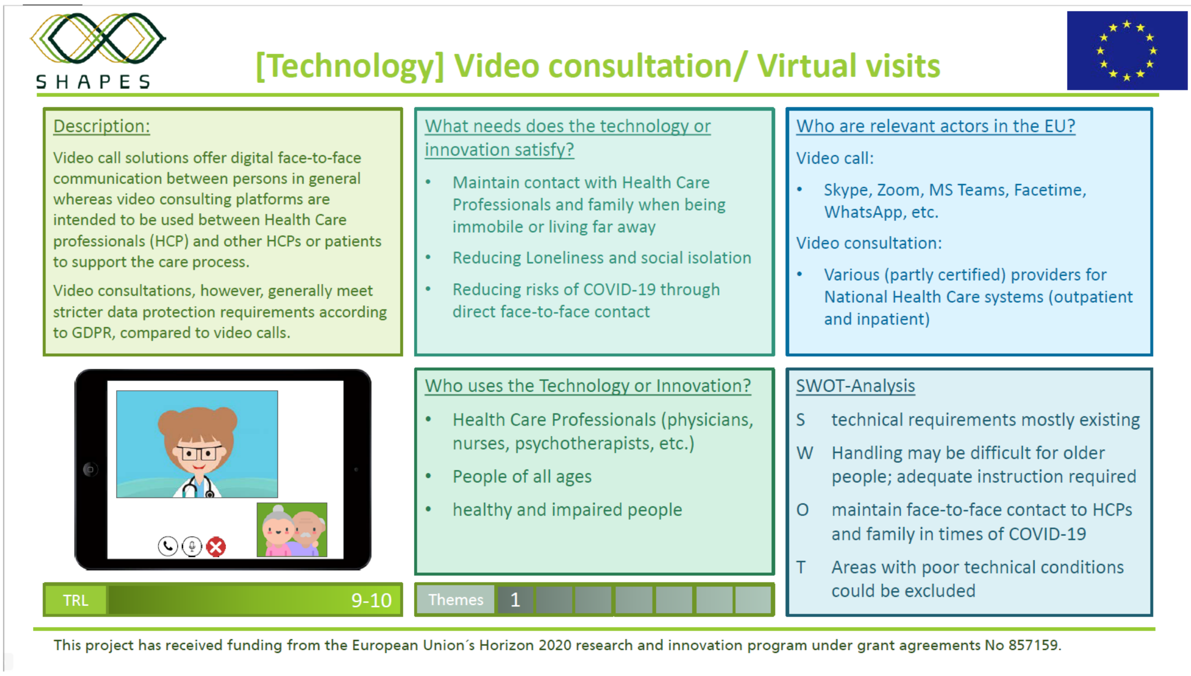

Figure 23: Exemplary individual results of the 2nd and 3rd Foresight Exercise_3

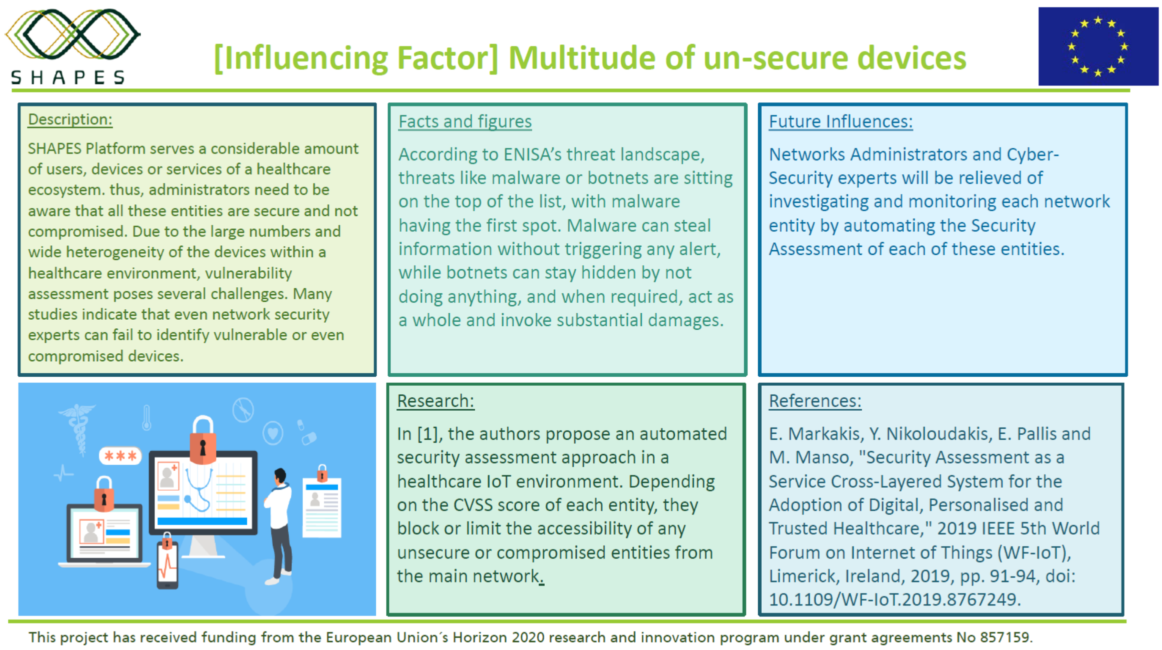

Figure 24: Exemplary individual results of the 2nd and 3rd Foresight Exercise_4

The full list of key and emerging technologies as well as influencing factors developed during the foresight exercises contain the following topics (the technology cards and influencing cards are presented in Annex 1):

- Sensors for water use on appliances and water taps
- Air quality measurement device: air-Q"
- eCare –Personalized Care Intelligence Platform
- Smart Textiles
- Authentication, Security and Privacy Assurance
- Security assessment as a Service
- Multitude of un-secure devices
- Environmental Sensing IoTs for Health   Environmental Sensing IoTs for Health
- "ELLI.Q" the connected companion for older adults
- Video consultation/ Virtual visits
- SMART Insulin Pens
- Anomaly Detection and Behavioral Analysis
- Support on using modern technologies   Support on using modern technologies
- eHealthPass–Chronic Disease self-management solution
- "ARI" healthcare assistant and companion
- Video Consultation
- Smart audio analysis
- Contactless Vitaldata Monitoring
- Anomaly Detection Systems
- AHA Business Clusters
- Inertial Measurement Units

- Smart Fitness Wearables
- eCare -Monitoring PhysicalActivity
- Smart Sleep Trackers
- eCare -Monitoring Sleep Quality
- SMART Canes
- 4G IoT Medical Devices
- A thermal, radar, and sound monitoring system for Senior Safety

5.2 Summary of SHAPES foresight exercises

All Foresight Exercises were originally planned as **attendance workshops**. Hence, the workshops of all Foresight Exercises would have been carried out in a World Café style, this means:

- Groups of people discuss the respective topics at several tables, with individuals switching tables periodically and getting introduced to the previous discussion at their new table by a "table host“
- Input of the participants will be collected at each table
- In this way the different rounds of discussions build on each other
- In the virtual workshop all participants work in one group and contribute both via chat or video talk

Due to Covid-19, four virtual workshops were held instead. Unfortunately, the received input was less than expected.

As a result, the following Foresight Exercises were conducted as **paperwork exercises**. This provided the advantage that all contributing partners had more time for literature review and hence gave more detailed input.

However, not all relevant stakeholders of the SHAPES ecosystem are included in the Foresight Exercises. In particular, there is a lack of input from older people and external stakeholders of SHAPES in the performed Foresight Exercises.

At the moment, there are many more new technology tools available that allow for virtual workshops and digital exchange than last year. Thus, FhG aims for the upcoming Foresight Exercise again as (virtual) workshops in which as many relevant users and key stakeholders of the SHAPES ecosystem as possible will participate.

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6 Conclusion

This deliverable has presented the SHAPES innovation and knowledge management strategy as well as a first version of the SHAPES innovations and results of the foresight exercises.

The **innovation model** for SHAPES is based on the innovation model of the 3rd generation with the aim to find a balance between technology push and market pull factors. The **technology push factors** are the digital solutions and the SHAPES overall platform of the SHAPES partners, the new digital solutions included via the open calls and also the results of the foresight and technology watch exercises. The **market-pull factors** include the user requirements, which have been developed in a co-creation process, as well as the anthropological, societal and ethical context environment.

The different i**nnovation methodologies and tools** which are in use in the different innovation steps of the SHAPES project are:

- In-depth **interviews**
- Different **participatory workshop formats**
- **Co-creation elements** (co-development of use cases)
- **Feedback-loops** with end-users (mock-up tests, prototype testing)
- (Online) **conferences with participatory elements**
- **Dissemination** via several channels/media to invite feedback
- **Risk assessment**
- The usage of the ICT tool **Microsoft TEAMS**

Additionally, all SHAPES **technological and non-technological innovations** have been presented in this Deliverable.

The **technical innovations** of SHAPES are all in the area of digital health. They are classified according to the subcategories of (Ronquillo et al. 2021):

- Remote sensing and wearables
- Telemedicine and health information
- Data analytics and intelligence, predictive modelling
- Health and wellness behaviour modification tools
- Medical social media
- Digitized health record platforms
- Patient -physician-patient portals
- DIY diagnostics, compliance, and treatments
- Decision support systems

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- Imaging

SHAPES is also generating a lot of **non-technical innovations**. These innovations work as influencing factor and support the technical innovations to maximise the positive impact on the life of the older persons.

Relevant innovations outside of SHAPES are published on Information Cards (Technology Cards and Influencing Factor Cards) on a regular basis (see Annex 1).

To support the **knowledge sharing and management** within SHAPES the following guidelines have been developed:

- Trust and commitment
- Clear roles and expectations
- Overcome barriers and challenges of knowledge sharing
- Openness to new ideas
- Responsible Research and Innovation

In the upcoming months Fraunhofer will monitor the innovation process of SHAPES to make sure that all necessary innovation steps are included into the SHAPES project. Additionally, the foresight exercise will continue and produce more insight on emerging technologies and future influencing factors. In M48 Fraunhofer and NUIM will deliver the final innovation and knowledge management directory.

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7 Ethical Requirements Check

The focus of this compliance check is on the ethical requirements defined in D8.4 – *SHAPES Ethical Framework* and having impact on WP1. For innovation and knowledge management no specific ethical requirement is applicable, as the knowledge management does not refer to the capture and storage of personal data, but on general processes and guidelines of knowledge sharing and management.

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This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No 857159

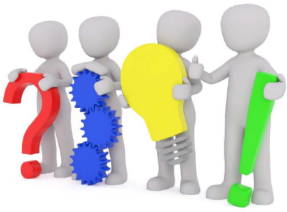
Annex 1 Information Cards: Technology Cards and Influencing Factor Cards

SHAPES – TASK 9.2

SHAPES

Innovation Watch, Cross-Fertilization and Foresight Exercises

Technology and Innovation Cards resulting of Foresight Exercise 2



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SHAPES

Results

! Smart Living Environment for Healthy Ageing at Home

- Sensors for water use on appliances and water taps
- Air quality measurement device: air-Q"
- eCare – Personalized Care Intelligence Platform
- Smart Textiles
- Authentication, Security and Privacy Assurance
- Security assessment as a Service
- Multitude of un-secure devices
- Environmental Sensing IoTs for Health
- “ELLI.Q” the connected companion for older adults
- Video consultation
- SMART Insulin Pens
- Anomaly Detection and Behavioral Analysis
- Support on using modern technologies
- eHealthPass – Chronic Disease self-management solution
- “ARI” healthcare assistant and companion

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[Technology] Sensors for water use on appliances and water taps

Description:

Water sensors on water using appliances and tap to measure and alert when water is running too long.

The sensors should be linked to an app or similar so that the alert can be sent to the older people and its care giver.

What needs does the technology or innovation satisfy?

These sensors could satisfy the need for even more security. These sensors would be another building block to create a smart home. Older people in particular gain a certain independence, as they can better control their environment and intervene if necessary, for example by turning off the tap if they have forgotten to do so. On the other hand, older people can be sure that if they are not able to intervene themselves, a trusted person (care giver) will receive an alert and will be able to take the appropriate steps.

Who are relevant actors in the EU?

- Household appliance manufacturers
- Providers of smart home products
- Building technology/services manufactures / providers

Example:

Sensor for measuring water use on a shower tap. The sensor is installed between the tap and the shower head.

Who uses the Technology or Innovation?

- Everybody how wants to have a smart home.
- Mainly older people
- Trusted person / care giver from the elderly

SWOT-Analysis

S	create smart home, increase security
W	new product, costs of market launch and roll out, different providers – different interfaces
O	increase the independence from older people
T	Costs

TRL

Themes 1

Picture: Source

This project has received funding from the European Union´s Horizon 2020 research and innovation program under grant agreements No 857159.

[Technology] Air quality measurement device: air-Q

Description:

The air-Q is a powerful and intelligent indoor air quality measuring device that can measure, differentiate, monitor and analyze the components of the air, the indoor climate and environmental influences in real time. If unfavorable situations are detected, the associated smartphone app provides information on possible solutions. In addition, air-Q functions as an important data transmitter and modern smart home device.

What needs does the technology or innovation satisfy?

The air-Q evaluates the air in terms of health and physical as well as mental performance. The air-Q can also derive complex situations in care from the measurement data of different gas sensors. This can be used to support the nursing staff. In addition dangerous situations (cases of smoke/carbon monoxide, fire, low oxygen content) can be detected.

Accordingly, it supports the needs to guarantee safety, it helps in everyday life and supports nursing staff.

Who are relevant actors in the EU?

- Corant GmbH
- www.air-q.com
- Air standard providers

Who uses the Technology or Innovation?

- Everybody how wants to have a smart home.
- Mainly older people
- Care facilities / nursing homes

SWOT-Analysis

S	create smart home, increase security
W	new product, costs of market launch and roll out, different providers – different interfaces; able to handle an app
O	increase the independence from older people, support nursing staff
T	Costs

TRL

Themes 1

Picture: Source

This project has received funding from the European Union´s Horizon 2020 research and innovation program under grant agreements No 857159.

[Technology] eCare – Personalized Care Intelligence Platform

Description:

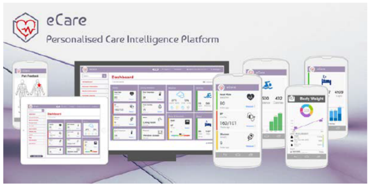
eCare is a personalized care intelligence platform that, collecting and integrating health, well-being, quality of life and environmental data, empowers individuals to create smart living environments that promote healthy lifestyles and improve independent living conditions.

What needs does the technology or innovation satisfy?

- To allow individuals to manage their self-care and health condition
- To support care professionals in the remote monitoring of individuals' health and wellbeing parameters
- To build smart living environments

Who are relevant actors in the EU?

- Alcove (UK)
- Current Health (UK)
- Withings (FR)
- Philips Healthcare (NL)
- Medtronic (IE)
- Eurecat (SP)



Who uses the Technology or Innovation?

- (Older) Individuals attentive to own health, wellbeing and quality of life
- Patients requiring remote monitoring of their health and wellbeing condition
- Informal caregivers and care professionals

SWOT Analysis

S Combination of health, wellbeing and environmental data in a single platform; Full control of user data

W Dependence to third-party devices

O Constrained health budgets; eHealth; Ageing population; IoMT

T Large market players and partnerships

TRL 6-9

Themes 1 2 3 4

This project has received funding from the European Union´s Horizon 2020 research and innovation program under grant agreements No 857159.

[Technology] Smart Textiles

Description:

Healthy ageing is much more than just physical wellbeing, important though that is. The motivation for adding electronic functions into textiles is in order to assist healthy ageing.

E-textiles can include a wide range of functions such as sensing, signal processing, lighting, wireless data transmission and actuation.

What needs does the technology or innovation satisfy?

- Wearable and comfortable EEG devices
- Wide range of different sensors (Inertial sensors, fabric electrodes, textile pulse oximetry, strain gauges, temperature sensors, moisture sensors, textile pressure sensors…)
- Strong batteries for long-term applications
- E-textile processing must be compatible with mass manufacture
- Data processing, storage and privacy issues

Who are relevant actors in the EU?

- Paul Hartmann AG, Germany
- Porcher Industries, France
- Getzner Textil, Austria
- Lenzi Egisto by FF, Italy

Who uses the Technology or Innovation?

- Fashion & Entertainment
- Medical
- Protection & Military
- Sports & Fitness
- Transportation

SWOT-Analysis

S Avoid disease & disability, reduce risk factors, increase functional ability

W Fake websites assuring service guarantees for products, limited sources for Advertising

O Establishing Brands, Global Expansion, ..

T Competitors, Web Spoofing, privacy, ...

TRL

Themes 1

Picture: https://pixabay.com/de/illustrations/transformation-netz-gehirn-netzwerk-4990455/

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[Technology] Authentication, Security and Privacy Assurance

Description:

Numerous complete digital solutions require authentication for their users, devices or services that request connectivity. The Authentication, Security and Privacy Assurance Component (ASAPA) consolidates this in one simple solution for authenticating each of the afore-mentioned entities with respect to the latest protocols and guidelines.

Key Points:

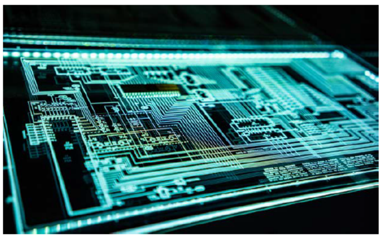
- Secure Stateless tokens
- IoT Friendly
- End-to-end encryption
- Single Sign On Interface
- Modular Architecture

Who are relevant actors in the EU?

Any SHAPES user, digital solution or device that requires authentication.

Example:

When a user or a device requests to use a Digital Solution inside the SHAPES platform, it will require authentication. This will be achieved through this component utilizing a secure connection to minimize compromises.



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[Technology] Security assessment as a Service

Description:

Considering the enormous cohort of devices connected to the internet today, it is extremely challenging to verify each individual entity's security integrity, especially manually. Thus, we propose SAaaS to automatically assess any entity connected to the SHAPES network, to minimize compromises and ensure secure interaction between entities.

Key Points:

- CVSS scoring
- Multiple report formats
- Monitors the entire network
- Segregates entities based on their CVSS score

Who are relevant actors in the EU?

The SHAPES network administrator and all network-enabled entities connected to the SHAPES network.

Example:

An extensive number of individuals are not cyber-security aware, with no indication if their device is secure. SAaaS is responsible to assure network administrators and SHAPES users of a secure internal SHAPES network.

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[Influencing Factor] Multitude of un-secure devices

Description:

SHAPES Platform serves a considerable amount of users, devices or services of a healthcare ecosystem. thus, administrators need to be aware that all these entities are secure and not compromised. Due to the large numbers and wide heterogeneity of the devices within a healthcare environment, vulnerability assessment poses several challenges. Many studies indicate that even network security experts can fail to identify vulnerable or even compromised devices.

Facts and figures

According to ENISA's threat landscape, threats like malware or botnets are sitting on the top of the list, with malware having the first spot. Malware can steal information without triggering any alert, while botnets can stay hidden by not doing anything, and when required, act as a whole and invoke substantial damages.

Future Influences:

Networks Administrators and Cyber-Security experts will be relieved of investigating and monitoring each network entity by automating the Security Assessment of each of these entities.

Research:

In [1], the authors propose an automated security assessment approach in a healthcare IoT environment. Depending on the CVSS score of each entity, they block or limit the accessibility of any unsecure or compromised entities from the main network.

References:

E. Markakis, Y. Nikoloudakis, E. Pallis and M. Manso, "Security Assessment as a Service Cross-Layered System for the Adoption of Digital, Personalised and Trusted Healthcare," 2019 IEEE 5th World Forum on Internet of Things (WF-IoT), Limerick, Ireland, 2019, pp. 91-94, doi: 10.1109/WF-IoT.2019.8767249.

This project has received funding from the European Union´s Horizon 2020 research and innovation program under grant agreements No 857159.

[Technology] Environmental Sensing IoTs for Health

Description:

IoT technologies have sprung over few last decades , many of which focusing on monitoring environment in the context of possible negative effects on human wellbeing and health. Such platforms, some proprietary and other ones open and public (e.g. European Environmental Agency), offer gathering air and water pollution with various types of substances. Concentrations of such pollutants can be correlated with adverse effects on (especially) sensitive user groups and elderly.

What needs does the technology or innovation satisfy?

Primarily ability to detect conditions that might cause mild or even severe adverse health effects, such that sensitive user groups could avoid exposure during increased pollution times, such as asthma and pulmonary chronic diseases.

Who are relevant actors in the EU?

There are number of technology providers of both sensors/detectors and IoT platforms, including those controlled by public national (National Ministries of Health in EU Member States) and EU authorities (e.g. European Environmental Agency gathering hourly and yearly concentration data from national authorities).

TRL 6-9

Who uses the Technology or Innovation?

Such technologies have been used not only in e-Health, but nearly in every domain. Applicability to e-Health has been recognized since decades, while advanced in both sensing and IoT platforms combined with advances in health modelling in correlation with external factors made such technologies even more applicable.

Themes 1 2 3 4 5 6 7

SWOT-Analysis

- S already available from numerous providers, in many cases offering data for free
- W too many technologies with limited interoperability, hence room for technologies like SymbIoTe
- O clear needs rom e-Health
- T none really

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[Technology] “ELLI.Q” the connected companion for older adults

Description:

ElliQ is specially designed for older adults, giving them everything they need to stay sharp, connected and engaged. ElliQ creates a magical relationship with each individual user, providing older adults with a device that they truly want to converse and interact with. ElliQ is equipped with several easy-to-use baseline features that have already been validated and accepted by older adults – some of the most popular include: Wellness, Health reminders, Cognitive games, Curated videos, …..

What needs does the technology or innovation satisfy?

- To allow individuals to manage their everyday life
- To help families with elderly people living alone
- To build smart living environments

Who are relevant actors in the EU?

Intuition Robotics

TRL

Who uses the Technology or Innovation?

(Older) Individuals attentive to own health, wellbeing and quality of life

Themes 1 2 4 6

SWOT-Analysis

S pro-active AI initiated Interactions and easy to use

W New product, need to be validated on a large scale

O clear demand of such a product

T none really

This project has received funding from the European Union´s Horizon 2020 research and innovation program under grant agreements No 857159.

[Technology] Video consultation/ Virtual visits

Description:

Video call solutions offer digital face-to-face communication between persons in general whereas video consulting platforms are intended to be used between Health Care professionals (HCP) and other HCPs or patients to support the care process.

Video consultations, however, generally meet stricter data protection requirements according to GDPR, compared to video calls.

What needs does the technology or innovation satisfy?

- Maintain contact with Health Care Professionals and family when being immobile or living far away
- Reducing Loneliness and social isolation
- Reducing risks of COVID-19 through direct face-to-face contact

Who are relevant actors in the EU?

Video call:

- Skype, Zoom, MS Teams, Facetime, WhatsApp, etc.

Video consultation:

- Various (partly certified) providers for National Health Care systems (outpatient and inpatient)

TRL 9-10

Who uses the Technology or Innovation?

- Health Care Professionals (physicians, nurses, psychotherapists, etc.)
- People of all ages
- healthy and impaired people

Themes 1

SWOT-Analysis

S technical requirements mostly existing

W Handling may be difficult for older people; adequate instruction required

O maintain face-to-face contact to HCPs and family in times of COVID-19

T Areas with poor technical conditions could be excluded

This project has received funding from the European Union´s Horizon 2020 research and innovation program under grant agreements No 857159.

[Technology] SMART Insulin Pens

Description:

Devices such as smart insulin pens have the potential to record the amount and timing of each insulin dose. The pens are often linked to Bluetooth enabled mobile apps that can track insulin, make dosing recommendations, and be linked with HCPs and caregivers.

What needs does the technology or innovation satisfy?

- Can improve adherence
- Assist in monitoring insulin and blood sugar levels.
- Assist with correct dosing.

Who are relevant actors in the EU?

Medtoronic. (Partner in Gatekeeper project, which is in the Health and Care Cluster).

Picture: Source

Who uses the Technology or Innovation?

- Older people
- Health care professionals
- Informal Caregivers

SWOT-Analysis

S	Easy to use. Assists with adherence
W	May have a high cost initially
O	Demand for products
T	N/A

TRL

Themes 1 2 3 4 5 6 7

This project has received funding from the European Union´s Horizon 2020 research and innovation program under grant agreements No 857159.

[Technology] Anomaly Detection and Behavioural Analysis

Description:

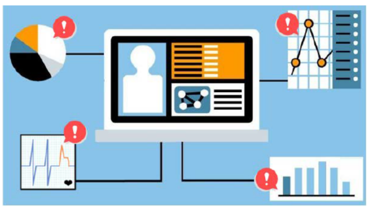
Anomaly detection is any process that finds the outliers of a dataset in order to recognize changes in behaviour over time. The application of machine learning algorithms to healthcare data can be used to detect anomalous physiological readings, potentially leading to faster emergency response or new knowledge about the development of a health condition.

What needs does the technology or innovation satisfy?

- Identification of erroneous health diagnostics
- To reduce emergency response time
- Creating new knowledge about the development of a health condition

Who are relevant actors in the EU?

- EtxeTIC (Bizkaia, Spain)
- Adinberri program (Gipuzkoa, Spain)
- Sphinx Project (H2020)



Who uses the Technology or Innovation?

- Health researchers
- Healthcare centers
- Hospitals
- Nursing homes

SWOT-Analysis

S	easy to apply
W	need reliable data to be competitive
O	improvement of patient health, tool to help health professionals
T	User acceptance, reliability

TRL 1-3

Themes 2 5

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[Technology] – Support on using modern technologies

Description:

Technology has come a long way over the last 20 years. Internet, for example, opened many doors, making it easier for everyone to work, learn, chat with their friends and families, shop, etc.

Young people easily adapted to use modern technologies, but older adults are generally less acceptant to use new technologies, because use technology is not natural for them. To overcome this situation, it is crucial that technology providers design user friendly solutions, engage with the end-user during the design phase and include videos/tutorials for older users.

TRL 6-9

What needs does the technology or innovation satisfy?

Easy to use technology with the support of tutorials, videos with examples on how to use the technology and the possibility to have support from the technical team, in case the user needs.

Who uses the Technology or Innovation?

Such technologies are useful for every domain, specifically in eHealth. Older adults can interact with their carers, monitor actively their health, perform rehabilitation exercises and memory games.

Themes 1 2 3 4 5 6 7

Who are relevant actors in the EU?

There are number of technology providers of eHealth in Europe, from SMEs to big players, but not all of them consider the opinion/needs of older users, who are not familiar to the technology.

SWOT Analysis

S More acceptance and engagement from older users

W More investment needed initially

O Ageing population adherence/acceptance

T N/A

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[Technology] eHealthPass – Chronic Disease self-management solution

Description:

eHealthPass is an eHealth solution that empowers the patients to self-manage their chronic disease and conditions (such as Diabetes and Chronic pain).

It provides self –management tools, collaboration between patient and doctor, connection with a range of IoT device and data privacy.

TRL 6-9

What needs does the technology or innovation satisfy?

- Allows chronic diseases patients to self-manage their condition
- Allows the Health Care Professionals (HCP) to remotely monitor the progress of their patients

Who uses the Technology or Innovation?

- Patients with chronic diseases (such as diabetes or chronic pain)
- Health Care Professionals
- Informal caregivers
- Patient Associations

Themes 1 2 3 4 5 6 7

Who are relevant actors in the EU?

- Hospitals and healthcare centers in Spain, Portugal, Italy, France, Sweden, Turkey that have already used the eHealthPass solution.
- Patient associations such as the LIRE - Spanish Rheumatological League and ELEANA - Greek association for patients with rheumatological conditions
- Research partners such as the Aristotle University of Thessaloniki

SWOT Analysis

S Empowers patients to self-manage their condition, users are owners of their data, brings the stakeholders in the healthcare domain in one place

W Healthcare regulatory policies in each country.

O Digitalization of healthcare, 5g network

T Competition

This project has received funding from the European Union´s Horizon 2020 research and innovation program under grant agreements No 857159.

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[Technology] – "ARI" healthcare assistant and companion

Description:

As a social robot ARI can serve as a therapeutic assistant at hospitals, care-homes or user homes to foster social communication, reduce loneliness, stress, and increase overall user entertainment. In addition, it can carry out the tasks including hospital reception, patient registration. ARI can also be integrated with other devices -such as smart devices, biosensors, smartphones- for health monitorization and providing personalized feedback.

TRL 6-9

What needs does the technology or innovation satisfy?

- To reduce medical care cost by offering more in-home care
- To reduce loneliness and increase overall user enjoyment
- To free up employees so they may carry out higher-value activities
- Reduce caregiver workload
- Customer and employee engagement, enhancing their experience

Who uses the Technology or Innovation?

Older people with early-stage dementia or mild cognitive impairment, who live in sheltered apartments, and who can still live independently.

Hospitals, care-homes or user homes

Themes 1 2 4 6

Who are relevant actors in the EU?

- Softbank Robotics
- LuxAI
- Aisoy Robotics
- PAL Robotics
- KOMPAÏ

SWOT Analysis

S	pro-active AI initiated Interactions and easy to use
W	New product, need to be validated on a large scale
O	Less strain on employees
T	Costs, user acceptance

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SHAPES – TASK 9.2

Innovation Watch, Cross-Fertilization and Foresight Exercises

Technology and Innovation Cards resulting of Foresight Exercise 3

This project has received funding from the European Union´s Horizon 2020 research and innovation program under grant agreements No 857159.

Results

! Improving In-Home and Community-based Care

- Video Consultation
- Smart audio analysis
- Contactless Vitaldata Monitoring
- Anomaly Detection Systems
- AHA Business Clusters
- Inertial Measurement Units
- Smart Fitness Wearables
- eCare - Monitoring Physical Activity
- Smart Sleep Trackers
- eCare - Monitoring Sleep Quality
- SMART Canes
- 4G IoT Medical Devices
- A thermal, radar, and sound monitoring system for Senior Safety

This project has received funding from the European Union´s Horizon 2020 research and innovation program under grant agreements No 857159.

[Technology] Video Consultation

Description:

Video consultation is a appropriate technical platform to consult and care for patients without contact. Therapy, counselling and aftercare consultations are just as possible as the normal regular visit or obtaining a second opinion.

Video-based, digital consultation for doctors and patients

What needs does the technology or innovation satisfy?

Convenient and barrier-free access to quality medical care, even in the case of geographical or mobility limitations, as well as in pandemic situations.

Who are relevant actors in the EU?

- CCS (Provider) and MedicalSyn (TecPartner, Development)
- Other provider from video consultation

Who uses the Technology or Innovation?

- Patients
- Doctors
- Care provider

SWOT-Analysis

S easy handling; resource-efficient; no data storage, certified; increase safety

W internet connection necessary; periodic certification necessary - costs

O can be used in the entire medical and care sector

T

TRL

Themes 2

Picture: Source

This project has received funding from the European Union´s Horizon 2020 research and innovation program under grant agreements No 857159.

[Technology] Smart audio analysis

Description:

An App on a wearable (smartwatch) for permanent acoustic monitoring and coupling to the smartphone of the care receiver for recommendations and to the smartphone of the caregiver for an alert if necessary.

What needs does the technology or innovation satisfy?

- Healthy and safe ageing
- Fall detection; sleep monitoring (Snoring, sleep apnea); doorbell recognition; appliances recognition e.g.

Who are relevant actors in the EU?

- TU Chemnitz and other developer and engineers

Who uses the Technology or Innovation?

- Older people
- Care receiver
- Caregiver

SWOT-Analysis

S easy handling; automatic recognition, recommendations and alerts; increase safety

W internet connection necessary

O increase the independence from older people, support nursing staff

T incorrect alerts

TRL

Themes 2

Picture: Source

This project has received funding from the European Union´s Horizon 2020 research and innovation program under grant agreements No 857159.

[Technology] Contactless Vitaldata Monitoring

Description:

Vitaldata monitoring via everyday objects for example the bathroom mirror.

What needs does the technology or innovation satisfy?

- Monitoring the vitaldata automatically and contactlessly;
- Increase the safety and the independence from older people

Who are relevant actors in the EU?

- Smart home provider

Who uses the Technology or Innovation?

- Especially elderly people
- But also everybody

SWOT-Analysis

S create smart home ,increase security

W new product, costs of market launch and roll out

O increase the independence from older people, support nursing staff

T costs

TRL

Themes 2

Picture: Source

This project has received funding from the European Union´s Horizon 2020 research and innovation program under grant agreements No 857159.

[Technology] Anomaly Detection Systems

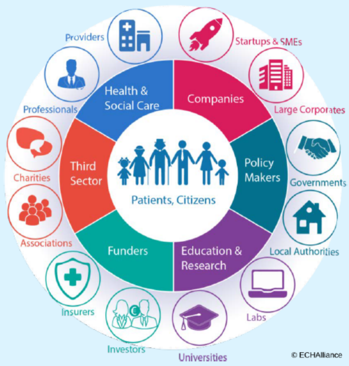
Description:

Anomaly Detection Systems are generated by applying AI techniques to biometric data in order to predict decompensations or overall changes in an older adult's health.

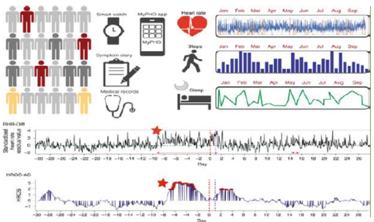
What needs does the technology or innovation satisfy?

Given that the majority of healthcare costs are incurred during the later years of a person's life, it is important to manage any chronic conditions and identify decompensations at an early stage in order to improve individual's healthcare outcomes and quality of life while simultaneously limiting costs.

Who are relevant actors in the EU and who uses the Technology or Innovation?



Source: https://www.pngaaa.com/detail/1636202



Source: https://www.nature.com/articles/s41551-020-00640-6

SWOT-Analysis

S Real-time results, enables early intervention, non-invasive

W Dependency on technology, wearables require charging/ maintenance, correct use of wearables

O Improve older adults' QoL and healthcare outcomes, decrease healthcare costs

T Manages sensitive biometric data, requires additional security

TRL 2-7

Themes 2

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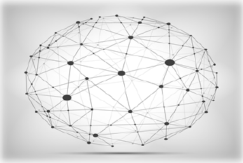
[Influencing Factor] AHA Business Clusters

Description:

Nowadays, the cooperation between business, research, and educational systems based on the open innovation principles in R&D&I processes represents strategic elements for sustainable and competitive development. Active and Healthy Ageing (AHA) is a societal challenge shared by all European countries, but it is also an opportunity to cluster industries (digital, medical, care...) around the AHA sector to be more innovative and therefore to obtain greater global competitiveness.



Facts and figures

According to the European Panorama of Clusters and Industrial Change 2020, there are 2.950 regional industrial clusters across Europe. Digital Industries and Medical Devices are catalogued as high-tech emerging cluster industries, which employs more than 15 million people in Europe. Both industries are complementary to reach further technological deployment to ensure high levels of AHA, through using efficiently the available European resources, both tangible (financial, infrastructure, human resources...) and intangible (knowledge, values...).

Future Influences:

- European Innovation Partnership on Active and Healthy Ageing.
- The silver economy is expected to grow at around 5% a year from € 3.7 trillion in 2015 to € 5.7 trillion in 2025.
- Connection ties between the European agents involved in the AHA through the different EU financed projects and initiatives and strong Knowledge scientific base about AHA.
- Digital technologies bring the opportunity to share information and data without geographical barriers.

Research:

- Innovative Solutions for independent living (SIVI) (Spain).
- Healthy Ageing Innovation Cluster (HAIC) (Scotland).
- Healthy Ageing Network Northern Netherlands (HANNN) (The Netherlands)

References:

https://ec.europa.eu/eip/ageing/about-the-partnership_en.html
https://unece.org/population/active-ageing-index
https://www.clustersivi.org/
https://www.dhi-scotland.com/
https://www.hannn.eu/over-hannn/europa

This project has received funding from the European Union´s Horizon 2020 research and innovation program under grant agreements No 857159.

[Technology] Inertial Measurement Units

Description:

Inertial Measurement Units (IMUs) are motion sensors that integrate accelerometers, gyroscopes and magnetometers to measure acceleration, impacts and orientation of the object or person where they are attached. They are nowadays integrated in many devices such as Smart phones, watches and wrist bands.

What needs does the technology or innovation satisfy?

- Level of activity monitoring
- Activity recognition
- Fall detection
- Gait analysis
- Detection of early signs of dementia
- Rehabilitation monitoring

Who are relevant actors in the EU?

- Bosch is one of the market leaders of IMU devices

TRL 6-9

Who uses the Technology or Innovation?

- Aging people
- Care giver of elderly
- Therapists
- Vehicles and aerospace industries
- Transportation and logistics (integrity of goods)

Themes 1 2 5 6

SWOT-Analysis

S Easy to integrate as a wearable and low cost

W Communication range and battery life

O Non-obstrusive monitoring of people activity and potential accidents

T Integration issues with technological platforms

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[Technology] Smart Fitness Wearables

Description:

Smart fitness wearables refer to the set of activity bands, watches and rings that keep track of the individuals' steps, heart rate and activity level. They provide several workout modes, register exercise sessions with steps counted, distance and calories burned, and also offer tools to monitor overall health and wellbeing.

What needs does the technology or innovation satisfy?

- Monitoring and tracking of physical activity parameters
- Monitoring of physical rehabilitation processes
- Execution of care plans involving a physical activity component

Who are relevant actors in the EU?

- Oura (FI)
- Polar (FI)
- Withings (FR)
- Most relevant actors in this sector come from outside of the EU: Fitbit (US), Apple (US), Garmin (US), Xiaomi (PRC), Huawei (PRC) and Samsung (SK)

Who uses the Technology or Innovation?

- (Older) Individuals aware of the importance to adopt an active lifestyle
- Informal caregivers
- Care professionals attentive to the importance of physical activity in individual health and wellbeing

SWOT-Analysis

S Low cost; Easy-to-use; Unobtrusive

W Short battery life; inaccurate data measurements

O IoMT; Rising awareness of active lifestyle; Growing geriatric population;

T Concerns on privacy; Rapid technology changes; Lack of skilled technicians

TRL 9

Themes 1 2 3 4 6

This project has received funding from the European Union´s Horizon 2020 research and innovation program under grant agreements No 857159.

[Technology] eCare - Monitoring Physical Activity

Description:

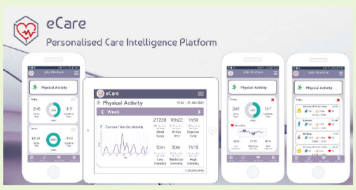
eCare is a personalized care intelligence platform that combines health and wellbeing information, including physical activity data, to help individuals establish active and healthy lifestyles and improve their quality of life. Physical activity is key for good health outcomes and relevant for evidence-based interventions.

What needs does the technology or innovation satisfy?

- To allow individuals to monitor their physical activity and manage their self-care and health condition
- To support care professionals in the remote monitoring of individuals' physical activity parameters
- To build active and healthy lifestyles

Who are relevant actors in the EU?

- Oura (FI)
- Polar (FI)
- Withings (FR)
- Most relevant actors in this sector come from outside of the EU: Fitbit (US), Apple (US), Garmin (US), Xiaomi (PRC), Huawei (PRC) and Samsung (SK)



Who uses the Technology or Innovation?

- (Older) Individuals attentive to own health, wellbeing and quality of life
- Patients requiring remote monitoring of their physical activity and health and wellbeing condition
- Care professionals monitoring patients' physical activity

SWOT-Analysis

S Combination of physical activity data with health, wellbeing and environmental data in a single platform; Full control of user data

W Dependence to third-party devices

O IoMT; Rising awareness of physical activity relevance; Ageing population;

T Large market players and partnerships

TRL 6-9

Themes 1 2 3 4

This project has received funding from the European Union´s Horizon 2020 research and innovation program under grant agreements No 857159.

[Technology] Smart Sleep Trackers

Description:

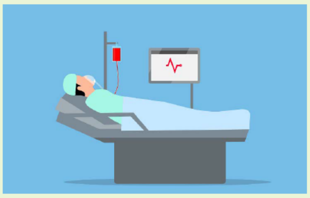
eCare is a personalized care intelligence platform that combines health and wellbeing information, including physical activity data, to help individuals establish active and healthy lifestyles and improve their quality of life. Physical activity is key for good health outcomes and relevant for evidence-based interventions.

What needs does the technology or innovation satisfy?

- Monitoring and tracking of sleep sleep-related health concerns (e.g., sleep apnea, insomnia, snoring)
- Supporting care professionals in the screening for sleep disorders, stress, anxiety, or other mental health concerns

Who are relevant actors in the EU?

- Oura (FI)
- Polar (FI)
- Withings (FR)
- Most relevant actors in this sector come from outside of the EU: Fitbit (US), Apple (US), Beautyrest (US), Garmin (US), Xiaomi (PRC)



TRL 6-9

Who uses the Technology or Innovation?

- (Older) Individuals attentive to own health, wellbeing and quality of life
- Care professionals screening for sleep disorders -related concerns, stress, anxiety, or other mental health concerns

Themes 1 2 3 4

SWOT-Analysis

S Easy-to-use; Different brands and price ranges

W Steep learning curve (complex data); Connection to home Wi-Fi

O eHealth; IoMT;

T New market sector: lack of awareness on sleeping conditions and available wearables for sleep tracking

This project has received funding from the European Union´s Horizon 2020 research and innovation program under grant agreements No 857159.

[Technology] eCare - Monitoring Sleep Quality

Description:

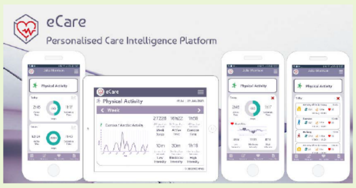
eCare is a personalized care intelligence platform that combines health and wellbeing information, including sleep data, to help individuals establish active and healthy lifestyles and improve their quality of life. Sleep quality is key for good health outcomes and relevant for evidence-based interventions.

What needs does the technology or innovation satisfy?

- To allow individuals to monitor their sleep and manage their self-care and health condition
- To support care professionals in the remote monitoring of individuals' sleep quality parameters
- To build active and healthy lifestyles

Who are relevant actors in the EU?

- Oura (FI)
- Polar (FI)
- Withings (FR)
- Most relevant actors in this sector come from outside of the EU: Fitbit (US), Apple (US), Beautyrest (US), Garmin (US), Xiaomi (PRC)



TRL 6-9

Who uses the Technology or Innovation?

- (Older) Individuals attentive to own health, wellbeing and quality of life
- Patients requiring remote monitoring of their sleep and health and wellbeing condition
- Care professionals monitoring patients' sleep

Themes 1 2 3 4

SWOT-Analysis

S Combination of sleep data with health, wellbeing and environmental data in a single platform; Full control of user data

W Dependence to third-party devices

O IoMT; Rising awareness of physical activity relevance; Ageing population;

T Large market players and partnerships

This project has received funding from the European Union´s Horizon 2020 research and innovation program under grant agreements No 857159.

[Technology] SMART Canes

Description:

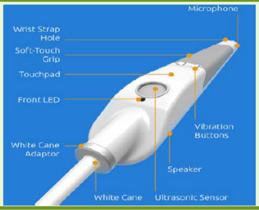
A cane that uses smart technology aims to help visually-impaired people navigate their surroundings. The devices can be equipped with built-in speakers, smartphone integration, and sensors that send vibrations to warn users of obstacles up ahead.

What needs does the technology or innovation satisfy?

- Enhanced mobility

Who are relevant actors in the EU?

- Mainly in project stage at EU level
- WeWalk in USA



TRL

Who uses the Technology or Innovation?

- Visually impaired people

Themes

SWOT-Analysis

S	Easy to use. Assists with navigation
W	May have a high cost initially
O	Demand for products
T	Poor wifi connection in some areas

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[Technology] 4G IoT Medical Devices

Description:

IoT Medical Devices allows for seamless measurement and transfer of the vitals of patients to the Health Care Professionals, thereby enabling continuous and remote monitoring of the patients' condition. 4G alleviates the need for Bluetooth or smartphone integration rendering the use of such devices simpler for older individuals.

What needs does the technology or innovation satisfy?

- 4G IoT medical devices simplifies drastically their use from older individuals who are not very competent with technology.
- Allows the Health Care Professionals (HCP) to remotely monitor the progress of their patients

Who are relevant actors in the EU?

- IoT Medical device manufacturers
- Telecom providers
- Digital health products manufacturers

TRL 6-9

Who uses the Technology or Innovation?

- Patients with chronic diseases (such as diabetes or chronic pain)
- Health Care Professionals
- Informal caregivers

Themes

SWOT-Analysis

S	Empowers elderly people and patients not competent with technology to use IoT medical devices.
W	Requires cellular network coverage to operate
O	Digitalization of healthcare, 5G network
T	Poor cellular network coverage in remote areas

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[Technology] A thermal, radar, and sound monitoring system for Senior Safety

Description:

It provides a robotic monitoring system for the large population of seniors and patients who live by themselves, providing an alert to request help whenever they might be in potentially dangerous situations. It doesn't require human intervention for monitoring, which encourages independence. The system allows the user to request help if needed through voice activation, and it uses artificial intelligence sensors, which provide human-like monitoring. The device provides: Body temperature analysis; Sleep analysis; Danger detection; Abnormal behavior detection.

TRL

What needs does the technology or innovation satisfy?

- Home safer for seniors

Who uses the Technology or Innovation?

- (Older) Individuals at home,
- Caregivers, family

Themes 1 2 5

Who are relevant actors in the EU?

- Aeyesafe

SWOT-Analysis

S Interaction using voice, AI intelligence and easy to use

W none really

O clear demand of such a product

T none really

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Annex 2 Detailed tables which list all Technological and Non-Technological Innovations

Partner name	Type of innovation	Which concept, principle, model, method, procedure, technique, tools or instrument was used to find the innovation?	Innovation (product or service)	Usage in use case	Usage in SHAPES (aim, need of the user)	Important improvements since working in SHAPES consortium	Interoperability (integration in SHAPES platform, data in- and output)	Market readiness	Challenges and obstacles
ICOM	technology	Further development of own product	SymbloTe CIM compliant with FHIR	All	Support for interoperability among DIOgital Solutions for IoT-related e-Health monitoring data	Extension of generic IoT CIM to FHIR standard compliance	Core IoT interoperability	Under development	Significant differences between SymbloTe IoT model and FHIR one
UAVR	non-technology	Depli study	Consolidated knowledge on the terms and procedures for usability evaluation	all	Establish good practices and guide the procedures for evaluating usability within the pilots.	Access to a wide range of domain experts	-	-	Experts adherence to filling the delphi
UAVR	non-technology	Depli study	Consolidated recommendations on user interface design	all	Establish good practices and guide the user interface design within SHAPES digital solutions.	Access to a wide range of domain experts	-	-	Experts adherence to filling the delphi
UAVR	technology	Digital solution development	DanceMove	PT4-UC001	Adaptation of the original Stepmania interface to the elder population. Clear interface, intuitive interaction, cognitive and physical activity adequate to elder participants	Access to the elder participants	via eCare	Under development	Dependence on the dance mat
UAVR	non-technology	Study protocol including clinical, social, economic and technological evaluation of outcomes, under a SHAPES Pilot Plan (Phase 1 to Phase 5).	DanceMove	PT4-UC001	Improve psycho-social and cognitive stimulation through a technological solution that engages older adults in a ludic activity (dance)	To deploy a pilot study with SHAPES methodology and plan, in two pilot sites (Portugal and Greece).	N/A	N/A	Translation to Greek
GNO	technology	Further development of own product	COVIDshield, COVIDshield is a post lockdown solution to manage patients in quarantine, chronic disease patients and the general public during and after the pandemic.	PT3-UC general PT7-UC001-003	identification of covid-19 suspected cases and self-management of the disease	access to a wide range of potential use cases and users	under development	ready for pilot deployment	
GNO	technology	Further development of own product/ knowledge research and development	Shared Care Plan to enable collcaboration between patients and Health Care Professionals (HCPs) and promote self-management of a conddition from the patients	PT5-UC3 PT7-UC1	enable patient self-mangement and collaboration with health care professionals	Enhance the capabilities of the shared care plan to accommodate the use cases of the SHAPES pilots	integration with SHAPES digital solutions and data lake	ready for pilot deployment	
GNO	technology	Further development of own product/ knowledge research and development	eHealthPassTM mobile application for patients. Patients can use the application to self-manage their condition, collaborate with their HCP and receive critical information and alerts when abnormal activitiy is detected	PT3-UC general PT2-UC1 PT5-UC3 PT7-UC1	enable patient self-mangement and collaboration with health care professionals	Enhance the capabilities of the mobile application to accommodate the use cases of the SHAPES pilots	integration with SHAPES digital solutions and data lake	ready for pilot deployment	

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Partner name	Type of innovation	Which concept, principle, model, method, procedure, technique, tools or instrument was used to find the innovation?	Innovation (product or service)	Usage in use case	Usage in SHAPES (aim, need of the user)	Important improvements since working in SHAPES consortium	Interoperability (integration in SHAPES platform, data in- and output)	Market readiness	Challenges and obstacles
GNO	technology	Further development of own product/ knowledge research and development	eHealthPassTM clinical dashboard for Health Care Professionals (HCP). HCPs can prescribe shared care plans to the patients, monitor their pogress, be presented with aggregated information and rich analytics and interfere with followup acitivities /quetionnaries for the patient when required.	PT3-UC general PT2-UC1 PT5-UC3 PT7-UC1	enable HCPs and researchers to monitor the progress of the patients and the users of the shapes solution	Enhance the capabilities of the clinical dashboard to accommodate the use cases of the SHAPES pilots	integration with SHAPES digital solutions and data lake	ready for pilot deployment	
NHSCT									
UCC									
AUTH	non-technology	1. Investigation of Deliverable 2.5 and exploitation of SHAPES Personas as starting point 2. Literature review and AUTH's experience from participation in previous health-related research projects 3. Focus group with nurses 4. Evaluation of persona using the Persona Perception Scale	Formal Caregiver Persona	UC-PT5-004	Development of a new formal caregiver persona aiming at reflecting the UC-PT5-004 and pilot scenario in a more inclusive and effective way	The first formal caregiver persona introduced	-	-	-
AUTH	technology	OpenLabyrinth	Virtual Patients Scenarios	UC-PT5-004	Addressed to formal healthcare caregivers aiming to develop decision making, reasoning and training skills in their workplace competency and provide sufficient day care and support to older adults with Neurodegenerative diseases, including Alzheimer's, Parkinson's disease and mild cognitive impairment	A wide range of virtual scenarios, which address unique care giving needs and help with the identification and management of AD/RD symptoms	Communication via web-based platform; has still to be integrated in the SHAPES platform	Under development	-
FhG	non-technology	Knowledge management	Information cards	-	Informs the reader, gives new impulses	Cards are divided in "Technology Cards" or "Innovation Cards" and "Influencing Factors"	-	-	

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Partner name	Type of innovation	Which concept, principle, model, method, procedure, technique, tools or instrument was used to find the innovation?	Innovation (product or service)	Usage in use case	Usage in SHAPES (aim, need of the user)	Important improvements since working in SHAPES consortium	Interoperability (integration in SHAPES platform, data in- and output)	Market readiness	Challenges and obstacles
KOM	technology	A walking assistance bar that equips our personal service robot.	Product	PT6-002	Physical rehabilitation	User feedback will help us improve this feature.	Parameters to be measured during the exercise such as walking time, distance traveled, number of rests requested, and user satisfaction that will be logged in.	Under development	
SciFY	technology	Co-creation with journalists	NewSum	PT2-003	News summarization App - new category for elderly.	In progress: new category for the elderly / their carers. Update 9/2021: The new category is added and is ready to be tested in Phase 3 of the PT2-UC003 Pilot	Android app. It will be integrated into the general SHAPES Android app.	Needs to be integrated with the SHAPES Authentication Scheme - Ready to be integrated into PIlot Theme 2.	Lack of enough sources on active ageing.
SciFY	technology	Co-creation with ocuupational therapists	Talk and Play / Talk and play marketplace	PT2-003	Tool for people with cerebral palsy for Communication/Entertainment/Serious Games - customization to the needs of the individual, automatically taking into account the user's profile. Talk and Play App is mostly targeted towards the elderly user group (after a set up by the carers), while the Talk and Play marketplace is targeted towards the health professionals, the carers, and the community in general.	In progress: Addition of a new language (German). Update 9/2021: Both Talk and Play and Talk and Play Marketplace apps have been translated and are ready to be tested in the PT2-UC003 Pilot.	Web app. It will be available as an integrated solution with the other web apps collections.	Needs to be integrated with the SHAPES Authentication Scheme.	-

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Partner name	Type of innovation	Which concept, principle, model, method, procedure, technique, tools or instrument was used to find the innovation?	Innovation (product or service)	Usage in use case	Usage in SHAPES (aim, need of the user)	Important improvements since working in SHAPES consortium	Interoperability (integration in SHAPES platform, data in- and output)	Market readiness	Challenges and obstacles
SciFY	technology	Co-creation with ocuupational psychologists	diAnia / diAnia marketplace	UC-PT2-002	Smartphone app for carers of people at the early stages of dementia - offering diAnoia in 3 languages & adapt the code so that the app is easily translated in more languages. diAnia App is targeted at the carers as direct users and the elderly as indirect users, while the diAnia marketplace is targeted towards the health professionals, the carers, and the community in general.	In progress: Addition of 3 new languages (EN, IT, SP) In progress: Addition of new activities for carers of people with dementia.	Android App. It will be integrated into the general SHAPES Android app.	Needs to be integrated with the SHAPES Authentication Scheme	Localization of cognitive excerices
SciFY	technology	Co-creation with special education teachers and blind children	Memor-i / Memor-i Studio	UC-PT4-002	Memory Game/match identical items - use of the platform in 3 languages, easy expansion to other languages, easy creation of new games in many languages. SciFY will create a Memory Marketplace component so that its contributors can offer their games publicly. Memor-i is targeted towards the elderly user group, while the Memor-i Studio is targeted towards the health professionals, the carers, and the community in general.	In progress: Addition of 2 new languages (IT, SP).	Memor-i Desktop App. It will be offered in PT4 via a robot. Memor-i Studio Web App. It will be available as an integrated solution with the other web apps collections.	Needs to be integrated with the SHAPES Authentication Scheme - Working on translations for Pilot Theme 4.	Needs to be integrated into the robot hardware.
SciFY	technology	Co-creation with people with disabilities (low vision)	ICSee	UC-PT7-002	Smartphone App for citizens with low vision, which processes the image/video of the device's camera in real time.	In progress: Addition of 1 new language (PT).	Android App. It will be integrated into the general SHAPES Android app.	Needs to be integrated with the SHAPES Authentication Scheme - Pilot requirements analysis for Pilot 7, and KPI definition. We need to define the required translations based on the piloting sites.	-

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Partner name	Type of innovation	Which concept, principle, model, method, procedure, technique, tools or instrument was used to find the innovation?	Innovation (product or service)	Usage in use case	Usage in SHAPES (aim, need of the user)	Important improvements since working in SHAPES consortium	Interoperability (integration in SHAPES platform, data in- and output)	Market readiness	Challenges and obstacles
LAUREA	non-technology	Literature review, content analysis, design science	Ethics toolkit (also as part of ISO work in T2.3)		Ethical requirements for the SHAPES technology, user support, business and governance	In progress		The approach has gradually been developed and implemented in 5 projects	
UNRF	non-technology	Development of three personas including the scenario for the three use cases among PT3, PT5 and PT7 we are participating in including interconnection with user requirements	Personas	UC-PT3-gen, UC-PT5-004 and UC-PT7-001	Development of scenario for three interconnected personas aiming to approach the data collection's overlapping among the different pilot activities. The main objective is to enhance the collected data's quantity along all the pilot activities to generate more accurate results.				
MedSyn	technology	Further development of own product	video consultation/ communication software	UC-PT1-001	video communication between older people and their relatives and friends	Adaptation for primarily non-medical use by elderly people	Under development (APIs for specific data exchange intended)	Under development	-
MedSyn	technology	Further development of own product	medical database system (eHR)	UC-PT1-003	capture, storage and sharing of the required participant data	Implementing additional functions for specific user groups	Under development (APIs for specific data exchange intended)	Under development	-
MedSyn	technology	Further development of own product	survey system	UC-PT1-001	questionaire integration for periodic survey	Integration of smiley scale and specfic questionnaires	Under development (APIs for specific data exchange intended)	Under development	-
EDGE	technology	Further development of own product	eCare - Development of novel system instantiation, specifically designed to interact with older individuals	PT1-001; PT2-001; PT3-general; PT3-001; PT4-001	Development of a personalised care intelligence platform allowing older individuals to monitor their health and wellbeing condition and create living ambients promoting improved quality of care	Creation of new system instantiation to address the older individuals public	SHAPES Digital Solution	Under development	Adaptation to specific requirements of the older individuals public
EDGE	technology	Further development of own product	eCare - Development of novel system instantiation, specifically designed to allow care professionals to remotely monitor the health and wellbeing conditions of older individuals	PT1-001; PT3-general; PT3-001; PT4-001	Development of a personalised care intelligence platform allowing care professionals to remotely monitor the health and wellbeing condition of the older individuals they are caring for.	Creation of new system instantiation to address the needs of care professionals accompanying the health and wellbeing of older individuals	SHAPES Digital Solution	Under development	Adaptation to specific requirements of the care professionals caring for older individuals

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EDGE	technology	Further development of own product	eCare - Development of augmented data analysis capabilities focusing on physical activity	PT1-001; PT2-001; PT3-001; PT4-001	Incorporation of personalised data analytics focused on physical activity, highly pertinent to support active and healthy ageing and improved quality of life	Development of augmented capabilities based on synergies with SHAPES partners dealing with data analytics	SHAPES Digital Solution	Under development	Integration challenge
EDGE	technology	Further development of own product	eCare - Development of augmented data analysis capabilities focusing on sleep quality	PT1-001; PT2-001; PT3-001; PT4-001	Incorporation of personalised data analytics focused on sleep quality activity, highly pertinent to support active and healthy ageing and improved quality of life	Development of augmented capabilities based on synergies with SHAPES partners dealing with data analytics	SHAPES Digital Solution	Under development	Integration challenge
EDGE	technology	Further development of own product	eCare - Development of augmented data analysis capabilities focusing on the prediction of heart failure	PT3-general; PT3-001	Incorporation of personalised data analytics focused on the prediction of heart failure, highly pertinent to support preemptive measures and timely intervention.	Development of augmented capabilities based on synergies with SHAPES partners dealing with data analytics	SHAPES Digital Solution	Under development	Integration challenge
EDGE	technology	New product	ONE - Development of a platform to perform the remote monitoring of the symptoms of COVID-19 patients being treated at home	PT3-general	Development of a system to monitor the COVID-19 symptoms in COVID-19 patients being treated at home, either because they are infected (quarantine) or because they are at risk of being infected with COVID-19 (profilactic isolation).	Opportunity to remotely monitor the COVID-19 symptoms in a high risk population group (individuals above 65 years old)	SHAPES Digital Solution	Ready for pilot deployment	The integration of the solution in use cases that were not designed to consider the COVID-19 pandemic.
FINT	technology	Further development of own product	SHAPES Gateway	UC-PT1-001 UC-PT2-002	Facilitate the collection and management of the IoT data that are generated by various IoT devices and forward them to the SHAPES Core platform. There they can be utilised by the SHAPES solutions and services for providing personalised services, solutions and information to the care receivers and care givers that are part of the SHAPES Intelligent Living and Care Environment	Access to a wide range of domain experts	Integration with Symbiote and IoT edge sensors and devices (Ongoing work)	Needs Formulation	Heterogeinity of standards and technologies of the particpating technological platforms, IoT devices, etc.

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UPORTO	non-technology	Search external / third partner to apply SHAPES Open Call (OC1-Enablers-ST5 Speech-enabled chatbots), especially for Portuguese and Greece Languages	To find a external / third partner to apply SHAPES Open Call (OC1-Enablers-ST5 Speech-enabled chatbots)	UPORTO will use that innovation on PT5_UC-002, but the innovation will be used by other SHAPES partners in their use cases.	SHAPES Open Call (OC1-Enablers-ST5 Speech-enabled chatbots)	SHAPES Open Call (OC1-Enablers-ST5 Speech-enabled chatbots)	N/A	N/A	Services costs and data protection
UPORTO	non-technology	Intervention Study protocol that includes clinical, social, economic and technological evaluation of outcomes, under a SHAPES Pilot Plan.	Online Training Program designed by WHO: 23 sessions, distributed over five thematic modules that address different aspects of care delivery, and caregivers (or end-user) can create their own personalized plan.	PT5_UC-001	Reducing perceived burden, anxious and depressive symptoms, and in increasing quality of life, positive aspects of providing care and general self-efficacy.	To deploy a pilot study with SHAPES methodology and plan, in two pilot sites from Portugal and Ireland.	N/A	N/A	Integration on SHAPES Plarform
UPORTO	non-technology	Intervention Study protocol that includes clinical, social, economic and technological evaluation of outcomes, under a SHAPES Pilot Plan (Phase 1 to Phase 5).	Digital Voice Assistance empowered by a Smart Speaker and aCaregiver Administration Panel (Web Interface) with four skills from base: reminders; follow-ups; how-to; and questionnaires.	PT5_UC-002	To improve cognitive, social and physical quality of life of older adults with Mild Cognitive Impairment (MCI), but also its potential to reduce the psychological burden of informal caregivers.	To deploy a pilot study with SHAPES methodology and plan, in four pilot sites from Portugal, Spain, Greece and Ireland.	VICOM	N/A	Portuguese and Greece languages are only available by external/third parties (e.g. Google Cloud Services).
UPORTO	non-technology	Intervention Study protocol that includes clinical, social, economic and technological evaluation of outcomes, under a SHAPES Pilot Plan (Phase 1 to Phase 5).	eHealthPassTM, as a online platform that is able to integrate and analyse several health parameters collected by different digital and technical devices, such as smartphone, smart bracelet, smart pillbox, but also parameters provided by the end-users. It's also an App. and a Web Interface.	PT5_UC-003	Digitalization of several caregiving delivery, such as: collection and analysis of health data; providing remote and personalized care and support; feed health alerts based on health data analysed; and assess the health status by pre-program questionnaires.	To deploy a pilot study with SHAPES methodology and plan, in four pilot sites from Portugal, Spain, Greece and Ireland.	GNOMON	N/A	Interconnection with formal caregivers (e.g., GP, Pharmacies, Social Worker)
UPORTO	non-technology	Literature Review about Evaluation Methodologies for Large-scale Pilots	Literature Review and Participation on International Congress	N/A	Participation on SHAPES D6.1	N/A	N/A	N/A	N/A
UPORTO	non-	Literature Review about Integrated Care Models	Literature Review	N/A	Participation on SHAPES D3.2	N/A	N/A	N/A	N/A

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UPORTO	non-technology	Case Study on a Local Health Unit from North Region of Portugal (ULSM)	Documental collection and Interview to Administrative Council	N/A	Participation on SHAPES D3.2	Translation of toolkit (Invitation, Frames, Consent Form, Guidelines) and to know other European cases	N/A	N/A	N/A
UPORTO	non-technology	To design a new Persona based on PT5 Use Cases	A persona for informal caregivers	PT5_UC-002	Participation on SHAPES D2.7	N/A	N/A	N/A	N/A
UPORTO	non-technology	Ethnographic Fieldwork - 5 Case Studies of Older Individuals (the goal is 10 case studies)	Translation of Ethnographic toolkit to Portuguese and deploying cases	N/A	Participation on T2.1	To achive 5 Case Studies (+/- 30 hours of conversation, transcriptions , anonymizations and translations for english)	N/A	N/A	N/A
UPORTO	non-technology	Propose a Portuguese representative for SHAPES Advisory Board	List of available and suitable persons and adress the invitation and clarifications	N/A	Contributions for T1.5	N/A	N/A	N/A	N/A
UCLM	technology	Further development of own product/ knowledge research and development	3D depth cameras, smart bands, and other wearables to older individuals requiring exercise routines during recovery periods after accidents, surgery ...	PT6- Physical Rehabilitation at Home	Development of an interactive caregiving platform aiming at the physical rehabilitation	Integration and communication established between the different sensors	under development / planned to be integrated into the SHAPES platform	TRL4	Need to be used by the real users to redefine and to implement improvement base on its usability / connectivity between wearables
CH	technology	Further development of own product	Chatbot	PT3-001	Collection of data from questionnaires/conversations		communication via an app (Android); has still to be integrated in the SHAPES platform		Language accent Heard of hearing Speaking disabilities
CH	non-technology	Own product applied in other areas	Dialogue frame	PT4-002	Supervisor, companion in cognitive activities		via ARI (PAL)		Heard of hearing Frustration
CH	non-technology	Own product applied in other areas	Dialogue frame	PT6-002	Supervisor, companion in gait rehabilitation	When integrated with KOMPAI, conversations triggered by user localization	via KOPAI robots		

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VICOM	technology	Natural Language Processing and artificial intelligence to build Chatbots	ADILIB	PT1-001 PT1-002 PT1-003 PT2-001 PT2-004b PT3-001 PT4-002 PT5-002 PT6-002	Allow the consortium to build chatbots/assistants to acompany the end-user in their daily duties and activities.	Development of Adilib Skills to make easier to instantiate specific logics in the chatbot.	Via custom/propietary interfaces tailored by each Use Case	Adilib - TRL4, Skills - TRL3, Wake-up TRL4, Speech Recognition (EN/ES)- TRL4, Text to Speech (EN/ES) - TRL4	The need of several languages that was not initially contemplated. The lack of partners that have the technical knowledge to use Adilib. The lack of partners that can build an interface to integrate with Voice Assistants/Chatbots.
VICOM	technology	Computer vision and machine learning for image analysis and encryption techniques for biometric data management	FACECOG	PT1-004 PT2-004a PT2-004b PT4-002 ALL PT6	User's facial recognition to support the user authentication process and for user identification at a distance	Adaptation of the interactivity with this system adapted to elderly users and heterogeneous IoT platforms	Adapted to support ASAPA and the frontend for the user authentication, and with custom interface for user identification at a distance	TRL5	Further tests when fully integrated in robots/gateway with ASAPA and the frontend in operational environments for each pilot are required to increase the TRLs accordingly
VICOM	technology	Computer vision and machine learning for image analysis	OROFACE	PT6-001	User's orofacial gestures analysis in sessions for training of orofacial musculature	Adaptation of the system to specific orofacial gestures for the training of orofacial musculature for elderly users, and improved efficiency for embedded systems	Adapted to support the Phyx.io platform	TRL4	Further tests when fully integrated in the Raspberry Pi of Phyx.io are required in an operational environment for the pilot is required to cinrease the TRL accordingly

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VICOM	technology	Data analysis and Machine learning for cardiac decompensation	Heart Failure Prediction (HFPRED)	PT3-001 PT3-gen PT3-001c	User's cardiac decompensation risk estimation	Adaptation to do connection with partners. Analysis if its improvement with environmental data (temperature, weather..). Feature Selection	It will be dockerized and it will be a service to be consulted by the partners	TRL5	Dealing with irregular data and non constant measurements such as missing values. Different data sources.
VICOM	technology	Data analysis and Model-driven Decision Support System	Model-drovem Decision Support SystemCWDSS	PT1-001 PT2-001	Allows to generate personalized wellbeing recommendations through alert system	Development of alerts through the analysis of user data obtained via wereables devices and inputs from the same users done by the mobile application	It will be included in the EDGE notification system	TRL4	The stablishment and definition of fixed parameters to generate the rules enginee, due to the lack of documentation in some modules. Dealing with dinamic data: rules enginee needs fixed rules and not movible ones.
VICOM	technology	Individual models to monitor various health and fitness parameters,.	Anomaly detection (DAML)	PT1-001 PT2-001 PT5-002 PT6-004	Detect anomalous situations in the health state of users	Development of anomalous system detection through the analysis of user data obtained via wereables devices and inputs from the same users done by the mobile applicaton	It will be included in the EDGE notification system	TRL4	Need of partners data to develop the anomaly detection system to detect when a parameter is out of normality. Previous definition of normaliazed parameters to stablish when an anomaly will be taking place

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