Interreg CENTRAL EUROPE
Co-funded by the European Union

PROCAREFUL

D.1.1.2 ANALYSIS REPORT THAT PRESENTS EXPERTS' RANKING EVALUATION ABOUT THE E-CARE, M-HEALTH HOME CARE

WP1. Mapping and benchmarking of good practices of existing proactive and e-care solutions

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1. Introduction

1.1. Context

This study is the second report of the PORCAREFUL programme, which is aimed at developing a hybrid model of care for the elderly. D.1.1.1 contained an analysis of external (political, social, economic and technological) factors and the stakeholder characteristics (including their needs). An integral part of the previous report was also a preliminary analysis of competitive solutions, which has served as input data for this report.

This part of the study includes a description of pre-mapped solutions available on the market and their 3-level multi-criteria assessment. The purpose of this analysis is to obtain information to be used to determine the following initial design assumptions:

- Functional - i.e., determining the scope of functionality and specification of the developed solution.
- Technical - i.e., identification of the main conditions related to the technical aspects of the solution implementation (e.g., mobile application vs. web application)
- Business - i.e., understanding the factors determining the effective commercialization of a product.

It should be emphasized that the result of the study is only the first stage of drafting the design assumptions of the developed solution, prepared on the basis of literature data and analysis of the current state of technology. In further stages of the PROCAREFUL programme implementation, a secondary verification of the project assumptions is planned with the participation of representatives of all stakeholders.

1.2. Report assumptions

D.1.1.2 Analysis report that presents experts' evaluation of e-care and m-health home care systems. This report contains a detailed ranking and evaluation of selected relevant solutions. The collected data were used to develop a series of recommendations and indications based on the aspects that have already fostered positive outcomes and the observed obstacles for the Model implementation.

1.3. Methods

The following methodology was adopted to prepare the report:

- Phase 1: Pre-selection of solutions subject to further analysis:

A team of experts from the project partner countries, appointed on the basis of recommendations and conclusions of study D.1.1.1, shall make the first pre-selection of those solutions mapped in the above-mentioned report which are consistent with the project assumptions.

- Phase 2: In-depth analysis of the state of technology:

The selected solutions shall then be subjected to a detailed analysis in terms of their functionality and business model (including technical aspects). The mapped solutions, along with a full

description of the functionality and business model, shall be subjected to comparative analysis in order to determine possible patterns and factors that may determine the commercial success of the said solutions. This analysis shall be performed on the basis of objective data, mainly numerical data, e.g., number of users, price of the solution, etc.

- Phase 3: Qualitative analysis carried out with the participation of representatives of Partner States:

Alongside the comparative analysis, an assessment form shall be developed to evaluate the individual functionalities included in the analysed solutions. The functionalities will be assessed by experts representing the Partner States participating on the project. It is assumed that the assessment will concern three categories:

  - Cognitive Prevention Functionalities
  - Physical Decline Prevention Functionalities
  - Social Isolation Prevention Functionalities

- Phase 4: Qualitative Analysis conducted in collaboration with external experts:

Preliminary analysis results will be further assessed by independent experts during dedicated webinars at both national and international levels.

1.4. Glossary

In order to ensure consistent understanding of the terms contained in the following document, the meaning of the terms used in the document is presented below[1].

Long-term care means a range of services and assistance provided to people who, as a result of mental and/or physical frailty and/or disability over an extended period of time, depend on help with daily living activities and/or are in need of some permanent nursing care.

Personal care activities include bathing, dressing, eating, getting in and out of bed or a chair, moving around, using a toilet, and controlling bladder and bowel functions.

Household activities include preparing meals, managing money, shopping for groceries or personal items, performing light or heavy housework, and using a telephone.

Formal home care means long-term care provided by professional long-term care workers, which can take the form of home care, community-based or residential care.

Home care means formal long-term care provided in the recipient's private home, by one or more professional long-term care workers.

Community-based care means formal long-term care provided and organized at community level, for example, in the form of adult day services or respite care.

Residential care means formal long-term care provided to people staying in a residential long-term care setting.

[1] Knowledge Centre on Migration and Demography (KCMD) Data Portal

2. Multi-criteria assessment of the current state of technology

2.1. Phase 1: Pre-selection of solutions subject to further analysis:

2.1.1. Input data

Forty solutions available on the market were pre-selected, mapped and described in the D.1.1.1 report. Table 1, Table 2, Table 3 and Table 4 present the list of all solutions categorized by prevention area. Indeed, the solutions have been initially classified according to their prevention area, as shown in Figure 1.

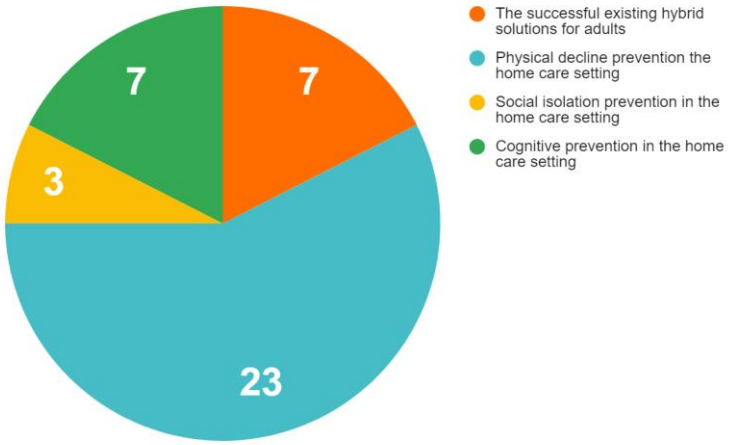

Figure 1. Number of solutions with regard to the prevention area

Additionally, it was also considered prudent to divide the solutions into those focused on health monitoring and those aimed at monitoring the user's safety in their surroundings. The division is presented in Figure 2.

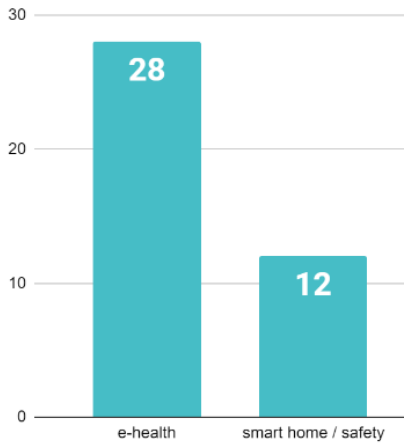

Figure 2. The number of solutions for monitoring patient's health (ehealth) and the ones for monitoring the environment (smart home / safety)

Table 1. Successful existing hybrid solutions for adults (+ 55 years old) and elderly people

Solution	Area	Brief description
KWIDO	Health Mementia Home	Kwido is a comprehensive care solution for elderly people. It is composed of 3 complementary modules (Kwido Health, Kwido Mementia, Kwido Home) being flexible and customizable modules that can be adapted to the needs of each company and the collected data are interrelated creating a complete 360° care solution.
DIPAS	Health Home	DiPAS (digital personal assistance system) is a platform intended to offer a smart IoT solution with a holistic approach for elderly people residences, nursing homes, hospitals and home care. The platform allows to control and constantly monitor people in order to anticipate potentially hazardous situations, which may have a major impact on the well-being of people as quickly as possible.
TICURO REPLY	Health Home	Ticuro Reply is based on the Internet of Things (IoT) and Big Data, combining wearables, medical devices and sensors to improve the quality of life of people. The platform allows to collect and analyse clinical and environmental data. It promotes continuity of care.
Silver technologies	Health	Silver monitor for seniors, wristbands and smart watches are simple, robust and easy to use. There are no cables, tape or calibration required. With only one ALARM button and very comfortable to wear. They enable continuous health care and safety monitoring. Currently, they can monitor the following parameters: blood pressure, heart rate, physical activity and location. Measurements are collected every 15 minutes. They enable us to achieve a precise understanding of senior's overall health status. The product has an integrated alarm system. Seniors can activate support service with just one click on a main activation button. The product can be upgraded. New parameters to be added soon, covering more measurements: fall detection, medicine reminder, temperature, diabetes monitoring, etc. The product is now available as a health and fitness version, but in the future, it will be certified as a medical device.
E-OSKRBA	Safety	E-OSKRBA is a social service which enables all-day connection via a personal telephone alarm - remote protection
MAGDA Mobile	Social	Magda is the first Slovenian mobile application for elderly

application for elderly people		people, combining all important content and information in a single device. It focuses on areas that have a significant impact on the quality, activity and social diversity of the lives of the elderly. The application offers assistance in the use of new technologies, which in turn bring independence, information, access to various contents and greater inclusion in the society. important contacts (SOS numbers) News from a wide variety of fields Info point Classroom with text and video lessons Gym with text and video exercise programs Events with current reviews
DECT teleoskrba	Safety Social	DECT telecare is a pendant worn on the user's neck that allows them to call for help in the event of a fall, weakness or other unexpected situation. • Teleservices • Smoke alarm detection • Time reminders • Fall detection • Daily contact with family and friends • Voice assistant
TERRA 95 BT Hospice Services	Health	The privately-owned company provides hospice and home care services in northeaster Hungary. Its main functionality is the frequent use of a wide portfolio of innovative e-learning and smart tools. The service is provided in the patient's home, especially designed for nursing, physical therapy, physiotherapy, and speech therapy activities, using almost all types of medical tools, technology and devices available in Hungary

Table 2. Cognitive impairment prevention in the home care setting

Solution	Area	Brief description
BRAINER, PROFESSIONAL BRAIN TRAINER	mobile games; physical decline prevention in the home care setting	Brainer is a medical device, a web-based platform for cognitive rehabilitation. It provides neuropsychologists with a set of cognitive exercises that target different cognitive functions. The platform allows to manage medical records, create personalized rehabilitation programs, visualize results and progress. The platform is accessible from any device. Exercises are performed by users in the presence of a professional, who can subsequently assign exercises to be carried out at home.
MENSANA	mobile games	Mensana is a platform with cognitive exercises, a web application designed to train the mind and brain through exercises that can be performed comfortably on tablets and computers.
Neo Cogita system	mobile games physical decline prevention in the home care setting	Well-being technologies to help people stay healthy and maintain mental and social well-being, as well as maximize their individual potential. Evolvity solution: it allows all workers to monitor their health status (physical, mental and psychological) in a simple, fast, reliable and privacy-compliant (GDPR) way Brain wellness: an application that Neocogita has developed to enhance personal and professional performance. It offers widely used Mindfulness, Cognitive Training and Lifestyle Assessment protocols based on rigorous neuroscientific research. Transdermal Optical Imaging (TOI™) technology allows users to get a report of their physical and mental health in just 30 seconds
DAK Memory Coach	memory exercises	This application helps people with dementia to activate their long-term memory. - The following content is available: o Completing proverbs o Guessing fairy tales o Recognising sounds o Each correct answer can immediately provide a sense of achievement and helps to activate the memory.

GRADYS	cognitive function training	Software in the form of simulation exercises with elements of virtual reality to support the cognitive functions in normal ageing and pathological ageing in the course of dementia based on the method of cognitive training (GRADYS). Virtual game prototype - software with virtual reality elements to train cognitive functions of the elderly. The solution has not yet been commercialized
Accexible	Prognostic system - mild cognitive impairment	Accexible's alert system allows disease detection through speech analysis. At present, Accexible is developing AI models for mental health (depression & anxiety), and health conditions related to mild cognitive impairment (Alzheimer's, Parkinson's). The tool allows efficient detection and monitoring of mild cognitive impairment and dementia.
Lumosity	mobile games	A collection of scientifically developed games to support brain training. Exercises are grouped according to training objectives and game type (memory, attention, logical thinking, etc.). Lumosity offers an individualized training program based on the user's performance. It includes cognitive and neuropsychological tasks that train basic cognitive skills.

Table 3. Physical decline prevention in the home care setting

Solution	Area	Brief description
HTN Telemedicine	e-Health	An application containing all the user's health information, accessible at any time. It also records the patient's biological parameters. It as a sort of a digital medical record
COMARCH REMOTE MEDICAL CARE	e-Health	Telemonitoring is a telemedicine service which allows remote monitoring of health conditions of the patient. In this case, Comarch offers a web platform to which a set of medical tools are connected to monitor the patient's health. The monitoring results are sent to the telemonitoring centre and analysed automatically. In case of anomalies, the medical staff can contact the patient or notify the local emergency services
SEREMY	e-Health Safety	Seremy is a remote monitoring system for elderly or frail people. It consists of an autonomous smart bracelet. Seremy application can be downloaded to remotely follow the person wearing the bracelet. The application makes it possible to receive SOS requests, serious fall or stray alarms from the bracelet sent to a smart phone. Seremy tracks general well-being, sleep quality, heart rate regularity, and amount of physical activity to prevent and reduce risks.
HOWDY SENIOR	e-Health	HOWDY SENIOR is ComfTech's wearable monitoring device dedicated to adults. In collaboration with universities and specialized companies, ComfTech has developed HOWDY SENIOR: a wearable monitoring solution designed for adults, without age limits ECG, providing continuous, non-invasive and real-time detecting of vital signs such as heart rate, real time ECG, respiratory rate, position and movement. HOWDY SENIOR is ComfTech's wearable monitoring device dedicated to adults. The device is based on textile technology that allows the system to be integrated into the user's daily life as a flexible, adaptable and non-invasive support. The device is designed not to interfere with the person's lifestyle and can be worn all day long with total freedom. ComfTech's sensorised garments are made of special conductive yarn that guarantees full and long-lasting comfort.
LINDERA	e-Health	The Lindera App analyses individual fall risk factors, defines

		intervention targets for risk reduction and proposes tailored measures to reduce the fall risk and enhance mobility. The Mobility Analysis consists of two steps: the in-application fall risk questionnaire and a gait analysis via smart phone camera. The precise 3D motion tracking accurately calculates step patterns as well as body inclination – even with the use of walking aids. The resulting analysis provides personalized recommendations to reduce the fall risk and maintain mobility in old age. The repeated use of Lindera is associated with significant decreases in fall risk.
Procarement	e-Health	ProHerz is a therapy companion for patients with heart failure (ICD-10 code I50) to support their self-management and provide an early warning system informing them of changes in their health status. The vital signs measured daily by the patients (blood pressure, oxygen saturation, pulse, temperature, weight) are recorded and analysed automatically either manually or via Bluetooth connection to mobile devices (smart phone, tablet). This makes it possible to independently document and monitor the health status of patients with this chronic disease. After entering the data, the patient immediately receives a quick assessment of the current health status. In addition, ProHerz offers digitally implemented and personalised health coaching and other functions for risk prevention based on the obtained data and the individual health and therapy profile.
Sleep Cycle	e-Health	Sleep Cycle is the world's leading sleep tracking application and a pioneer in the sleep-wellness area. It provides sleep quality analysis
Instant heart rate application	e-Health	MAIN FUNCTIONS: - Heart rate measurement - Heart rate calculator for load range - Pulse wave diagram - Photoplethysmogram (PPG) in real time - Continuous or auto stop mode - Unlimited data storage and number of days - Data export for registered users - Valid test for fatigue and fitness verification
LOLA	e-Health	Automatic fall detection without pressing a button: LOLA

		automatically detects falls and summons help without having to press the emergency button Reminder functions: Appointments and birthdays Reminder functions: Medications Emergency call using a smart phone Emergency call using a smart watch. 24/7 security in case of an emergency
Medipee	e-Health	Medipee is a start-up in the area of medical technology that revolutionises health care and brings it directly into the home. Our system gathers important medical information such as urine quantity, drinking habits, frequency of urination, glucose, blood or nitrite (a decomposition product of bacteria) in urine. With the system developed by Medipee, this information is provided automatically, hygienically and easily. The device is attached to the upper rim of the toilet at home, similar to a fragrance stone. However, In this case, the main part of the device is located on the outside of the toilet. As soon as the device detects urine flow, the automatic measurement starts in a few seconds.
Kaia Health	e-Health	Kaia Back Pain is a digital therapy for holistic treatment of pain according to an individual therapy programme. Available in the application: - Physiotherapeutic movement exercises strengthen all your muscles. - Breathing and relaxation techniques help you reduce stress. - Knowledge units provide you with an understanding of your symptoms and give you tips for everyday life. With Kaia COPD digital therapy, you can increase your physical well-being and improve your breathing: - Physiotherapeutic movement exercises strengthen all your muscles. - Breathing and relaxation techniques help you cope with breathlessness and stress. - Knowledge sessions give you an understanding of your symptoms and helpful tips for everyday life with COPD.
MEDISTANCE Smart Tools	e-Health	The company offers digital health services that facilitate mobile health data transmission for elderly people. The main feature of the product is the direct transmission of blood pressure and

		blood glucose level data to doctors and relatives through GSM-based mobile data. The data collecting and monitoring tool packages offer various services: 1) access to the closed web portal of the Medistance group; 2) central data storage on protected data storage servers; 3) sending an e-mail message when a certain value limit is exceeded.
Šola zdravja	e-Health	An organisation of groups of activists exercising together every morning in all the Slovenian municipalities creating videos presenting the practices to be applied at home and educational videos for healthy living. • Free videos with morning exercises • Educational lectures about healthy lifestyle • A list of all groups that exercise around Slovenia (with contact information)
VEŠ KAJ JEŠ	e-Health	VešKajJeš identifies the food by scanning and informs about its nutritional composition. The consumer can take a photo of the bar code of the food with the smart phone camera, and the application will instantly show them key information about its nutritional composition, explained by means of traffic light colours signalising the nutritional value. If the food is not yet in the database, you can suggest replenishing the database.
Comarch WristBand	e-Health	The WristBand allows two-way phone calls (to and from the armband) and also monitors the heart rate, location or number of steps taken by the user. This data is sent to the Comarch WristBand mobile application, so the carer has easy and unlimited access to it. - SOS button - Voice prompts - GPS location - Wear sensor - Medication reminder - Heart-rate measurement - Fall detector - Two-way voice calls - Vibration - Pedometer

		- Stillness sensor - Mobile application for the patient's relatives
Sidly	e-Health	SiDLY creates state-of-the-art wearable technology with a data analysis system. It also provides its own medical Telecare Centre, where the work of medical personnel is supported by systems based on artificial intelligence. A remote care system for seniors, consisting of: Telemedicine armband Remote care and monitoring devices with a paging system Web platform and mobile application An in-house medical centre
eLifeCare Telemedicine platform	e-Health	The eLifeCare Telemedicine platform provides a set of solutions and services for Teleconsulting, Telecare and Telemonitoring to support all health operators involved in patient care and monitoring at home. - Remote monitoring - Telemedicine and Teleconsulting - Monitoring of drug supply - Reporting and filing systems - Patient's medical history in electronic folders
Halo help alarm system	Safety	Ability to contact medical staff who are on duty 24 hours a day.
Neuroforma	e-Health	A hybrid rehabilitation system that enables exercises either at home or a centre, and the provision of telerehabilitation. The database of interactive exercises includes tasks that address a variety of areas of cognitive functioning (e.g., visual analysis, memory, attention) and motor functioning (e.g., hand muscle strength, range of motion, coordination of both hands). Each exercise is associated with a combination of improved functions, making it easy to adapt them to different goals of rehabilitation. An intuitive search engine suggests which exercises will best suit the user's needs.
CareTech	SmartHome/Safety	A security system in and out of the home, consisting of a number of different sensors and two-way communication capabilities. Elderly Care Solutions: - CareTech Solutions

		- Personal Alarms - Pendant Alarms - Care Hub - Care Hub Plus - Care Go - Fall Alarm - Smart Independent Living - Key Safe
InteliCare	SmartHome/Safety	InteliCare's smart care solution combines discreet sensors, wearable technologies and alert devices to provide multiple layers of intelligence and insights. This allows carers and care providers to track activity levels, patterns of behaviour, health indicators, sleep quality and more. Through identifying and highlighting behavioural trends and changes, InteliCare assists caregivers in detecting and preventing incidents, emergencies, and health issues. InteliCare sends the information collected by the sensors to a mobile application and desktop dashboard accessible to caregivers. The data is displayed in easy to understand graphs, which clearly highlight behaviour parameters outside of the expected values. The platforms update and analyse the data in real time, which means that caregivers have unrestricted access to patient monitoring 24/7.
ElderOn	SmartHome/Safety	ElderOn notifies the user when their relative falls, wanders out of bed or presses the SOS button. ElderOn enables elderly people to live independently at home without major lifestyle changes. It notifies their relatives via a mobile application if they fall, wander out of bed or press the SOS button. 1. Fall detection - Automatic fall detection and caregiver notification via mobile application. 2. Presence in bed - Notification In case of prolonged absence from bed during the night. 3. SOS button - Giving and receiving emergency calls. 4. GPS sensor - If you wish, you can track the location of the elderly person.
TESI eViSuS®	e-Health	TESI eVisus offers a unique on-line system providing training and

	guidelines to health professionals, assistants or care providers on performing healthcare procedures remotely, in a healthcare institution, in a local outpatient clinic or at patient's home. It also offers the possibility to receive audio-visual consultation and perform on-line training sessions.

Table 4. Social isolation prevention in the home care setting

Solution	Area	Brief description
ČVEKIFON	Social	ČvekiFON is a unique telephone network intended exclusively for elderly people. A toll free number 080 38 07 allows the user to register and make free calls. ČvekiFON randomly connects an elderly person with another elderly person (this randomness is actually a fun way to expand the social network of the elderly people) It is free and safe to use. Neither the caller nor the callee can see the other person's individual phone number - only the ČvekiFON telephone exchange number. Of course, if they find a common interest and wish to do so, they can give their individual phone numbers to each other. ČvekiFON works between 8:00 a.m. and 8:00 p.m.
No Isolation	Social	User-friendly and secure technology for photo sharing, text messaging, and video calls. Providing the capability of making video calls and sharing photos with their friends and family, Komp makes it easy for seniors to stay involved in the daily life of their families. On top of the user-friendly design, it also features a computer with only a single button, which is connected to an application on the user's friends and family's phones.
The United Kingdom's Campaign to End Loneliness	Social	A collection of analyses, research, and good practices related to eliminating loneliness and social isolation of the elderly.

2.1.2. Stage description

The pre-selection was conducted by a team of experts and analysts, taking into account the results of the D.1.1.1 report with particular emphasis on external (market) factors and the actual needs of all stakeholders. The team also considered the purpose and assumptions of the entire solution, so the following aspects were analysed:

- holistic approach - understood as addressing the needs of all stakeholders
- adaptability - i.e., the ability to easily optimize and adapt the solution to the changing conditions
- scalability - i.e., the possibility of expanding the solution and/or opening up to new groups of potential users
- technical conditions - e.g., Internet access
- economic conditions - e.g., acceptable expected final price for the customer.

2.1.3. Result and discussion

The conducted pre-selection allowed for the selection of 13 out of 40 solutions. Pre-selected solutions are listed in Table 5. The result of the analysis was to define the solution as an application (mobile or web-based), not as a physical solution (e.g., IoT, MIoT). The reasoning behind a particular choice was as follows:

- Holistic: assuming that the solution is possibly designed as a tool for all stakeholders, constituting a kind of platform for all parties, where different functionalities address different needs. The platform/application shall offer such capabilities as.
- Adaptability: Solutions in the form of mobile/web applications shall provide the opportunity to constantly expand their functionality, iterative development taking the emerging market feedback into account, as well as the possibility to quickly and easily update the application.
- Scalability: Solutions in the form of mobile/web applications shall not only be easy to expand, but also their introduction to the market by means of dedicated platforms (Apple Store / Google Play) shall facilitate the provision of the finished product to potential users.
- Technical conditions: The pre-selection process also concerned the design, technological, production, service and implementation issues. Creating a physical product is a time-consuming and complex process, and therefore extremely expensive. Physical products also have significantly limited adjustment/adaptation capabilities in response to emerging feedback - these barriers result mainly from the production and logistics processes. Therefore, it seems reasonable to start work on the product in the form of a web/mobile application, which may be integrated with existing hardware solutions.
- Economic conditions: the above-mentioned costs resulting from the production process, logistics and provision of the physical product would have to be amply covered in the sales price of the finished product. Software solutions require similarly high financial investment during their first

implementation, however, product maintenance and further development, i.e., operating costs, are significantly reduced. All this translates into the final price for the customer.

Taking the above considerations and the main assumptions of the project into account, the following 13 out of 40 solutions were selected. These are software solutions that address all three prevention areas:

- Cognitive Prevention Functionalities
- Physical Decline Prevention Functionalities
- Social Isolation Prevention Functionalities

Table 5. Pre-Selected solutions

Solution	Prevention area
KWIDO	the successful existing hybrid solutions for adults
BRAINER, PROFESSIONAL BRAIN TRAINER	cognitive impairment prevention in the home care setting,
MENSANA	Cognitive impairment prevention in the home care setting,
DIPAS	the successful existing hybrid solutions for adults
SEREMY	physical decline prevention in the home care setting,
Neo Cogita system	cognitive impairment prevention in the home care setting,
VOIZE	physical decline prevention in the home care setting,
DAK Memory Coach	cognitive impairment prevention in the home care setting,
TERRA 95 BT Hospice Services	the successful existing hybrid solutions for adults
Lumosity	cognitive impairment prevention in the home care setting,
GRADYS	cognitive impairment prevention in the home care setting,
Accexible	cognitive impairment prevention in the home care setting,
Neuroforma	physical decline prevention in the home care setting.

2.2. Phase 2: In-depth analysis of the state of technology:

2.2.1. Input data

Information regarding the pre-selected solutions available on the Internet was used to conduct an in-depth analysis and a comparative analysis and identify possible regularities and good practices. The data were obtained from materials posted on official websites, technical specification of the applications and from Apple Store/Google Play.

2.2.2. Stage description

The in-depth analysis assumed obtaining three categories of information:

- Business conditions
- Technical conditions
- Functions of individual solutions.

In the case of **business conditions**, it was deemed reasonable to use a classification consistent with the BMC methodology, which was supplemented with additional information. As a result, it was possible to compare data regarding:

- Target groups / group
- Number of users
- Availability in individual countries
- Availability in various language versions
- Marketing activities, mainly in relation to the presence in social media
- Information regarding possible certification as a medical application (for compliance with MDR 2017/745)
- Partnership/support from industry authorities
- Monetization model
- Content availability in the freemium model
- Price
- The data were assessed by a team of experts and analysts who compared objective data in a way that allowed them to find any regularities in the effectively implemented solutions.

In the case of the **technical data**, the team performed a preliminary assessment of such elements as:

- Availability/compatibility with hardware components (physical products)
- Availability of a mobile application
- Availability of a web application
- Possible use of artificial intelligence/machine learning algorithms.

Mapping of **individual functionalities** of the analysed solutions was also important. In accordance with the project assumptions, the described functionalities provide support to the users in the following areas:

- Cognitive Prevention Functionalities
- Physical Decline Prevention Functionalities
- Social Isolation Prevention Functionalities.

The business model (Figure 3) and technical data (Table 6) were analysed by a team of experts, while the functionality assessment (Table 7) was performed in the form of a qualitative assessment by professionals representing partner countries.

Business Model Specification

	TITLE	Target group	Number of users	Availability in various countries	Language/s	Communication channels + SM	certification as a medical device,	Support of scientific/medical authorities,	Is Freemium Available	Price	Sales Model (e.g. subscription)?
1	KWIDO	Older people Professionals Informal caregivers:	Number of downloads : Kwido Mementia: more than 1000 Kwido Caregivers: more than 1000	Spain, United Kingdom, Portugal, Italy, Austria, Luxembourg, Austria, Romania and Poland	Spanish, English, Portuguese, Polish, Romanian, German, Italian, French	Website: https://kwido.com/ Social media activities Participation in and coordination of numerous technological projects for older people mainly funded by the AAL Programme. Organization of annual event on ageing. Presence in numerous events, both Europe and worldwide, such as OptimizeIT, AAL Forum 2018 and 2019 and Ageing Fit.	No	Several studies have been conducted on Kwido Mementia, analysing its performance and offering different results on its benefits, both for users (Kwido Mementia Study at BetION) and for the organizations that use them (Unidad de Memoria Cognitive Study). A clinical study was even conducted by an independent external organization, which was published on an international level. (Study of the Effectiveness of Kwido's Cognitive Stimulation).	Not available	Not available	Not available
2	BRAINER, PROFESSIONAL BRAIN TRAINER	Neuropsychologists: Brainer can be a tool to provide patients with a variety of cognitive exercises, personalized cognitive rehabilitation programs, and to monitor progresses Older people for prevention of decline People for rehabilitation	Not available	Italy	Italian	Website https://www.brainer.it/ Social media Newsletter / blog	Yes (class I medical device)	Scientific partners, conducted several research projects	14-day free trial	Brainer professional package (77 exercises): € 90 monthly / € 240 quarterly / € 450 six-months / € 840 annually / € 1320 two-year Possibility to add optional packages. E.g., Home exercises per user: € 24 monthly / € 56 quarterly / € 89 six-months / € 119 annually / € 179 two-years Physiotherapy videos: € 18 monthly / € 43 quarterly / € 81 six-months / € 150 annually / € 238 two-years	Subscription
3	MENSANA	the average target is people aged 55 but all people can train	Not available	Italy	Italian	Website https://mensana.brainer.it/index.php	No	Mensana derives from neuropsychological research and neuroscience	No	Monthly: €15 six-month: € 59 Annual: € 89 Bi-annual: € 119	Subscription
4	DIPAS	Older people at home or in residential facilities Professionals to monitor health of older people	Not available	Italy	Italian	Website Social media Commercial director	No	Not available	Not available. Free consulting available.	Not available	Not available, probably subscription
5	SEREMY	Bracelet is for: Older people Frail older people Lonely people People with dementia The app for monitoring is for caregivers	More than 10.000 downloads. 15000 users (according to website)	Italy	Italian	Website Social media Seremy smart YouTube channel Blog	RED (2104/53/EU) certification, making it compliant with all European electronic and medical devices in terms of electromagnetic emissions.	Not available	30-day money back guarantee	€ 119 to buy the smart bracelet + € 9 monthly subscription +5 family members option: € 5 monthly subscription	Braclet purchase + mobile app subscription. Data traffic Italy and SIM included
6	Neocogita system	Companies Workers Citizens	100+ downloads	Italy	Italian, English	Website Social media Blog	Not available	All protocols are built on the basis of rigorous neuroscientific research	Not available	Not available	Not available
7	VOIZE	Nursing staff who carry out nursing documentation (test engineers) (developers (of apps))	Not available	Germany	German, English	Website Blog	Not available	Speech recognition and artificial intelligence investigated in the BMBF-funded research projekct PYSA	2 weeks free trial possible	Not available	Pilot project: up to 3 months; Individual packages for 50 to over 10,000 users
8	DAK Memory Coach	The skill is primarily suitable for people with mild dementia	Not available	Germany	German	Website	Not available	Not available	Not available	Not available	Not available
9	TERRA 95 BT Hospice Services	In general, the target group is not narrowed to a specific age group, it rather focuses on the patient's needs in the home care service system	Not available	Not available	Not available	Not available	Not available	Not available	Not available	Not available	Not available
10	Lumosity	Software for people of all ages, not dedicated to the elderly.	100 million members (according to website), 10 mln + downloads (google play)	USA	English, Spanish, French, Portuguese, German, Japanese, Korean	Website Social media Additionally, the marketing message is supported by expert opinions and scientific publications containing the results of scientific research.	No	Yes - in-house Science team is committed to translating cognitive science into accessible brain training	The pay-per-view model is available with a three-game-daily free version	Monthly: 11,99 EUR Annual: 59,99 EUR	Subscription
11	GRADYS	people over 60	Not available - the solution has not been commercialized	Poland	The solution has not been commercialized	The solution has not been commercialized	No	Yes	The solution has not been commercialized	The solution has not been commercialized	The solution has not been commercialized
12	Accexible	Older people	More than 50 neuropsychologists, neurologists and psychiatrists use Accessible with 10.000 patients (according to website)	Spain	Espanish, English	Website Social media	No	Yes, linguistics, neuroscience and mathematics	Not available	Not available	Not available
13	Neuroforma	Neuroforma supports improvement of motor and cognitive functions - stroke - multiple sclerosis - brain injuries - Alzheimer's disease - Parkinson's disease - Huntington's disease - learning problems - preventive health care for seniors - and many others	More than 10.000 of users (according to website), 150 + medical centers	Poland	Polish, English, Spanish, Lithuanian, German, French, Bulgarian, Dutch	Website Social media	No	Yes, extensive scientific research in many areas, implementation of many R&D projects	Not available	6,5 tys EUR - hardware for professionals.	Not available - probably subscription. Hardware elements for proffesionalist - purchasing

Figure 3. Business model specification of pre-selected solutions

Table 6. Technical specification of pre-selected solutions

	TITLE	Element hardware	Mobile application	Web platform	AI/ML
1	KWIDO	Yes - Kwido Home system of non-intrusive sensors; autonomous sensor system that monitors and issues alerts on any abnormal behaviour of an elderly person. Not only does Kwido Home offer its own devices but can also connect to third party systems. It could even connect to sensors from existing telecare or security companies that have already placed technology in their customers' homes	YES	YES	YES
2	BRAINER, PROFESSIONAL BRAIN TRAINER	NO	NO	YES	No info
3	MENSANA	NO	NO	YES	No info
4	DIPAS	Yes - dedicated solutions.	YES	YES	No info
5	SEREMY	Yes - dedicated smartband	YES	YES	No info
6	Neocogita system	NO	YES	YES	YES
7	VOIZE	Any Android mobile phone with Android 10 or newer can be used.	YES	NO	No info
8	DAK Memory Coach	Alexa voice assistant	YES	YES	No info
9	TERRA 95 BT Hospice Services	NO	YES	YES	No info
10	Lumosity	NO	YES	YES	No info
11	GRADYS	Yes - VR glasses	NO	YES	No info
12	Accexible	NO	NO	YES	YES
13	Neuroforma	Yes - smart phone with a camera	YES	YES	YES

Table 7. Proposition value (functionalities) of pre-selected solutions

	TITLE	Cognitive Prevention Functionalities	Physical Decline Prevention Functionalities	Social Isolation Prevention Functionalities
1	KWIDO	- thousands of cognitive exercises, which can be adapted to the cognitive level of each user; - exercises developing a range of skills: Attention, Calculation, Executive Functions, Language, Memory and Orientation; - the system itself analyses the initial cognitive level of the user and offers them a comprehensive training schedule; - real-time information about patients' training; - activity reports; - the ability to analyse progress and share it with family members; - ability for therapists to create their own personalized games	- remote medical services in residences (telemedicine platform that allows 24/7 monitoring of a patient's health) - video call and appointment scheduling possibilities, in order to add teleconsultation to health monitoring	- home monitoring system; - autonomous sensor system that monitors and issues alerts on any abnormal behaviour of an elderly
2	BRAINER, PROFESSIONAL BRAIN TRAINER	- 77 exercises; - 5 cognitive areas; - 3 difficulty levels - story exercises (2 stories made up of different exercises) - ecological games and exercises	- physiotherapy videos (includes 138 videos of varying duration, between 90 and 120 seconds each. The videos are divided into 7 categories based on the type of exercise performed: coordination, cues, balance, preparatory exercises, postural steps, sequences, carpet)	
3	MENSANA	- web application designed to train the mind and brain; - initial check-up; - from time to time. the user can decide which mental skill to develop; - 5 levels with increasing difficulty; - strengthens attention and concentration, memory, reasoning, logic and speed of thought		- interaction with other users and comparing the results of training sessions

4	DIPAS		- Non-wearable sensors, which automatically notify the responsible person; - Environmental sensors; - Telemedicine devices	- Interface to communicate with relatives and caregivers and interact with the local medical network
5	SEREMY		- monitoring heart rate, sleep quality and activity levels, serious falls detection; help button; - mobile application for remote monitoring (requests for help, automatic alerts, level of well-being, location)	
6	Neocogita system	- Psychological parameters measuring: anxiety, depression, mental fatigue; - Evolvity - for companies that care for the well-being of their employees. With Evolvity, all workers can monitor their health status (physical, mental and psychological); - Brain Wellness™ - the mental and cognitive training programme; - audio-guided meditation courses concentrate on relaxation and focusing techniques; - Cognitive Training	- TOI™ technology uses the smartphone camera to measure and monitor some important vital parameters through a facial scan, which analyses blood flow in just 30 seconds; - general well-being index; - Vital signs; - Physiological parameters; - index of mental stress; - Physical parameters; - risk of cardiovascular disorders, stroke, heart attack, hypertension, hypertriglyceridemia, hypercholesterolemia, diabetes - Neocogita's Lifestyle Assessment - biofeedback sensor that allows to assess the quality of lifestyle	

7	VOIZE		- Nursing documentation through voice transcription; - Voize automatically creates accurate care reports, vital signs entries and movement logs and transfers them to your documentation system via an interface; - Mobile care assistant; - Wound doc with photos; - Medication plan; - Support in case of emergency
8	DAK Memory Coach	- DAK Reminder Coach: Add proverbs, Guess fairy tales, Recognize sounds	
9	TERRA 95 BT Hospice Services		temporarily unavailable
10	Lumosity	- Speed Games; - Memory Games; - Attention Games; - Flexibility Games; - Problem Solving Games; - Word Games; - Math Games; - a fresh set of games; - interpretation of results, feedback	
11	GRADYS	The lack of implementation and possibility of testing and presenting functionality	
12	Accexible	- Speech analysis for the early detection of mental health conditions - Screening tool - 30 to 60 patients' speech. Can be obtained via phone, website or app; - Monitoring tool - mood tracker allows the health professionals to monitor the emotional well-being of patients over time	- Telemedicine - Accexible's platform allows remote detection and monitoring of diseases

13	Neuroforma	- a hybrid rehabilitation system enabling exercises at home, in a centre and the provision of telerehabilitation; - online access to professional, interactive exercises; - daily progress information; - real-time results analysis; - possibility of telecare by a physiotherapist

2.2.3. Result and discussion

The analysis and assessment of the analysed results regarding the business model of the pre-selected solutions is as follows:

Target groups / group - 10/13 of the analysed solutions were dedicated to a specific group of users associated with the LTC area. Only two solutions have a "broader application" and are not addressed exclusively to elderly people but to people with specific ailments. It should be emphasized that stakeholders other than the elderly constitute an auxiliary group only - this means that none of the solutions discussed is dedicated strictly to a group of users other than the elderly.

In the case of the **number of users**, unfortunately most of the analysed web/mobile applications do not provide such information. However, based on data from official sources, it should be pointed out that the Lumosity application has over 10+ downloads (Google Play). Two applications declare over 10,000 users. The data were unavailable for 6/13 applications,.

When it comes to **internationalization**, only KWIDO is available in countries other than the country of origin. The application is available in Spain, Great Britain, Portugal, Italy, Austria, Luxembourg, Romania and Poland. However, this does not correspond to language availability.

Availability in various language versions - 6/13 solutions are available in two or more languages. Generally, the language other than the mother tongue is English. Nuurofora and Kwido are available in 8 languages, while Lumosity in 7.

When it comes to the **marketing** activities conducted by the analysed solution manufacturers, all solutions have an official website and at least one social media profile. However, it is worth noting that KWIDO is actively involved in co-organisation of dedicated events focused on the elderly.

In terms of the approach to **legal aspects and regulations**, only the Brainer application meets the definition of a medical device contained in the MDR 2017/745 regulation, which is why the application has been classified as a class I medical device. One of the requirements for the implementation of a medical device is to perform a clinical assessment of the solution, which somehow confirms (or at least documents) the effectiveness of a given solution.

In the case of established **cooperation** between individual teams, 9/13 manufacturers declared cooperation with research centres and scientists in a given area. It could be noted that partnerships were established to verify and confirm the effectiveness of the solution and to make it credible through scientific publications.

Unfortunately, in most cases, the issue of the **monetization model** and the related pricing policy is confidential. The predominant model in 5/6 solutions, for which data are available, is subscription. For 7/13 solutions this data is unavailable. The same applies to the price for using a given solution. The highest known price is a monthly fee of EUR 90 for the above-mentioned BRAINER solution. The price may result from the fact that the application is a certified medical device dedicated to both patients and therapists. In the case of other applications, prices range from EUR 10 to EUR 20 for a monthly subscription. It is also worth noting that none of the described solutions offers a Freemium model in the sense of providing a limited amount of content for free.

When assessing the **technical specification**, attention should be paid to the relatively large share of hybrid solutions in the sense of combining the application with hardware in the case of 7/13 solutions. Interestingly, in 3/7 cases, complementary physical products constitute proprietary solutions dedicated to application developers, the remaining 4/7 seem to be compatible with solutions available on the market with specific functionality. 6/13 solutions have no hardware support at all.

It is also worth noting that almost all solutions (12/13) come in the form of a **web application**. A **mobile application** is available in 8/13 solutions - it should therefore be assumed that the web application constitutes a kind of a market standard and the mobile application are complementary. There is little data on the use of artificial intelligence algorithms - only 4 companies declare their use. For the remaining analysed applications, this information is not publicly available.

As part of the in-depth evaluation, individual functionalities of the application were also identified, although they are subject to qualitative assessment carried out by experts representing partner countries.

2.3. Phase 3: Qualitative analysis carried out with the participation of representatives of Partner States:

2.3.1. Input data

The qualitative analysis in the form of expert assessment by industry representatives of the project Partner States was based on the listed functionalities of individual applications. The partners also had the opportunity to familiarize themselves with the solutions by downloading/installing/logging in to the analysed applications. At the end of the assessment form, respondents declared whether they used only the tabular evaluation or actually used the application itself.

2.3.2. Stage description

In order to perform a qualitative assessment, an assessment form was created on Google https://forms.gle/WzWemmMtWTyBRAzQ9. First, the tool involved the division of the analysed applications into four categories: three related to the area of operation, in order to be able to directly compare technical solutions addressing the same problem, and the fourth related to UX issues. The assessment form assumes rating of each application using a scale from 1 (negative rating) to 5 (positive rating). The final result was the arithmetic mean of the partial marks. Moreover, in order to obtain additional information, the form allowed leaving an additional comment regarding each application.

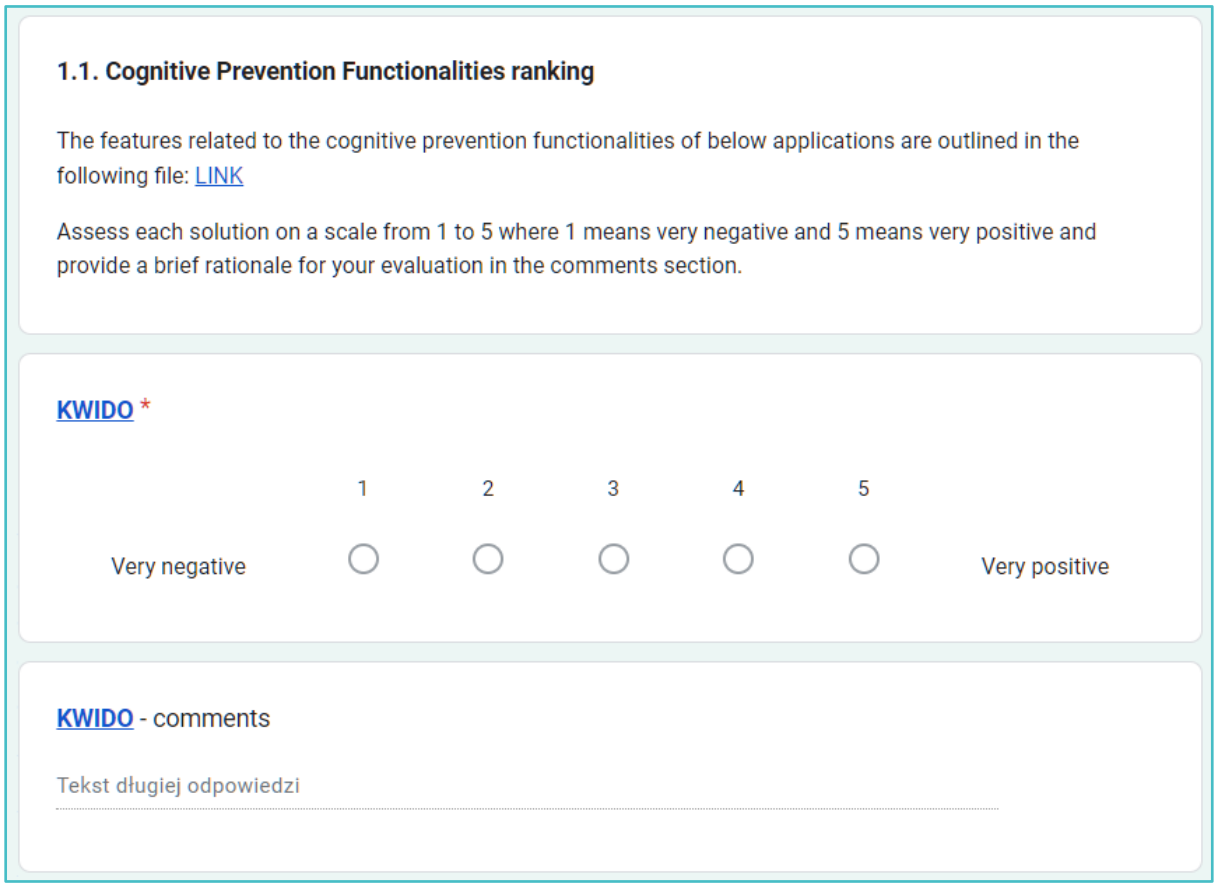

Figure 4. Sample view of questions included in the form

2.3.3. Result and discussion

The results for individual categories are presented in the tables below:

Table 8. Ranking of Cognitive Prevention Functionalities

TITLE	SOURCES	SCORE
KWIDO	https://kwido.com/	4.4
BRAINER, PROFESSIONAL BRAIN TRAINER	https://www.brainer.it/	4
MENSANA	https://mensana.brainer.it/index.php	4
Neo Cogita system	http://www.neocogita.com	3.8
DAK Memory Coach	https://www.dak.de/dak/leistungen/dak-erinnerungs-coach_28192#rtf-anchor-was-ist-der-dak-erinnerungs-coach	2.6
Lumosity	https://www.lumosity.com/en/	4.2
Accexible	https://accexible.com/	3.6

Table 9. Ranking of Physical Decline Prevention Functionalities

TITLE	SOURCES	SCORE
KWIDO	https://kwido.com/	4.6
BRAINER, PROFESSIONAL BRAIN TRAINER	https://www.brainer.it/	4.6
DIPAS	https://www.care4u.it/it/	3.6
SEREMY	https://www.seremy.it/	3.4
Neocogita system	http://www.neocogita.com	3.2
VOIZE	https://www.voize.de/	3.2
TERRA 95 BT Hospice Services	http://www.terra95.hu/ temporarily unavailable	2.4
Accexible	https://accexible.com/	3
Neuroforma	https://www.neuroforma.pl/	4

Table 10. Ranking of Social Isolation Prevention Functionalities

TITLE	SOURCES	SCORE
KWIDO	https://kwido.com/	3.4
MENSANA	https://mensana.brainer.it/index.php	3.4
DIPAS	https://www.care4u.it/it/	3.6

Table 11. Ranking of UX solutions

TITLE	SOURCES	SCORE
KWIDO	https://kwido.com/	4.6
BRAINER, PROFESSIONAL BRAIN TRAINER	https://www.brainer.it/	3.4
MENSANA	https://mensana.brainer.it/index.php	3.4
DIPAS	https://www.care4u.it/it/	2.8
SEREMY	https://www.seremy.it/	3.6
Neocogita system	http://www.neocogita.com	3.2
VOIZE	https://www.voize.de/	4.4
DAK Memory Coach	https://www.dak.de/dak/leistungen/dak-erinnerungs-coach_28192#rtf-anchor-was-ist-der-dak-erinnerungs-coach	2.8
TERRA 95 BT Hospice Services	http://www.terra95.hu/ temporarily unavailable	2
Lumosity	https://www.lumosity.com/en/	4.2

Accexible	https://accexible.com/	3.8
Neuroforma	https://www.neuroforma.pl/	3

The results allowed for the creation of the following ranking in individual application categories:

The three highest-rated solutions selected by partners after further subjective expert evaluation in the category of prevention of cognitive decline:

- KWIDO
- LUMOSITY
- BRAINER

The three highest-rated solutions selected by partners after further subjective expert evaluation in the category of prevention of health status deterioration:

- KWIDO
- BRAINER
- NEUROFORMA

The three highest-rated solutions selected by partners after further subjective expert evaluation in the category of prevention of social isolation:

- KWIDO
- MENSANA
- DIPAS

The three highest-rated solutions selected by partners after further subjective expert evaluation in the UX category (easy operation, content adjustment, etc.):

- KWIDO
- VOIZE
- LUMOSITY

Considering the results in a holistic manner, it is worth noting that KWIDO ranked first in all four categories. The ranking regarding the prevention of social isolation did not allow the selection of the three highest-rated solutions because only three solutions had such functionalities. This means that in this category the provided results should be considered in terms of ranking.

2.4. Phase 4: Qualitative analysis carried out with the participation of external experts

2.4.1. Input data and stage description (international level):

In order to diversify the sources of assessment of individual solutions, we took the opportunity to obtain feedback from experts participating in the international wrap-up meeting during which the results of the first stage of the PROCAREFUL project were presented. For this purpose, questions were created to obtain

feedback on the importance of functionalities dedicated to various users. The assessment included questions regarding functionalities dedicated to elderly people (e.g., the question of content presentation in the form of video materials) but also to specialists (e.g., the importance of the therapist's ability to build a training plan). The questions were presented in the form of an online survey, which allowed the results of the survey to be provided in real time.

2.4.2. Result and discussion

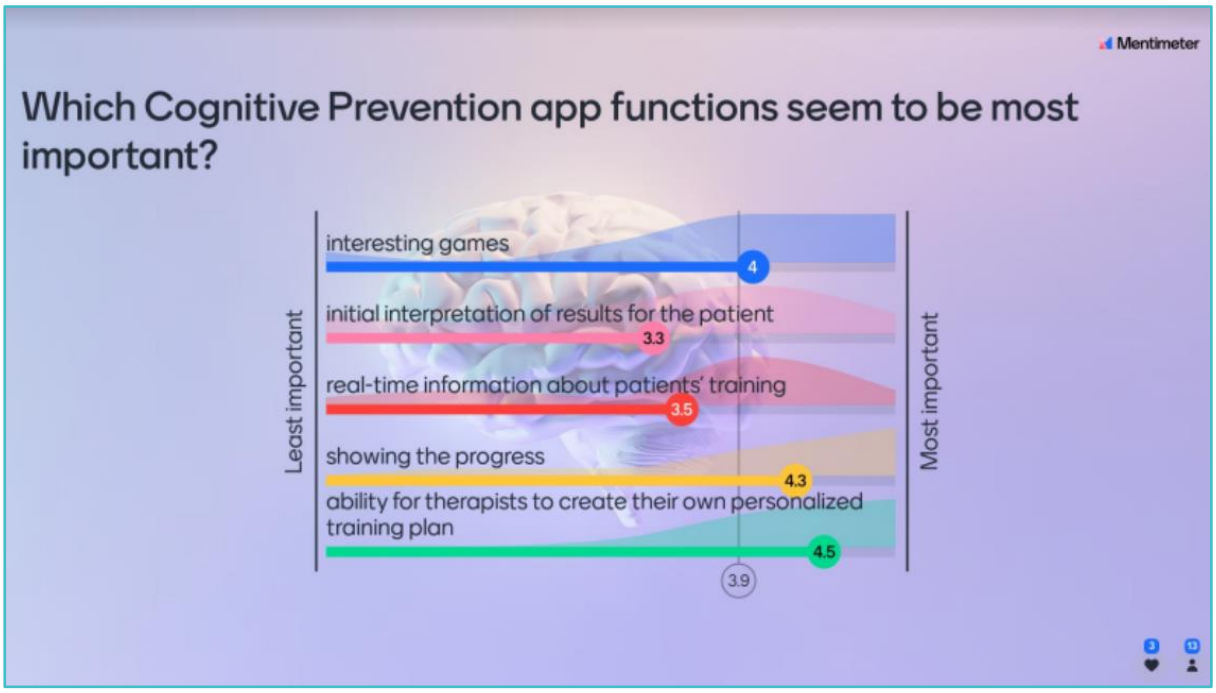

Figure 5. Question and ranking of the first question asked to external experts

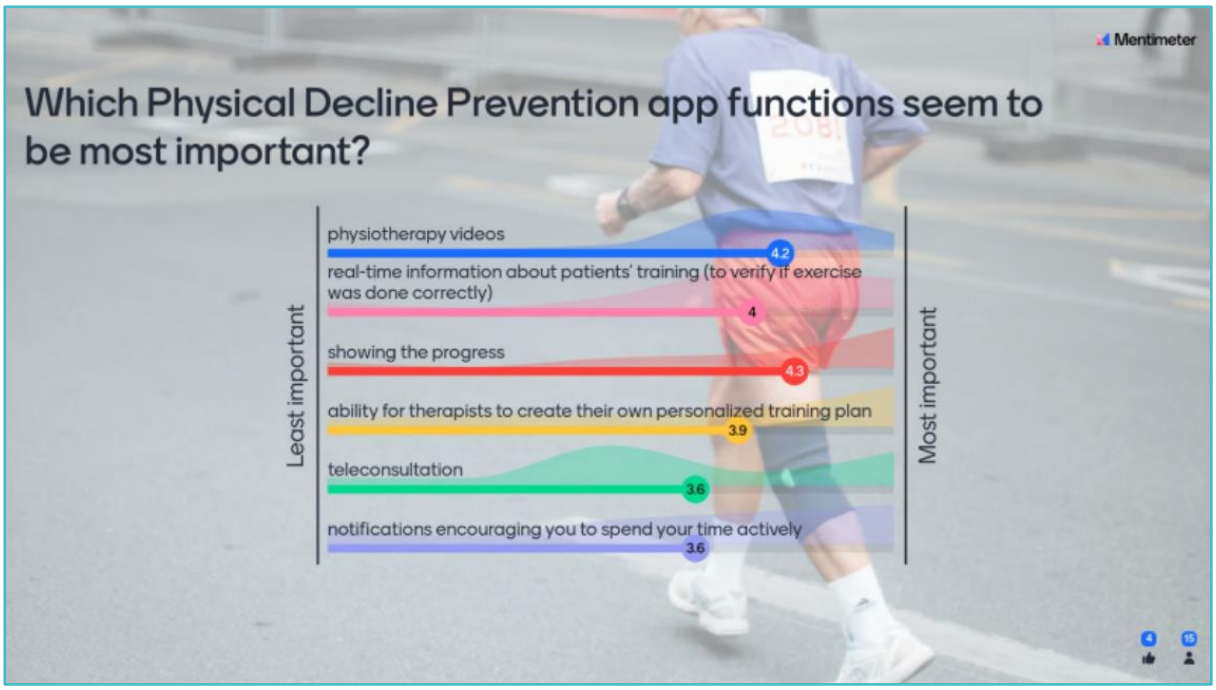

Figure 7. Question and ranking of the second question asked to external experts

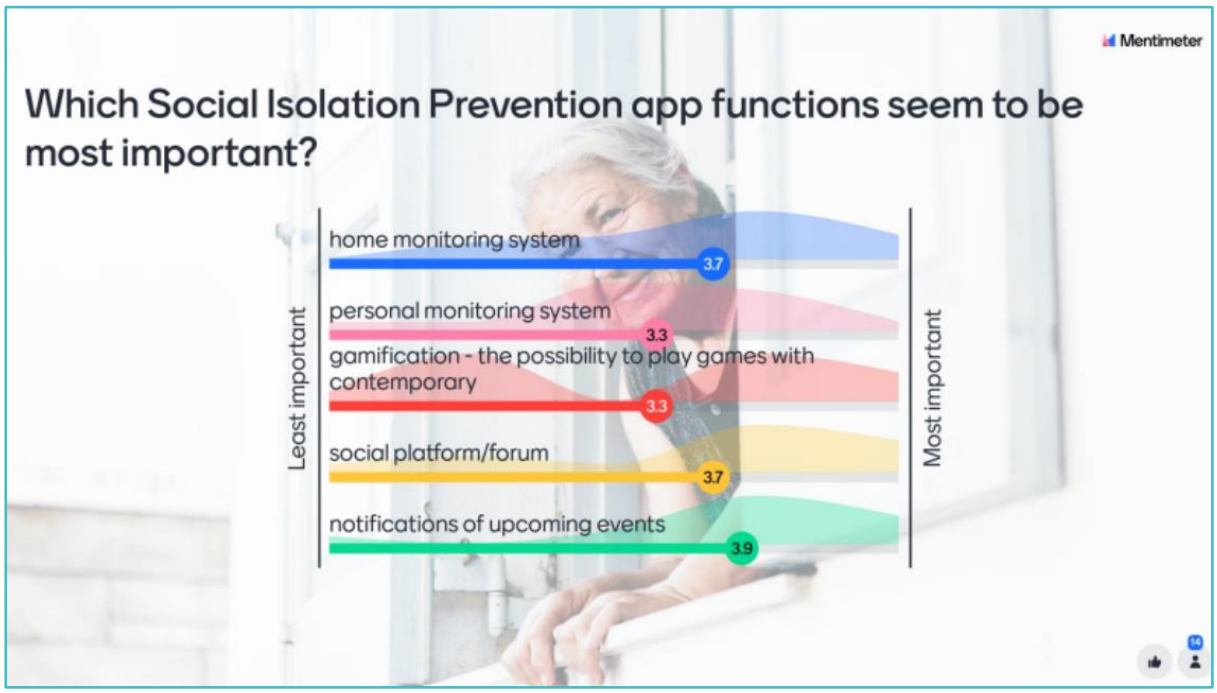

Figure 6. Question and ranking of the third question asked to external experts

The results in individual categories did not indicate any specific functionalities and therefore they did not point out to any needs of one specific group of users to be met. The results should be considered as confirmation of the project assumptions, which state the need to implement a holistic solution that will combine functionalities promoting cooperation between all stakeholders.

2.4.3. Input Data and Progress of the Stage (National Level):

One of the elements of PROCAREFUL project were local seminars at national/partner levels. They were intended to present the results of the work carried out in the first phase of the program. The adopted formula also included discussions among stakeholders, which included both formal assistance providers, informal caregivers and the elderly themselves. The purpose of this review (at the problem market fit level) was to obtain initial feedback on the problem defined in the project as well as to incorporate the feedback in further design work.

Local seminars conducted:

- Italy: “50 Sfumature di Cura | Comunità di Destino," Treviso, approx. 180 participants
- Germany: “The 3rd Digitisation Day for Older People”, Stuttgart, approx.150 participants.
- Poland: „Procareful, innowacyjny model opieki nad osobami starszymi”, Lublin, 18 participants.
- Slovenia: 5 seminars were organized in Muncipality of Log Dragomer; four of them were hold in the premises of the municipal administration and one was hold in the community hall, approx. 51 participants.
- Hungary: “Procareful Project Webinar”, online, approx. 40 participants.
- Croatia: National seminar, Split, 43 participants.

See D.1.1.3 for more information on national seminars.

2.4.4. Result and discussion

As the method for collecting feedback involved discussions, presented below is a summary of the topics covered. These can potentially contribute to the ongoing design process of the hybrid model.

A. General remarks

- Certain attendees emphasized the significance of comprehensive/ holistic solutions.
- They highlighted the significance of grassroots and commercial initiatives, especially in light of the often inefficient national-level system.
- Observations were made regarding the model's robust theoretical foundation, but full comprehension and evaluation are expected only with the completion of the solution.
- Additionally, it was underscored that while technological advancements are crucial and beneficial, they should complement rather than replace the fundamental human relationships that form the foundation of care.
- Home care providers mentioned that they have participated in similar projects and pilots, where models were never truly integrated into their work due to a lack of time and resources.
- Home care providers, as well as informal caregivers and volunteers, expressed that this model could make older individuals feel to be controlled in certain way. It is crucial to help them understand that such a "tool" will significantly improve their lives.

B. Technical considerations:

- There is a recommendation to incorporate educational elements (such as language learning).
- Suggesting the inclusion of gamification elements for both interaction and the potential for additional benefits (discounts, vouchers, etc.).

- There is a suggestion to display exercises performed by a real individual rather than an avatar.

C. Comments on a potential business model:

- There was a recommendation to clarify the target demographic, emphasizing that a single age criterion of 55+ may not adequately address the diverse range of needs.
- Considering the diversity of the target audience, the importance of the geographical location was also highlighted. If the enhancement of social integration relies on notifications about local events, this may be insufficient for individuals residing in rural areas due to the limited number of such events.
- The issue of responsibility for the execution of activities was brought up. While promoting activities that encourage active engagement appears to be a safe option, suggesting exercises that could potentially worsen a participant's condition may have repercussions.

3. The specification of recommendations

As a result of the presented work on the development of a hybrid model for supporting long-term care, observations were made that can be used for further development of both the business model and the technical solution itself:

- Customer segmentation: it was confirmed that the solution should include functionalities that address the problems of all stakeholders.
- Value proposition: The functionalities should enable prevention in all three areas (cognitive abilities, physical condition, social isolation). The carrier of the value proposition in the first iteration should be a web (or mobile) application, which will allow quick distribution of the solution but also quick implementation of changes as a result of market tests. In terms of the hardware part, it does not seem reasonable to design an original product, - however, it is reasonable to take into account the possibility of integration with existing wearable systems if a customer uses one.
- Work on the finished solution, along with the declared scope of the application operation, shall be closely monitored by people involved in the certification of medical devices. Some declarations and functionalities may require the application to be classified as a medical device, which translates into the need to meet a number of essential requirements contained in the EU MDR 2017/745.
- Considering the results regarding the adoption of new solutions, the need for market education should be taken into account. However, this fits into the idea of a hybrid model, where instruction from formal/informal caregivers could constitute an integral part of the solution.
- In the case of the monetization model, in accordance with generally accepted trends, the subscription/monthly subscription model seems to be justified. From the scarce amount of information, it could be concluded that the acceptable price for the end user, assuming no refunds, is in the range of EUR 10-20 per month. In the case of a customer segment such as professionals, this amount may be much higher depending on the range of functionalities offered.