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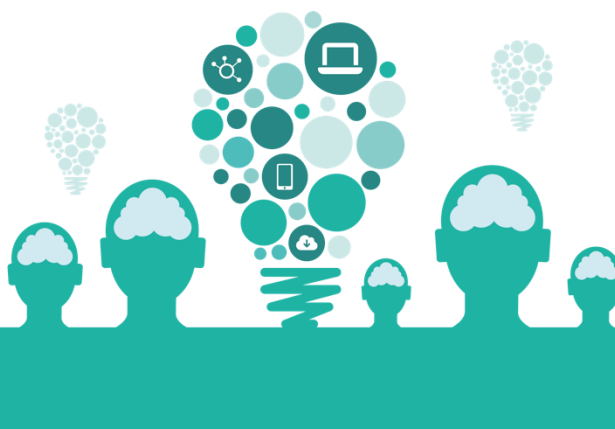
PROCAREFUL

D.1.1.1 META-ANALYSIS ON E-CARE, M-HEALTH SOLUTIONS, BENCHMARK PROJECTS AND LITERATURE FINDINGS OF EXISTING PROACTIVE AND E-CARE SOLUTIONS

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

Final Version

09 2023



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1. Introduction

1.1. Context

Objective data sources and statistics clearly indicate a trend towards higher life expectancy, i.e. ageing of the European society. This state of affairs increases the demand for long-term care services for elderly people, both at home and in specialized facilities. The need to ensure decent conditions and quality of life for elderly people and their caregivers on daily basis requires a holistic approach on many levels. Both systemic solutions and commercial initiatives that address the problems of a given group of stakeholders are important. It is therefore reasonable to try to map the needs and solutions that have won recognition on the market for various reasons and to use the aggregated knowledge to create a hybrid model of care for the elderly. Therefore, this study aims to define both the technical and marketing assumptions for the business model design that will support the implementation of the studied solutions on the markets of partner countries.

1.2. Report assumptions

D.1.1.1 The report constitutes a meta-analysis on e-care, m-health solutions, benchmark projects and literature findings. This document presents the structured data collected by PPs at EU and national level. It describes the results and main findings from the available literature. The document provides guidelines on how consensus on evaluation grid shall be reached and applied in the implementation model.

The report assumes both the identification of the problems faced by stakeholders and the analysis of the currently available technology in terms of the presently applied product and implementation strategies.

1.3. Methods

The structure of the report assumes the analysis of the following elements:

- External factors shaping the elderly care market
- Stakeholder characteristics
- Models used to support elderly care
- Technical solutions used

The data included in the report come from objective databases, mainly Eurostat. The information contained in the report comes from the years 2016-2023, depending on the source. The analysis of conditions at the national level was extended to include three additional EU Member States in order to compare and determine potential regularities in relation to the partner countries involved in the project. The European regions subjected to additional analysis are: the Benelux (Belgium), Scandinavia (Sweden) and the Iberian Peninsula (Spain).

This study also includes the results of own research conducted with the participation of project partners. Our own research was documented in the form of reports and attached to this report:

WP1_Market and target group analysis

WP1_Good practices and competitive analysis

The purpose of aggregating and analysing the above-mentioned factors is to synthesise the obtained data in the form of recommendations. They will be used to develop design assumptions for technical solutions and implementation model.

Key words: #Long-Term Care, #Ageing

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.

2. External factors

Considering factors affecting project implementation, external factors such as political conditions, macroeconomic forces, cultural background and technological trends must be taken into account. The above-mentioned factors ought to be treated as input data in the process of defining a ready-made solution, as they constitute a certain limitation to which the business model (including the value proposition) should be adapted. The list below contains general information relevant to the general population in question. A detailed description of the project stakeholders is presented in subsequent part of the study.

2.1. Political

2.1.1. European Care Strategy

DATA	Considering the impact of the policy on the European level, it is worth mentioning the events that took place last year. On September 7, 2022, the European Commission presented the European Care Strategy, which aims to ensure affordable and accessible high-quality care services across the European Union and improve the situation for both care users and caregivers, both professional and informal. According to the comment: The care strategy will support the implementation of the principles set out in the European Pillar of Social Rights, in particular those on gender equality, work-life balance, childcare, child support and long-term care. This strategy responds to the demographic changes taking place in the European Union and puts people first, from children to the elderly. The care is supposed to be person-centred

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

	and enable people to lead independent and dignified lives. Therefore, the strategy sets out an action program to improve the situation of both caregivers and care recipients. In result of the presented strategy and recommendations, in December 2022, the European Council issued recommendations for the Member States. The main pillars of the recommendations are: ▪ Adequacy, availability and quality of services provided. ▪ Support for caregivers. ▪ Management and reporting. The document also contains an annex regarding *Long-Term Care Quality Principles*, which include: ▪ Respect ▪ Prevention ▪ Person-centredness ▪ Comprehensiveness and continuity ▪ Focus on outcomes ▪ Transparency ▪ Workforce ▪ Facilities
SOURCE	https://commission.europa.eu/index_en
DISCUSSION	The recommendations concern the elements that make up long-term care strategies. According to the explanatory memorandum to the Council Recommendation, one of the reasons for drafting the document provided in the explanatory memorandum (11) is that there are significant differences between Member States in the level of public funds allocated to long-term care: some countries invest less than 1% of GDP, while others spend over 3% of GDP. The summary of expenses is presented in item 2.2. of this study. Insufficient expenditure at the national level translates into too few public entities providing LTC services. The private sector of formal LTC care, however, offers services that are financially unavailable to clients. In terms of accessibility, not only financial but also geographical limitations were included. The strategy indicates the need to find solutions that can be successfully used in less populated / depopulated areas. An important element of the strategy and recommendations are those related to the caregivers' labour market. The issue of too few people associated with the LTC market was raised, and the demand for their services will constantly increase due to the ageing of the population. The above components of the strategy related to availability, adequacy, quality and access to qualified staff were also supported by recommendations regarding the development of digital technologies, which may affect the scalability of solutions (availability), be standardized and may relieve the LTC staff of some of the care activities. Additionally, the entry in item 11 in the area of management and reporting is worth noticing, i.e.: “Member States are recommended to inform the Commission, within 18 months of the adoption of this Recommendation, of the set of measures they have taken or plan to take to implement it, based where appropriate on existing national strategies or plans and taking into account national, regional and local…” The provision is interesting because it allows us to assume that in the second half of 2024 it will be possible to become acquainted with the mechanisms adopted by all Member States.

IMPACT ON DESIGN ASSUMPTIONS

- It is recommended to read the report on the adopted LTC strategies, which, according to the Commission's Recommendations, should be prepared in the second half of 2024.
- It is recommended to constantly monitor the offered support at the European level, which may contribute to changing the business model, mainly in the area of monetization.

2.2. Economical

2.2.1. Age-Related Spending, Percentage of GDP, 2019

DATA

Data from 2019 are presented below, regarding the percentage of expenditure (%) of GDP on all areas related to the ageing society. This area includes expenses for:

- Pensions
- Healthcare
- Long-term care
- Education

For the EU, the average total value of all expenditures from the EU budget is at the level of **24% of GDP**. The total expenditure consists of: Pensions **11.6%,** Healthcare **6.6%,** Long-term care **1.7%** and Education **4.1%.** Among the project partner countries, Italy allocates the highest percentage of GDP to ageing-related areas (26.5%), with a significant share of expenditure on pensions (15.4%). The lowest percentages are allocated in Hungary, where the total expenditure on areas related to population ageing is 17.1%, of which 8.3% is expenditure on pensions.

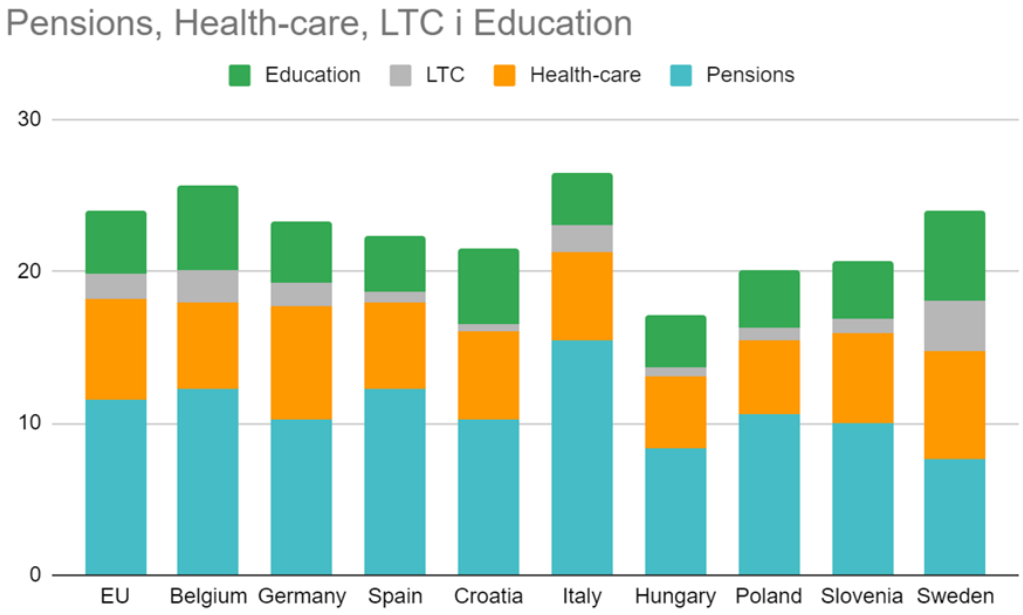
For each of the countries in the Figure 1, expenditure on pensions constitutes the largest share of costs incurred in connection with the ageing population. The average value of these expenses for the EU is **11.6%.** As mentioned above, among the partner countries, pensions constitute the highest percentage of GDP in Italy **(15.4%),** while the lowest percentage of GDP is spent in Hungary **(8.3%).**

In the case of healthcare expenditure, the average percentage for the EU is **6.6%.** Among the project partners, Germany has the largest share of expenditure on healthcare **(7.4%),** while Hungary **(4.7%)** and Poland **(4.8%)** the smallest.

Expenditure on long-term care constitute the smallest share of the total costs related to the ageing society. On average, the share of this expenditure in the EU is **1.7%,** with the smallest share of national GDP in Croatia **(0.4%)** and the largest in Italy **(1.7%).**

The last component of the overall costs related to the ageing society is education, with the percentage share in EU expenditure amounting to **4.1%.** The partner country with the highest share of expenditure on education in the national GDP is Croatia **(5%)** and the country with the smallest share is Hungary **(3.4%).**

Figure 1



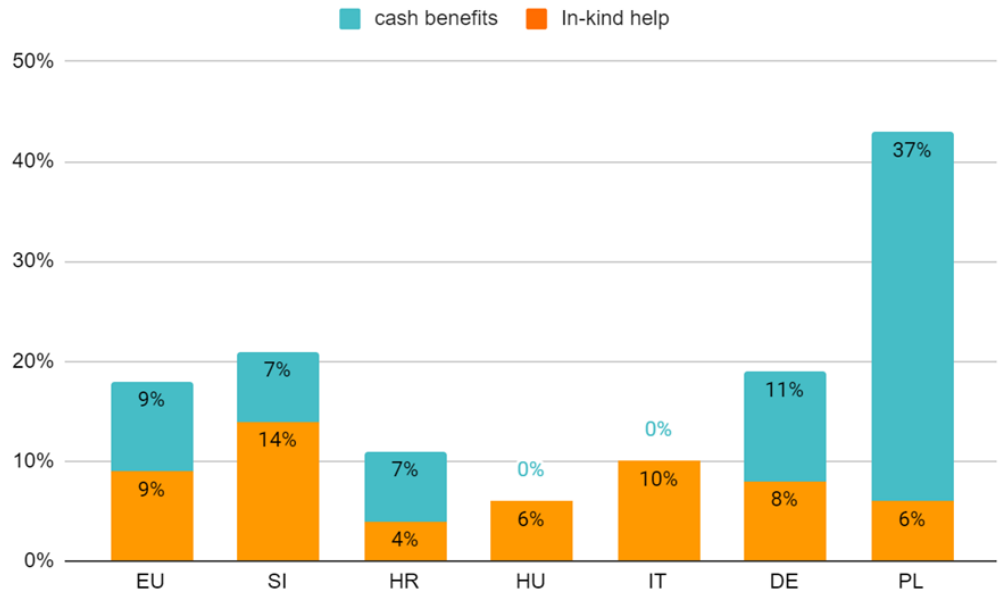
SOURCE	The 2021 Ageing Report. Economic and Budgetary Projections for the EU Member States (2019-2070)
DISCUSSION	The presented statistics demonstrate variation in the level of LTC expenditure referred to in the Council Recommendation of December 8, 2022, on access to affordable and good-quality long-term care. The recommendations suggest reaching the level of 2.5% of GDP, but the average percentage of expenditure in the EU in 2019 was 1.7%, which was also the highest value among the project partner countries (Italy). The presented data concern GDP, so it is subject to underestimation resulting from the "grey zone" and, what is more likely and significant for the project: informal healthcare provided by family and/or third parties. It should also be noted that the data comes from The 2021 Ageing Report, Economic and Budgetary Projections for the EU Member States (2019-2070), where some of the indicators may have become obsolete. Nevertheless, they demonstrate the comparison of trends and dependencies between individual spending areas at national and/or European level.
IMPACT ON DESIGN ASSUMPTIONS	No direct impact. The information constitutes independent confirmation of the problem and justify the undertaking of this project.

2.2.2. Type of Long-Term Assistance Provided

DATA	There are two mechanisms for providing long-term assistance (LTC) through in-kind services and cash benefits. The chart below (Figure 2) shows the percentage of people over 65 years of age who benefited from in-kind or cash assistance. For the project partner countries, these values are:

- EU: in-kind **9%** / cash benefits **9%**
- SI: in-kind **14%** / cash benefits **7%**
- HR: in-kind **4%** / cash benefits **7%**
- HU: in-kind **6%** / cash benefits **0%**
- IT: in-kind **10%** / cash benefits **0%**
- DE: in-kind **8%** / cash benefits **11%**
- PL: in-kind **6%** / cash benefits **37%**

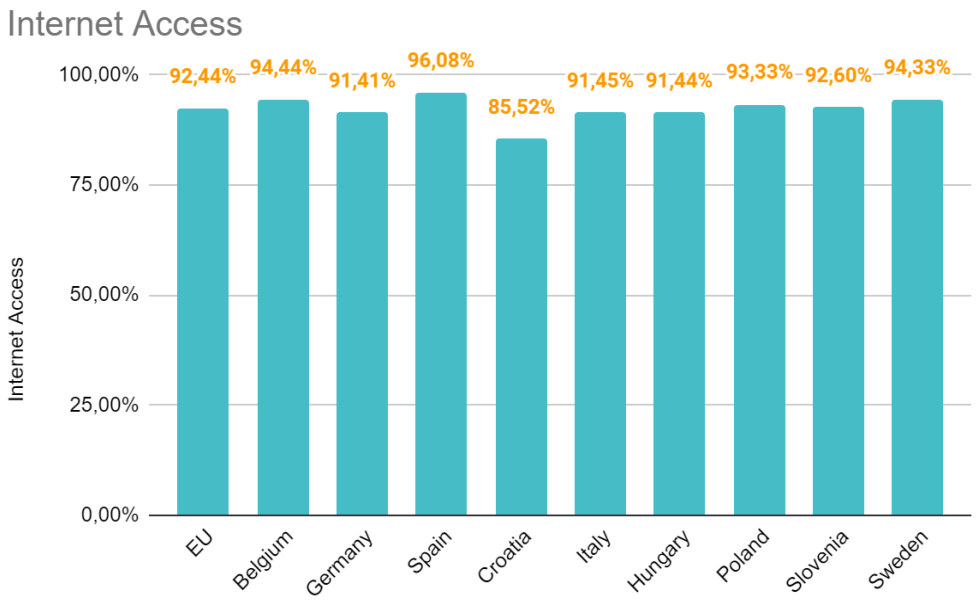
Figure 2



SOURCE	Knowledge Centre on Migration and Demography (KCMD) Data Portal, LTC presentation
DISCUSSION	The chart demonstrates a certain tendency, where Nordic countries are mostly the ones that provide mainly in-kind assistance. In the case of cash assistance (used by the beneficiary to spend directly on care purposes), a country that favours this form of assistance is, for example, Poland. These statistics seem interesting from the point of view of defining the decision-maker for purchasing a specific product/service related to long-term care. It can be assumed that the provision of in-kind assistance is more coordinated or systemically defined. In the case of Poland, part of the responsibility for the actions taken is transferred to the beneficiaries themselves.
IMPACT ON DESIGN ASSUMPTIONS	Customer segmentation should take into account both end users (b2c) and reaching institutions that decide on the granting of in-kind benefits.

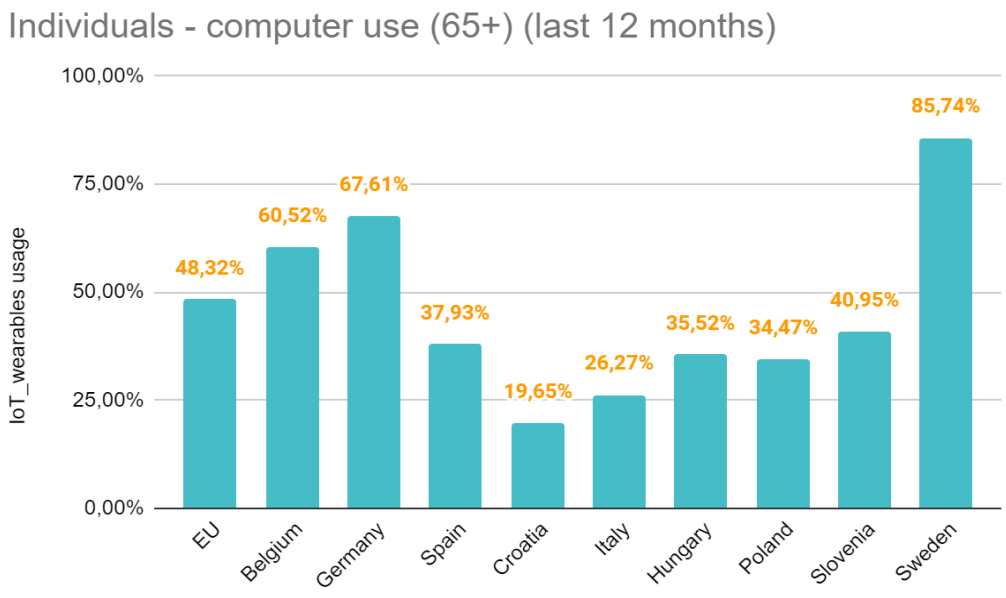
2.3. Technical

2.3.1. Level of Internet Access - Households

DATA	Information on internet availability for all households in a given country. The level of availability is as follows: ▪ EU: **92.44%** ▪ Slovenia: **92.60%** ▪ Croatia: **85.52%** ▪ Hungary: **91.44%** ▪ Italy:**91.45%** ▪ Germany: **91.41%** ▪ Poland: **93.33%** ▪ Belgium: **94.44%** ▪ Sweden: **94.33%** ▪ Spain: **96.08%** It is only in Croatia that **less than 90%** of households have Internet access. In other cases, the availability is over 90%, close to the European average.
Figure 3	
SOURCE	EuroStat: Level of internet access - households, [TIN 00134]
DISCUSSION	The data summary shows that there is a high rate of Internet access in the EU households. Such a high indicator suggests that the infrastructure at the national level is well developed and available. Therefore, it can be assumed that even if there is no Internet in a given household, there should be no infrastructural barriers to obtain Internet connection. This information is compiled for a given country, but an in-depth analysis of the availability and use of the Internet by the elderly seems reasonable.

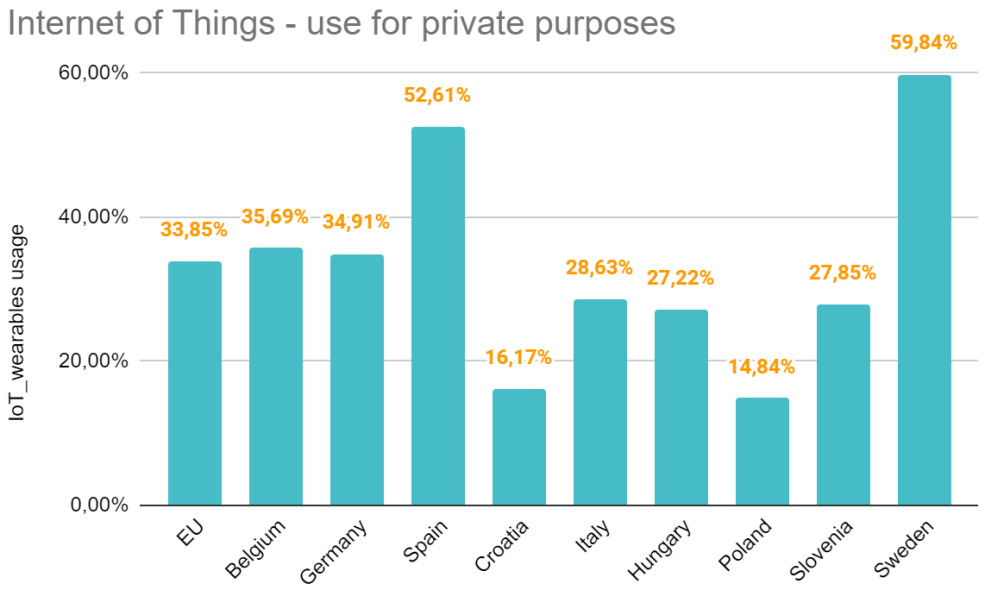
IMPACT ON DESIGN ASSUMPTIONS	The majority of households have access to the Internet.

2.3.2. Individuals - Computer Use (65+)

DATA	Information on computer use by people aged 65-74. Data from 2017. The following people declared using a computer in the 12 months preceding the survey: ▪ EU: **48.32%** ▪ Slovenia: **40.95%** ▪ Croatia: **19.65%** ▪ Hungary: **35.52%** ▪ Italy: **26.27%** ▪ Germany: **67.61%** ▪ Poland: **34.47%** ▪ Belgium: **60.52%** ▪ Sweden: **85.74%** ▪ Spain: **37.93%** It can be noted that apart from Germany, which has the highest rate (**67.71%**), none of the partner countries came close to the European average. As in the case of accessibility, the percentage of people aged 65-74 using a computer was the lowest in Croatia and amounted to less than 20%.
Figure 4	
SOURCE	EuroStat: Individuals - computer use (65+), [ISOC_CI_CFP_CU]
DISCUSSION	The number of people aged 65-74 using a computer on their own in the 12 months before the survey seems to be small. The average for partner countries participating in the project is ~37%. It can also be expected that extending the research group to 65+, with no upper age limit, would significantly reduce this value. Assuming that the statistical group has increased in number since the date of the

	study (2017-2023), this data should still be considered an important design assumption that may determine the tool or the way it will be used.
IMPACT ON DESIGN ASSUMPTIONS	▪ Nearly 40% of people aged 65-74 use a computer. This affects both the value proposition and the method of reaching the target group. ▪ There is a risk/need to educate the target population on how to use the tool.

2.3.3. Internet of Things - Use for Private Purposes (65-74)

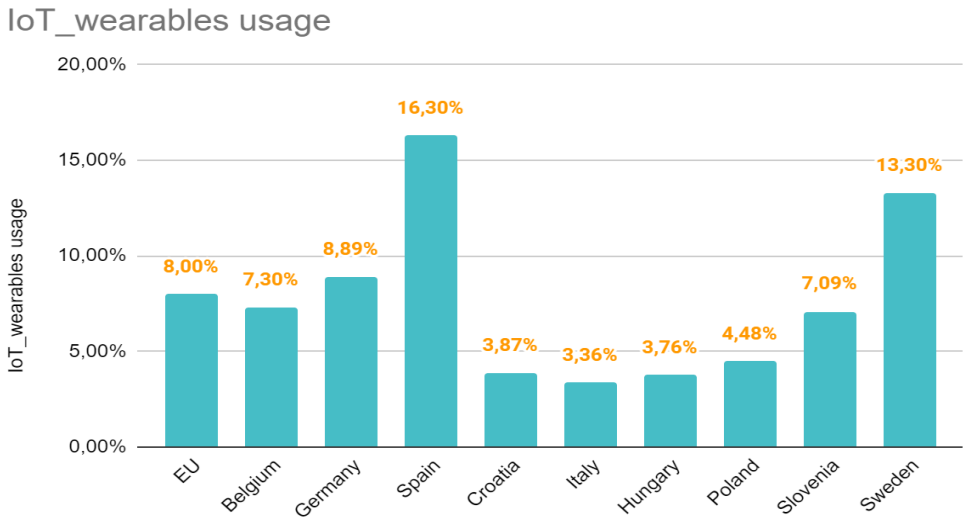
DATA	Information on the use of all Internet of Things products. It should be kept in mind that the specification includes assisting elements, wearables, smart home features, etc. The study concerns a group of people aged 65-74. Data from 2022. The use of IoT is as follows: ▪ EU: **33.85%** ▪ Slovenia: **27.85%** ▪ Croatia: **16.17%** ▪ Hungary: **27.22%** ▪ Italy: **28.63%** ▪ Germany: **34.91%** ▪ Poland: **14.84%** ▪ Belgium: **35.69%** ▪ Sweden: **59.84%** ▪ Spain: **52.61%** It can be noted that apart from Germany, which has the highest rate (**34.91%**), none of the partner countries exceeded to the European average. The use of IoT among people aged 65-74 is the lowest in Poland, where less than 1 in 7 people use IoT solutions.
Figure 5	
SOURCE	EuroStat: Internet of Things - use (65-74), [ISOC_IIOT_USE]

DISCUSSION	Taking into account that the study was conducted in the group aged 65-74 (not older), the question concerned IoT of any type, and considering that the data come from 2022, the number of people using IoT seems to be small. It seems reasonable to consider the data as an important design assumption that may determine the tool or the way it will be used.
IMPACT ON DESIGN ASSUMPTIONS	Impact on the business model: ▪ There is a risk/need to educate the target population on how to use the tool, if IoT is selected. ▪ It is necessary to consider the use of IoT for which the technological barrier to entry is not so high.

2.3.4. Internet Of Things - Wearables (65-74)

DATA	Information regarding the use of IoT products such as: a smart watch, a fitness band, connected goggles or headsets, safety-trackers, internet-connected accessories, internet-connected clothes or shoes. Therefore, the list includes wearable solutions, which can be identified with assisting and therapeutic solutions. The study concerns a group of people aged 65-74. Data from 2022. The use of IoT is as follows: ▪ EU: **8.00%** ▪ Slovenia: **7.09%** ▪ Croatia: **3.87%** ▪ Hungary: **3.76%** ▪ Italy: **3.36%** ▪ Germany: **8.89%** ▪ Poland: **4.48%** ▪ Belgium: **7.30%** ▪ Sweden: **13.3%** ▪ Spain: **16.3%** It can be noted that apart from Germany, which has the highest rate (**8.89%**), none of the partner countries exceeded to the European average. The use of IoT among people aged 65-74 is the lowest in Italy and amounts to 3.36%, although equally low values are observed in Hungary (3.76%) and Croatia (3.86%).

Figure 6



SOURCE	EuroStat: Internet of Things - use (65-74), [ISOC_IIOT_USE]
DISCUSSION	Unfortunately, the number of people in the 65-74 age group using wearable solutions is low. Excluding Germany (~9%) and Slovenia (~7%), in the case of the project partner countries the value is approximately ~3% of the population. Combining this with statistics on the use of IoT in general, it can be concluded that there is a lower barrier to the use of IoT in the elderly in terms of smart home solutions.
IMPACT ON DESIGN ASSUMPTIONS	Smart home IoT solutions (e.g., alarms) are used more often by people aged 65-74 than IoT wearable solutions (e.g., wristbands) - 8%.

3. Stakeholder characteristics - elderly people

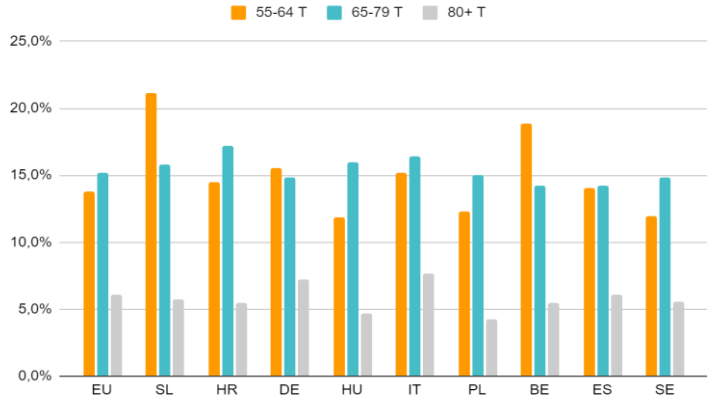
3.1. Elderly people - Total Addressable Market (TAM)

3.1.1. General Information

DATA	Data regarding the population of individual project partner countries are presented below. As in other analyses, percentages are used in the summary to objectify the analysis. The percentage share of particular age groups is evenly distributed and amounts to: **for the 55-64 age group: ~15% for the 65-74 age group: ~15% and for the 80+ age group: ~5%.** The total percentage of people over 65 years of age also constitutes **~20%** of the surveyed population. Based on the presented statistics, it can be concluded that the "eldest society" (with the largest share of people aged 65+) among the studied countries is Italy, while the "youngest" (with the smallest share of people aged 65+) is Poland.

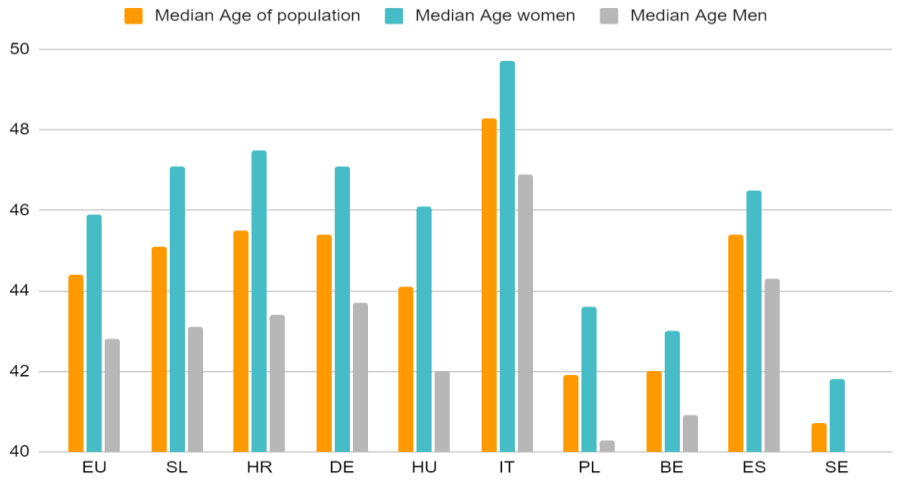
Figure 7 and Figure 8

	Total [mln]	55-64 M+F [mln]	Share in total population	65-79 M+F [mln]	Share in total population	80+ M+F	Share in total population	65+ M+F [mln]	Share in total population
EU	451,39	62,23	13,8%	68,63	15,2%	27,25	6,0%	95,88	21,2%
SI	2,12	0,45	21,1%	0,33	15,8%	0,12	5,7%	0,45	21,5%
HR	3,85	0,56	14,5%	0,66	17,2%	0,21	5,5%	0,88	22,7%
HU	9,69	1,15	11,9%	1,55	16,0%	0,46	4,7%	2,00	20,7%
IT	59,06	8,98	15,2%	9,67	16,4%	4,52	7,7%	14,19	24,0%
DE	84,55	13,12	15,5%	12,55	14,8%	6,12	7,2%	18,67	22,1%
PL	38,48	4,73	12,3%	5,78	15,0%	1,63	4,2%	7,41	19,3%
BE	11,73	2,22	18,9%	1,67	14,2%	0,64	5,5%	2,31	19,7%
SE	10,56	1,26	11,9%	1,57	14,8%	0,58	5,5%	2,15	20,3%
ES	47,98	6,76	14,1%	6,84	14,3%	2,91	6,1%	9,75	20,3%



SOURCE	EuroStat: Population on 1st January by age, sex and type of projection, [PROJ_19NP]
DISCUSSION	The total population of individual project partner countries varies significantly (2.12 million in Slovenia versus 84.55 million in Germany). However, this does not change the fact that the trends regarding the age structure of the respective societies are maintained. Of course, the market size understood as the number of potential recipients should be taken into account when developing a business model. Therefore, if the preferences of the users of the most capacious market are different from those of another, it will be justified to conduct a secondary analysis of a given issue.
IMPACT ON DESIGN ASSUMPTIONS	If the preferences of the users of the most capacious market (DE) are different from those of another, it will be justified to conduct a secondary analysis of a given issue.

3.1.2. Average Age

DATA	The average age is presented in the chart broken down by gender and data for the entire society. The data comes from the 2022 ranking. ▪ EU: 44.4 y.o. ▪ Slovenia: 45.1 y.o. ▪ Croatia: 45.5 y.o. ▪ Hungary: 44.1 y.o. ▪ Italy: 48.3 y.o. ▪ Germany: 45.4 y.o. ▪ Poland: 41.9 y.o. ▪ Belgium: 42.0 y.o. ▪ Sweden: 40.7 y.o. ▪ Spain: 45.4 y.o.
Figure 9	
SOURCE	EuroStat: Population on 1st January by age, sex and type of projection, [PROJ_19NP]
DISCUSSION	The average age depends on many factors and illustrates the current age structure of a given society. The high average age of the Italian society may result from the significant share of people over 80 years of age or the small number of young people.
IMPACT ON DESIGN ASSUMPTIONS	No direct impact

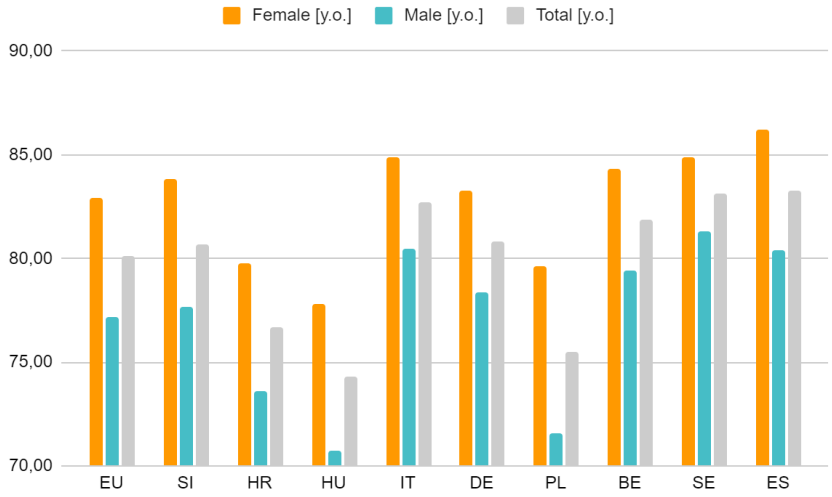
3.1.3. Average Life Expectancy

DATA	The average age is summarized below by gender and for the society as a whole. The data comes from the 2022 ranking. Based on the data below, it can be noted that in the surveyed project partner countries, on average, women live **5.6 years** longer than men. The country with the highest life expectancy is Italy (**82.7**

years). The countries with the lowest life expectancy are Hungary (**74.3**), Poland (**75.5**) and Croatia (**76.7**).

Figure 10 and Figure 11

	Female [y.o.]	Male [y.o.]	F-M (y.o.)	Total [y.o.]
EU	82,90	77,20	5,70	80,10
SI	83,80	77,70	6,10	80,70
HR	79,80	73,60	6,20	76,70
HU	77,80	70,70	7,10	74,30
IT	84,90	80,50	4,40	82,70
DE	83,30	78,40	4,90	80,80
PL	79,60	71,60	8,00	75,50
BE	84,30	79,40	4,90	81,90
SE	84,90	81,30	3,60	83,10
ES	86,20	80,40	5,80	83,30



SOURCE	EuroStat: Life expectancy by age and sex , [DEMO_MLEXPEC]
DISCUSSION	In the case of the studied societies, it was demonstrated that, on average, women live 5.6 years longer. This state of affairs confirms that there are significantly more elderly people aged 80+ among women. It is also worth noting that among the surveyed men living in the project partner countries, only Italian citizens reach an average age of over 80.
IMPACT ON DESIGN ASSUMPTIONS	In the 80+ group there are many more women than men for whom the value proposition should be adjusted.

3.2. Elderly people - Serviceable Available Market (SAM)

3.2.1. People Who Need Help with Care and Household Tasks

DATA

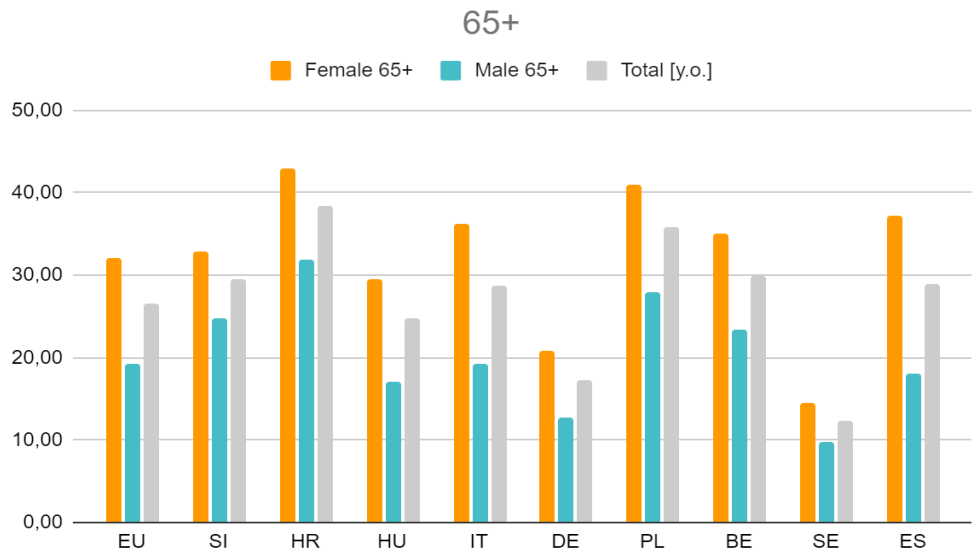
The statistics below show the percentage of people with problems related to personal care or household activities. The data are presented taking gender into account, as it seems to be of great importance in the statistics in question. A comparison was made in two age groups, i.e., 65+ and 75+.

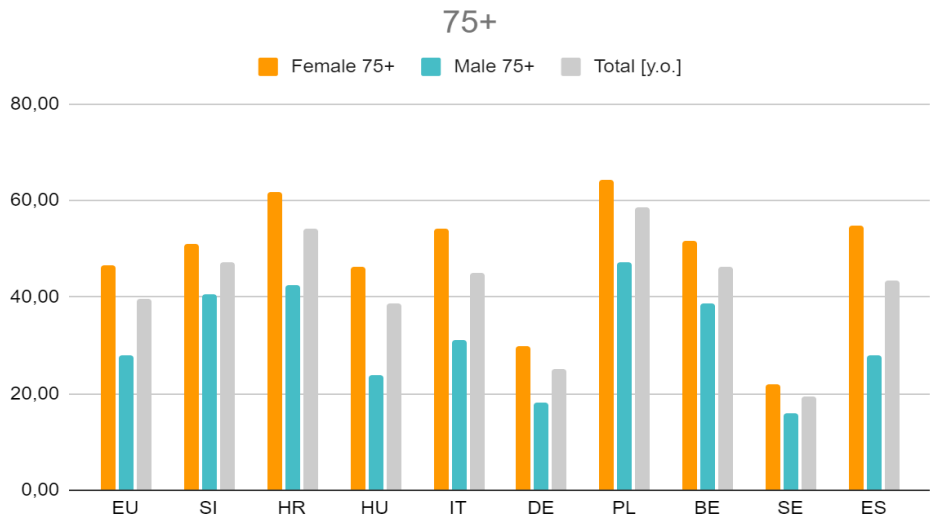
In the case of people over 65 years of age, the residents of Croatia (**38.5% T; 43% F; 31.9% M**) and Poland (**35.9% T; 41% F; 28% M**) encounter most difficulties with daily care and household duties. The most "independent" nation in the 65+ age group is Germany (**17.3% T; 20.9% F; 12.8% M**). The average for the EU is **26.6%.**

In the case of people over 75 years of age, the residents of Poland encounter most difficulties with daily care and household duties (**58.5% T; 64.4% F; 47.1% M**). Again, the most "independent" nation in the 75+ age group is Germany (**25.1 T; 30% F; 18% M**). The average for the EU is **39.5%.**

Figure 12, Figure 13 and Figure 14

	Female 65+	Male 65+	Total [y.o.]	Female 75+	Male 75+	Total [y.o.]
EU	32,10	19,30	**26,60**	46,70	28,00	**39,50**
SI	32,90	24,80	**29,50**	51,00	40,50	**47,20**
HR	43,00	31,90	**38,50**	61,80	42,60	**54,30**
HU	29,50	17,10	**24,70**	46,30	23,80	**38,80**
IT	36,30	19,20	**28,80**	54,30	31,10	**44,90**
DE	20,90	12,80	**17,30**	30,00	18,00	**25,10**
PL	41,00	28,00	**35,90**	64,40	47,10	**58,50**
BE	35,10	23,40	**29,90**	51,80	38,60	**46,40**
SE	14,50	9,70	**12,30**	22,10	16,10	**19,50**
ES	37,30	18,10	**28,90**	54,90	27,90	**43,50**





SOURCE	EuroStat: Difficulties in personal care activities or household activities by sex and age, [HLTH_EHIS_TAI]
DISCUSSION	The statistics clearly show the need for help in carrying out daily care and household duties. There is also a significant difference in needs depending on gender. As many as every third woman aged 65+ and almost every second woman aged 75+ need support in everyday functioning. Statistics for men, although more favourable, are not optimistic either. The need for assistance increases with age. Among women aged 75+, in 4 out of 6 partner countries, over half of women need help with daily tasks.
IMPACT ON DESIGN ASSUMPTIONS	Nearly every second woman aged 75+ requires help with daily care/household duties - this has a direct impact on the size of the customer segment in question.

3.2.2. . Number of older people who reported using LTC services (formal / informal) in 2018/2019

DATA

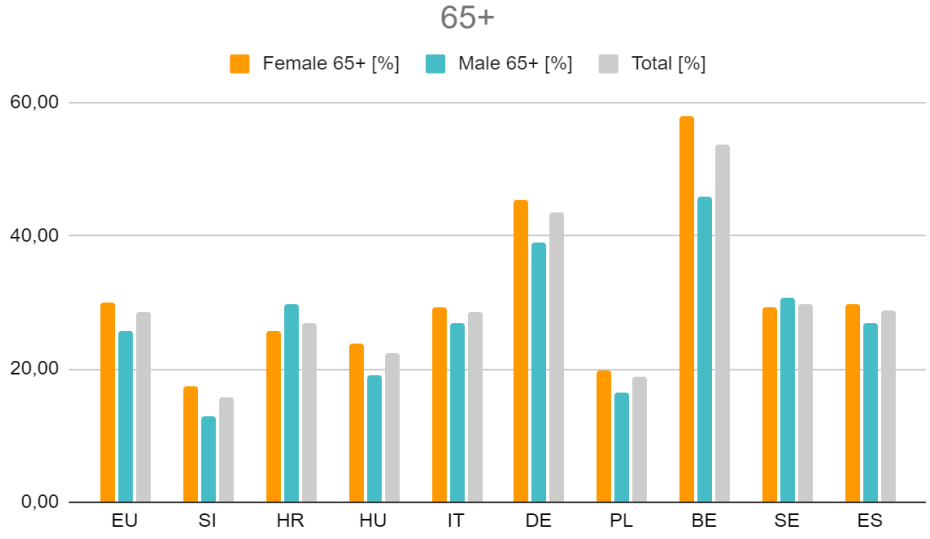
The statistics below show the percentage of people who took advantage of personal care or assistance in household activities. The data are presented taking gender into account, as it seems to be of great importance in the statistics in question. A comparison was made in two age groups, i.e. 65+ and 75+. The data should also be compared to the number of people declaring the need for assistance. Information from 2019.

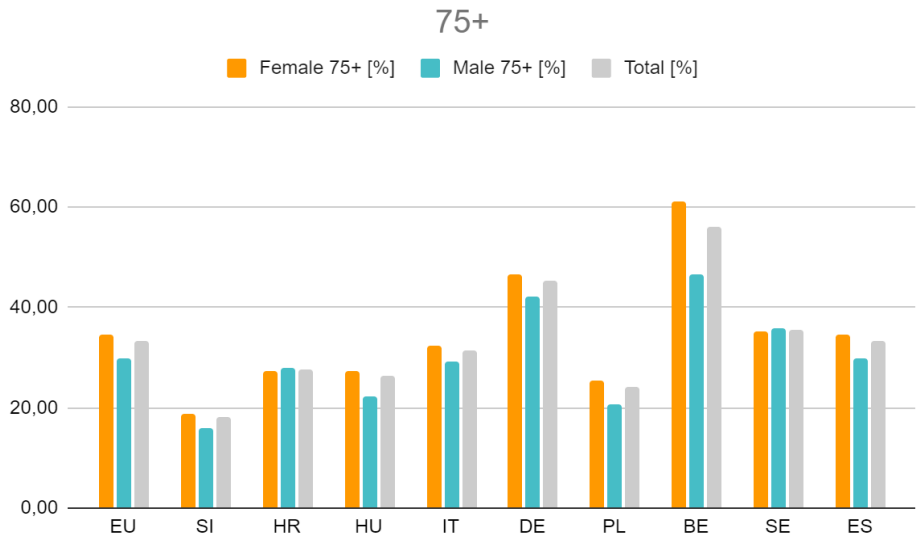
In the case of people over 65 years of age, the residents of Germany received most benefits associated with daily care and household duties (**43,5% T; 45,3% F; 39% M**). The smallest number of people who received benefits live in Slovenia (**15.8%**) and Poland (**18.8%**). The average in the **EU** is **28.6%**.

The situation repeats itself in the 75+ age group. The residents of Germany received most benefits associated with daily care and household duties (**45.3%; 46.6% F; 42.1% M**). The smallest number of people who received benefits live in Slovenia (**18%**). The average in the **EU** is **33.4%**.

	Female 65+ [%]	Male 65+ [%]	Total [%]	Female 75+ [%]	Male 75+ [%]	Total [%]
EU	29,90	25,70	**28,60**	34,70	30,00	**33,40**
SI	17,50	12,80	**15,80**	18,90	16,10	**18,00**
HR	25,60	29,70	**26,90**	27,30	27,80	**27,50**
HU	23,80	19,00	**22,50**	27,30	22,40	**26,30**
IT	29,20	26,90	**28,50**	32,30	29,20	**31,40**
DE	45,30	39,00	**43,50**	46,60	42,10	**45,30**
PL	19,80	16,50	**18,80**	25,50	20,80	**24,20**
BE	57,90	45,90	**53,70**	61,10	46,50	**56,20**
SE	29,30	30,60	**29,80**	35,10	35,90	**35,40**
ES	29,70	26,80	**28,90**	34,60	29,80	**33,30**

Figure 15, Figure 16 and Figure 17





SOURCE	EuroStat: Self-reported use of home care services by sex, age and level of difficulty with personal care or household activities , [HLTH_EHIS_AM7TA]
DISCUSSION	The presented data demonstrate that most partner countries are unable to meet the long-term care needs of their citizens. In the group of people aged 65+, only Germany and Italy exceeded the average value for the EU, which is **28.6%** of the aid granted (with the declared demand of **26.6%**). In the group of people aged 75+ in need of assistance, only Germany managed to exceed the average value for the EU, which amounted to **33.4%** (with a declared demand of **39.5%**) In some cases, as in Poland, there is a huge gap between the declared needs (58%) and the assistance provided (24%). It should also be noted that, with minor exceptions, the distribution of the provided benefits by gender does not indicate any anomalies.
IMPACT ON DESIGN ASSUMPTIONS	No direct impact

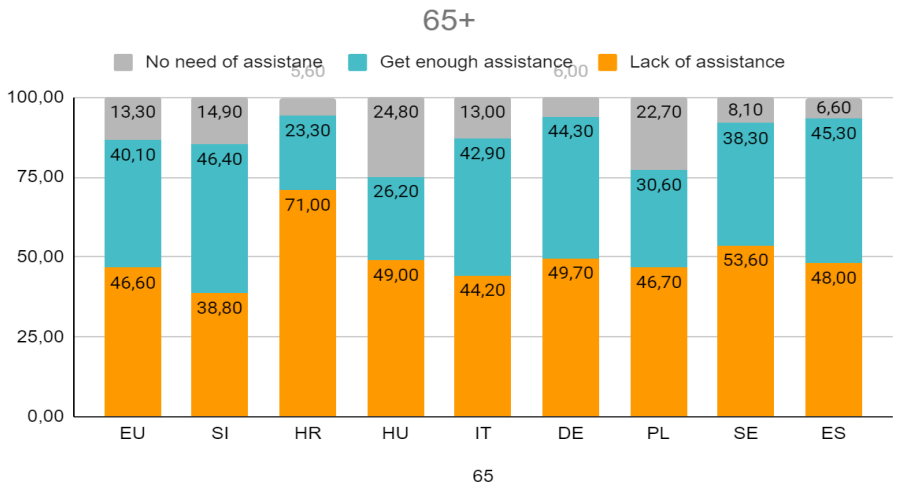
3.2.3. The Level of Meeting Needs in the LTC Area

DATA	The statistics below show the percentage of people whose LTC needs were met sufficiently, insufficiently, and people who generally did not declare a need for long-term care. The specification was made for people of both genders in the **65+** age group (and 75+ age group in the tabular form). Data from **2019**. In the EU, for people over 65 years of age, the average share of people whose needs were not met sufficiently was **46.6%.** In the project partner countries, the values are at a similar level, except for Croatia where the rate was **71%**. In the EU, for people over 65 years of age, the average share of people whose needs were sufficiently met was **40.1%.** The lowest value was found in Croatia (**23.3%**) and Hungary (**26.2%**). On average, the share of people in the EU who had no need to use LTC was 13.3%. Among the project partner countries, the smallest share of people who did not need

help was observed in Croatia (**5.6%**) and Germany (**6%**). The partner countries with the largest number of people not requiring assistance were Hungary (**24.8%**) and Poland (**22.7%**).

Figure 18 and Figure 19

65	Lack of assistance	Get enough assistance	No need of assistane	75	Lack of assistance	Get enough assistance	No need of assistane
EU	46,60	40,10	**13,30**	EU	47,30	41,80	**10,90**
SI	38,80	46,40	**14,90**	SI	39,60	51,00	**9,40**
HR	71,00	23,30	**5,60**	HR	72,40	22,90	**4,70**
HU	49,00	26,20	**24,80**	HU	50,80	25,80	**23,50**
IT	44,20	42,90	**13,00**	IT	45,60	43,70	**17,90**
DE	49,70	44,30	**6,00**	DE	46,70	47,40	**5,90**
PL	46,70	30,60	**22,70**	PL	50,80	32,10	**17,20**
SE	53,60	38,30	**8,10**	SE	53,00	42,40	**4,60**
ES	48,00	45,30	**6,60**	ES	50,40	43,90	**5,70**



SOURCE

EuroStat: Need for help with personal care or household activities by sex, age and level of difficulty experienced in those activities , [HLTH_EHIS_TADLH]

DISCUSSION

The summary of data demonstrates that, on average, just over half of the Europeans are satisfied with the care they receive or do not require it (53.4%). A significant part of the partner countries' statistics also shows balance between people who received sufficient/insufficient care (~1:1 ratio). Only in Croatia does the level of insufficient care exceed 71% of all people over 65 years of age. It seems justified to verify the care model in Croatia in order to determine the detailed reasons for such response.

IMPACT ON DESIGN ASSUMPTIONS	The share of people who received insufficient assistance in Croatia exceeds 70%. It seems reasonable to verify the care model in Croatia in order to determine the detailed reasons for such a state of affairs.

3.2.4. Reasons Why People Do Not Use Long-Term Care

DATA

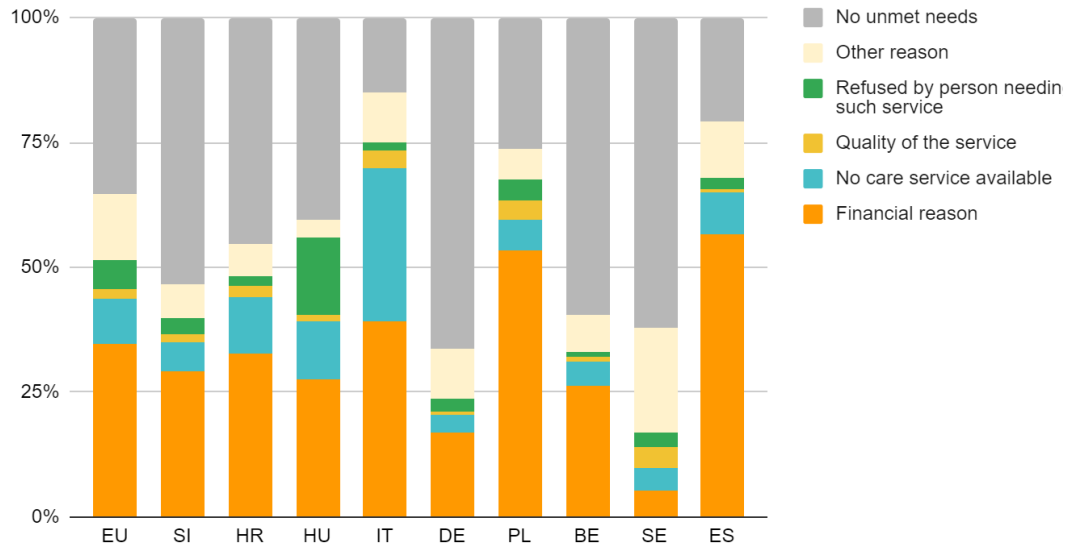
The statistics below demonstrate the reasons why elderly people do not use LTC. The specification was made for people of both genders in the **65+** age group. Data from **2016**.

In the EU, for people over 65 years, the main reason for not using LTC assistance concerns economic/financial factors (**34.7%**). Financial issues are the main reason not to use LTC in all partner countries. Other reasons include:

- lack of availability of care services (**EU average 9.2%**)
- quality of the provided services (**EU average 1.9%**)
- refusal on the part of the service recipient (**EU average 5.6%**)
- other. (**EU average 13.4%**)

Figure 20 and Figure 21

	Financial reason	No care service available	Quality of the service	Refused by person needing such service	Other reason	No unmet needs
EU	34,70	9,20	1,90	5,6	13,40	35,30
SI	29,20	5,60	1,70	3,2	6,80	53,40
HR	32,70	11,40	2,30	2	6,20	45,50
HU	27,50	11,70	1,20	15,6	3,40	40,50
IT	39,20	30,70	3,50	1,6	10,00	15,00
DE	17,00	3,30	0,90	2,3	10,10	66,20
PL	53,40	6,00	4,00	4,1	6,10	26,40
BE	26,40	4,70	1,00	0,8	7,50	59,50
SE	5,30	4,60	4,10	3	20,80	62,30
ES	56,60	8,20	0,90	2,1	11,40	20,70



SOURCE	EuroStat: Persons using or not professional home care services by household type, income group, degree of urbanization and reason for not using professional home care services , [ILC_ATS15]
DISCUSSION	It can be observed that the partner country with the smallest share of the financial barrier is Germany (17%), and the country with the largest share is Poland, where more than half of people aged 65+ who do not use LTC (53.4%) do not do so for financial reasons. It is worth paying attention to the statistics from Italy, where the barrier related to the lack of access to care services is equal to the financial barrier. Potential aid beneficiaries did not indicate qualitative factors as a reason for rejecting aid. This does not mean, however, that they were satisfied with the quality of the assistance they received and accepted. In the case of Hungary, it can be noted that the second most frequent reason why people aged 65+ do not use assistance is the rejection by a potential beneficiary. When creating an offer for this market, this factor should be taken into account.
IMPACT ON DESIGN ASSUMPTIONS	▪ The main reasons why people fail to receive assistance in the EU are financial issues. ▪ The model should also take into account the issue of barriers to access and availability of services.

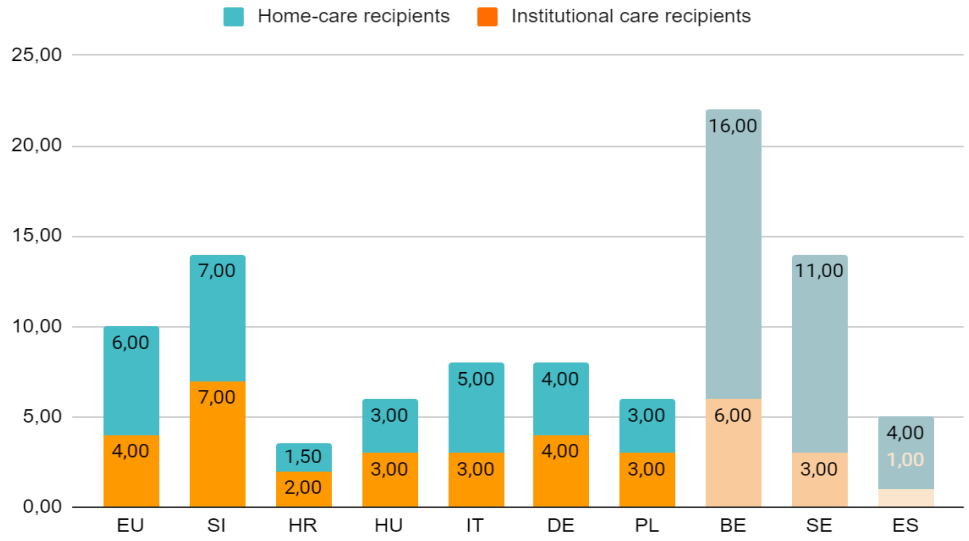
3.2.5. Place of Providing In-Kind Help

DATA	The data below demonstrate what proportion of people aged 65+ receive in-kind assistance. The assistance was also divided into in-kind help provided at home and in institutional settings. The specification was made for people of both genders in the **65+** age group. Data from **2019**. In the EU, for people over 65 years of age, the average share of people who received in-kind assistance was 10%, of which 6% constituted assistance provided at home. Among the partner countries, only Slovenia exceeded the European average in the share of in-kind benefits (14%),

	which is the highest value among the partner countries. The lowest share of in-kind benefits is provided in Croatia (3.5%).

Figure 22 and Figure 23

	Institutional care recipients	Home-care recipients	Total [%]
EU	4,00	6,00	10,00
SI	7,00	7,00	14,00
HR	2,00	1,50	3,50
HU	3,00	3,00	6,00
IT	3,00	5,00	8,00
DE	4,00	4,00	8,00
PL	3,00	3,00	6,00
BE	6,00	16,00	22,00
SE	3,00	11,00	14,00
ES	1,00	4,00	5,00



SOURCE	The 2021 Ageing Report. Economic and Budgetary Projections for the EU Member States (2019-2070)
DISCUSSION	In the case of in-kind assistance, the ratio of those provided with assistance at home and institutional settings is rather proportional (~1:1). A trend observed in pan-European data involving the Nordic countries and the Benelux region, which place significant emphasis on in-kind assistance. In most cases, it is provided at home. This state of affairs leads us to believe that they provide ready-made solutions, the aim of which is to make elderly people independent and help them in their immediate surroundings.
IMPACT ON DESIGN ASSUMPTIONS	▪ It is worth considering a model of material support that will be provided at home (Scandinavian countries, Benelux)

3.3. Elderly people - Forecasts

3.3.1. Total Addressable Market - TAM

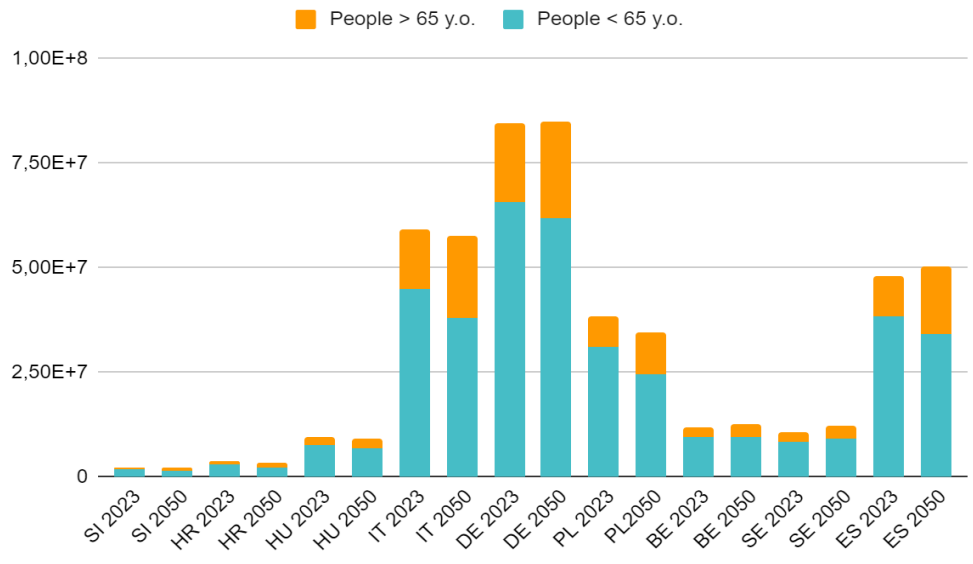
DATA

The data below show estimates of the total number of inhabitants of the partner countries and the growing share of people over 65 years of age. The specification was made for people of both genders in the **65+** age group. Data from **2023** are the data as of January 1, 2023, while the data for 2050 are predictive data.

Predictions for 2050 demonstrate that the number of inhabitants in the EU as a whole will decrease by over **3 million**. At the same time, the share of people aged 65+ will increase from the average of **21.2%** to **29%**. The project partner country, in which the share of people aged 65+ was the highest in 2023 and will be the highest in 2050, is Italy (respectively: **24%** and **33.7%**). Currently, Poland has the smallest share of people aged 65+ (**19.3%**), while in 2050 it may be Hungary (**26.8%**).

	People in total 2023	Share of people 65+ [2023]	People in total 2050	Share of people 65+ [2050]
EU	451385792	21,2%	447877407	29,0%
SI	2116709	21,5%	2094023	30,2%
HR	3854381	22,7%	3310003	30,0%
HU	9689361	20,7%	9230736	26,8%
IT	59058615	24,0%	57518500	33,7%
DE	84551929	22,1%	84813866	27,1%
PL	38482931	19,3%	34623544	29,1%
BE	11730662	19,7%	12559197	25,3%
SE	10561077	20,3%	12130240	23,4%
ES	47980384	20,3%	50460161	32,7%

Figure 24, Figure 25 and Figure 26



SOURCE	Knowledge Centre on Migration and Demography (KCMD) Data Portal
DISCUSSION	The data for 2050 are predictive data subject to uncertainty. However, a simultaneous analysis of population growth trends in previous years makes these predictions probable. The information presented in this way clearly shows that currently every fifth person in the EU is over 65 years old, while in 2050 it will be almost every third person. These data only justify the need to create models and solutions that will help the growing group of users/recipients.
IMPACT ON DESIGN ASSUMPTIONS	In the period from 2023 to 2050, the share of people over 65 years of age will increase from 21.2% to 29% of the total population.

3.4. Elderly people - economic and social factors

3.4.1. Average Amount of Pensions

DATA	The data below shows average amount of pensions in the partner countries. The values are the sum of pensions per year and the adopted currency is EURO. The specification was made for people of both genders in the age group eligible to receive pension on the respective national systems. Data from 2022. The table shows that the average pension in the EU is **EUR 19.1k** per year. Among the project partner countries, the highest pensions are paid in Germany, which is also the only country that exceeds the European average (**EUR 25k**). The pensions in Slovenia (**EUR 16.5k**) and Italy (**EUR 18.6k**) are close to the EU average. The lowest amount of pensions occurs in Hungary (**EUR 7k**), Croatia (**EUR 8.7k**) and Poland (**EUR 8.9k**).

Figure 27

	PEnsion per Year [EURO]
EU	19083,00
SI	16544,00
HR	8760,00
HU	6975,00
IT	18592,00
DE	25000,00
PL	8946,00
BE	27314,00
SE	26692,00
ES	16814,00

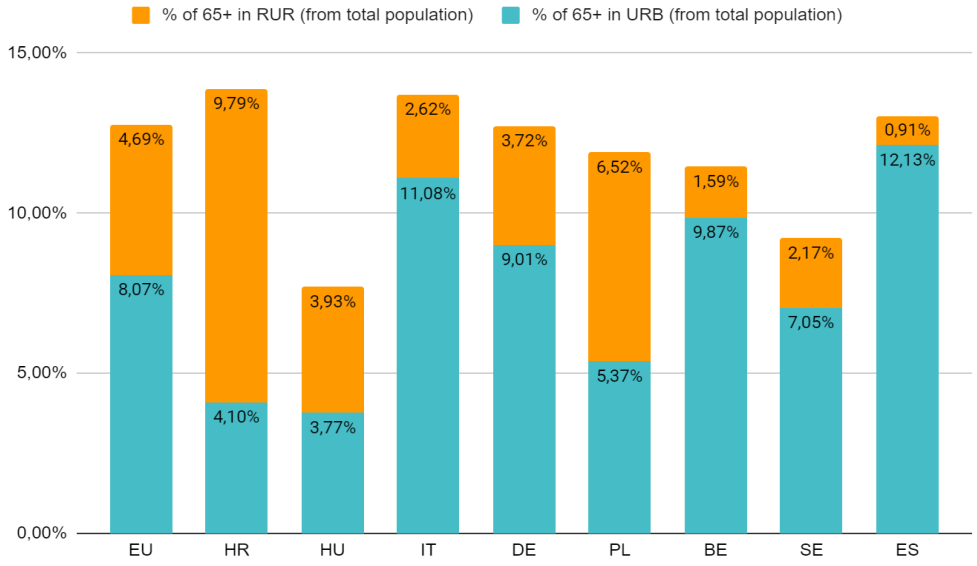
SOURCE	EuroStat: Mean and median income by age and sex - EU-SILC and ECHP surveys , [ILC_DI03]
DISCUSSION	The presented data indicate large differences in the amount of pension in the partner countries. There is no information on whether the data includes additional benefits (e.g. 13th pension in Poland). However, significant differences in the amount of pension are still expected. In an extreme case, a German citizen has a pension that is over three times higher than a pension of a Hungarian citizen. Assuming that the client or payer would be a person aged 65+, such significant differences in the income of elderly people should be taken into account. Therefore, you can adapt the value propositions to the purchasing capabilities of people from Hungary, Croatia and Poland, or consider another way to adapt the monetization model.
IMPACT ON DESIGN ASSUMPTIONS	▪ The monetization model should take into account the income from potential customers' pensions. Germans have pensions that are over three times higher than Hungarians. ▪ It should be considered to adapt the monetization model to the poorest citizens or diversifying the monetization model depending on the country.

3.4.2. Area of Residence

DATA	The data below demonstrate the share of elderly people living in rural and urban areas. The specification was made for people of both genders in the **65+** age group. Information from Slovenia is missing. Data from **2022**. The summary shows that nearly **8%** of EU residents over 65 years of age live in urban areas, while **4.7%** live in rural areas. Among the project partner countries, only Croatia (**9.8%**) and Poland (**6.5%**) have a higher share of people living in rural areas than the EU average. The countries where the majority of people live in highly urbanized areas are Italy (**11%**) and Germany (**9%**). At the level of partner countries, no consistent correlations can be found between the share of people living in rural areas and urban areas.

	% of 65+ in URB (from total population)	% of 65+ in RUR (from total population)
EU	8,07%	4,69%
HR	4,10%	9,79%
HU	3,77%	3,93%
IT	11,08%	2,62%
DE	9,01%	3,72%
PL	5,37%	6,52%
BE	9,87%	1,59%
SE	7,05%	2,17%
ES	12,13%	0,91%

Figure 28 and Figure 29



SOURCE	EuroStat: Population on January 1, by five year age group, sex and other typologies, [URT_PJANGRP3]
DISCUSSION	Among the project partner countries, the share of people living in rural and urban areas varies greatly. In order to ensure equal access to the discussed solution/model, it seems reasonable to omit the issue of the area of residence. In other words, the solution developed as part of the project should be adapted to recipients from both rural and urban areas, and should therefore be free from elements specific to one of these areas.
IMPACT ON DESIGN ASSUMPTIONS	Distinguishing between the area of residence seems to be difficult - the solution should be adapted to the capabilities of people living both in urban and rural areas.

3.4.3. Household Structure

DATA

The statistics below demonstrate the characteristics of households with elderly people living alone compared to households shared with other people. The specification was made separately for people of the two genders in the **65+** age group. The data come from 2022 and contain information on the number of people living:

- with a partner
- alone
- in other compositions.

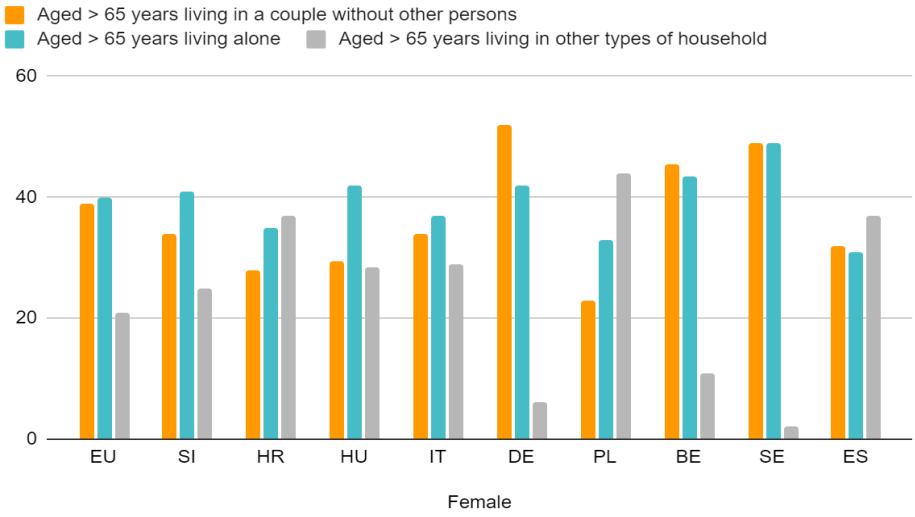
In the case of women in the EU, on average, **39%** live with a partner, **40%** live alone and **21%** live in another composition. In the case of men, the respective percentages are **59%, 21%** and **20%.**

- The partner country where the most women live with a partner is Germany (**52%**), alone - Germany and Hungary (**42%**), and in another composition - Poland (**44%**).
- The partner country in which the fewest women live with a partner is Poland (**23%**), alone - - also Poland (**33%**) and in another composition - Germany (**6%**).
- The partner country in which most men live with a partner is Germany (**66%**), alone - Hungary (**25%**) and in another composition - Poland (**43%**).

The partner country in which the fewest men live with a partner is Poland (**44%**), alone - also Poland (**13%**), and in another composition - Germany (**5%**).

Figure 30, Figure 31 and Figure 32

	Female			Male		
	Aged > 65 years living in a couple without other persons	Aged > 65 years living alone	Aged > 65 years living in other types of household	Aged > 65 years living in a couple without other persons	Aged > 65 years living alone	Aged > 65 years living in other types of household
EU	39	40	21	59	21	20
SI	34	41	25	58	20,5	21,5
HR	28	35	37	51	18	31
HU	29,5	42	28,5	56	25	19
IT	34	37	29	51	18	31
DE	52	42	6	66	29	5
PL	23	33	44	44	13	43
BE	45,5	43,5	11	64	23	13
SE	49	49	2	66,5	29	4,5
ES	32	31	37	49	19	32



SOURCE	EuroStat: Distribution of population aged 65 and over by type of household - EU-SILC survey , [ILC_LVPS30]
DISCUSSION	The first conclusion concerns the difference between the structure of households as a function of gender. In the case of women, there is a much higher share of people living alone, with the European average close to 40% (similar level is found in most partner countries). In the case of men, the same rate is nearly 21%, i.e. twice less. In the case of men, nearly 60% (EU average) of people live with a partner. This certainly results from the fact that men live statistically shorter. In the case of other household compositions, both for women and men, the share in the EU is close to 20%. This category will most often include living with a family other than your spouse. The high level of such households in Poland is noteworthy here (44% F, 43% M) - so-called multi-generational households may have different LTC needs.
IMPACT ON DESIGN ASSUMPTIONS	In Poland, a large proportion of people aged 65+ (44% F, 43% M) live in multi-generational households, where the needs may be different from those of single people.

3.4.4. Defined Long-Term Care Needs

DATA

The statistics below contain information on the most frequently reported needs in the field of long-term care, divided into personal and home care. The specification was made separately for people of the two genders in the **65+** age group. Data from **2019. The enumerated categories are:**

In the area of Home care:

- Occasional heavy housework
- Shopping
- Light housework
- "Taking care of finances and everyday administrative tasks"
- Preparing meals
- Managing medication
- Using the telephone

In the area of Personal Care:

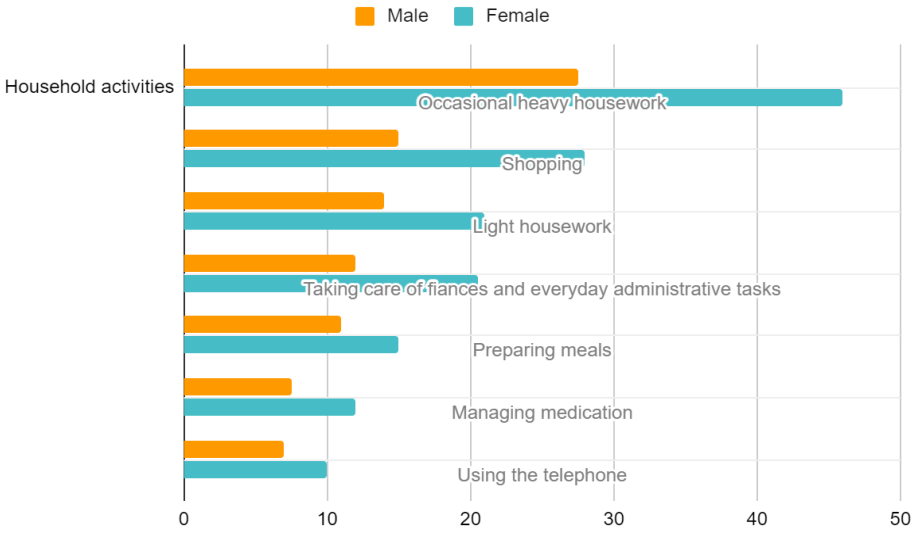
- Bathing or showering
- Dressing and undressing
- Getting in and out of a bed or chair
- Using a toilet
- Feeding oneself

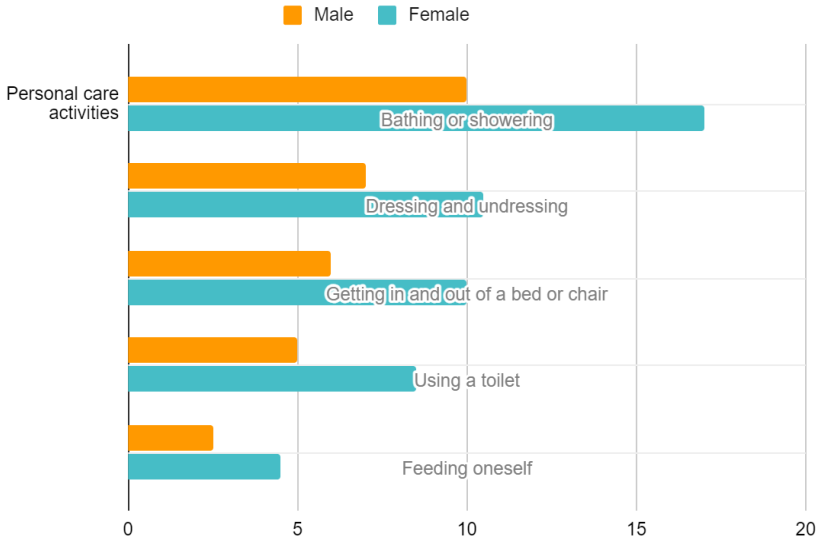
In the case of both women and men aged 65+, the activities related to household chores that most often require support are occasional, heavy houseworks (46% of women and 27.5% of men).

In the case of both women and men aged 65+, the activities related to personal care that most often require support are personal hygiene routines such as taking a bath or a shower (17% of women and 10% of men).

Figure 33, Figure 34 and Figure 35

		Male	Female
Household activities	Occasional heavy housework	27,5	46
	Shopping	15	28
	Light housework	14	21
	Taking care of fiances and everyday administrative tasks	12	20,5
	Preparing meals	11	15
	Managing medication	7,5	12
	Using the telephone	7	10
		Male	Female
Personal care activities	Bathing or showering	10	17
	Dressing and undressing	7	10,5
	Getting in and out of a bed or chair	6	10
	Using a toilet	5	8,5
	Feeding oneself	2,5	4,5





SOURCE	EuroStat: Difficulties in personal care activities by sex, age and educational attainment level , [HLTH_EHIS_PC1E] EuroStat: Difficulties in household activities by sex, age and educational attainment level , [HLTH_EHIS_HA1E]
DISCUSSION	The longer average life expectancy of women is the reason why there is a greater proportion of women among those needing help with LTC. Interestingly, however, regardless of gender, the significance of needs is maintained in both cases. Among the household chores that require support, heavy housework was mentioned first. However, it should be noted that minor repairs that fall within this term are occasional. In everyday life, the following items seem to be even more important to manage: ▪ Shopping ▪ Light housework

	▪ "Taking care of finances and everyday administrative tasks"
IMPACT ON DESIGN ASSUMPTIONS	The value proposition should Include the clearly defined LTC needs regarding household chores and personal care constituting the data concerning this area.

3.5. Elderly people - health factors

3.5.1. The Reported Ailments Related to Age

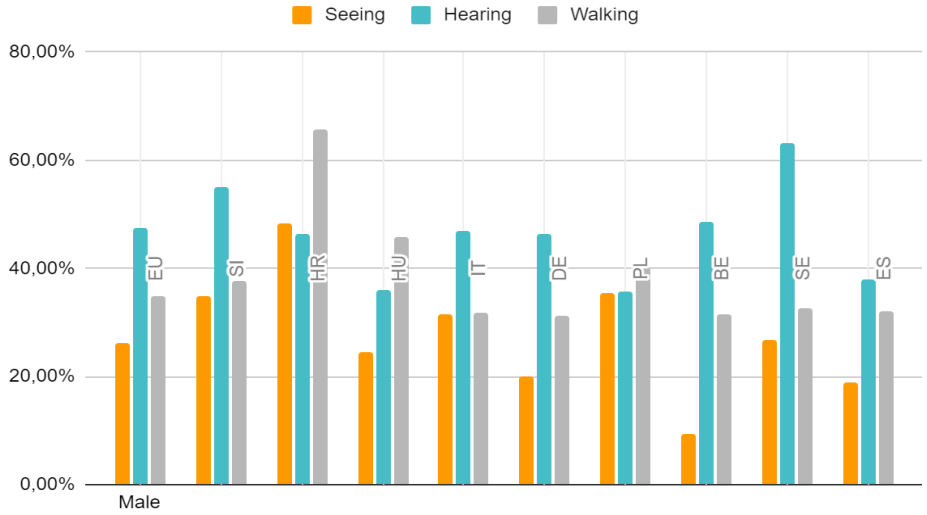
DATA

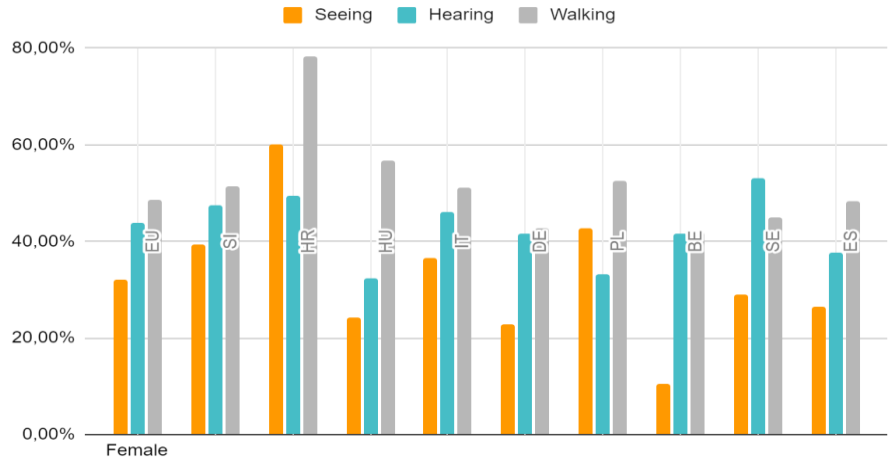
The statistics below contain information on the most frequently reported health-related issues with respect to gender. The specification was made separately for people of the two genders in the 65+ age group. Data from 2022.

In the case of men, the most common disorders affect hearing (**47.5%**), musculoskeletal system (**34.8%**) and vision (**26.2%**). In the case of women, the most common ailments are related to walking (**48.5%**), hearing (**43.7%**) and vision (**32%**). Among the project partner countries, Croatian women most often experience ailments in all three areas, i.e., they have problems with vision (**60.2%**), hearing (**49.3%**) and walking (**78.2%**). Croatian men also most often suffer from vision disorders (**48.4%**) and problems with walking (**65.8%**). In the case of hearing problems, they most often affect Slovenians (55%).

Figure 36, Figure 37 and Figure 38

		Seeing	Hearing	Walking
Male	EU	26,20%	47,50%	34,80%
	SI	35,00%	55,00%	37,70%
	HR	48,40%	46,40%	65,80%
	HU	24,50%	35,90%	45,80%
	IT	31,50%	46,80%	31,90%
	DE	20,10%	46,40%	31,10%
	PL	35,40%	35,70%	40,30%
	BE	9,50%	48,70%	31,50%
	SE	26,80%	63,20%	32,60%
	ES	18,90%	38,00%	32,10%
		Seeing	Hearing	Walking
Female	EU	32,00%	43,70%	48,50%
	SI	39,40%	47,60%	51,30%
	HR	60,20%	49,30%	78,20%
	HU	24,20%	32,30%	56,70%
	IT	36,50%	46,20%	51,10%
	DE	22,90%	41,50%	42,70%
	PL	42,60%	33,30%	52,40%
	BE	10,60%	41,70%	41,80%
	SE	28,90%	53,20%	44,90%
	ES	26,40%	37,60%	48,20%





SOURCE	EuroStat: Population on January 1, by five year age group, sex and other typologies, [URT_PJANGRP3]
DISCUSSION	In both women and men, it can be observed that over 40% of people aged 65+ have hearing problems. It should be noted that this is the most common ailment in men, while in women, walking problems are the most prevalent. Interestingly, the total value exceeding 100% indicates that some dysfunctions are comorbid, i.e. one person has more than one dysfunction.
IMPACT ON DESIGN ASSUMPTIONS	▪ The most common ailments in men are hearing problems (EU average 47.5%) ▪ The most common ailments in women are problems with walking (EU average 48.5%)

3.5.2. Chronic Diseases

DATA

The statistics below contain information on chronic diseases occurring in a given society. Chronic diseases are listed in the table below. The specification was made for people of both genders in the 65+ age group. Data from **2022**.

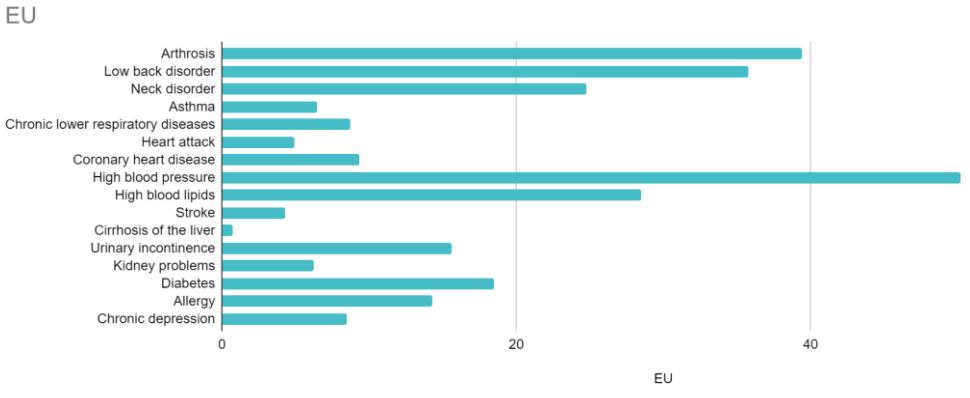
In Europeans, the five most common chronic diseases are:

- High blood pressure **50.2%**
- Arthrosis **39.4%**
- Low back disorder **35.8%**
- High blood lipids **28.5%**
- Neck disorder **24.8%**

The remaining chronic diseases do not occur more frequently than in 20% patients.

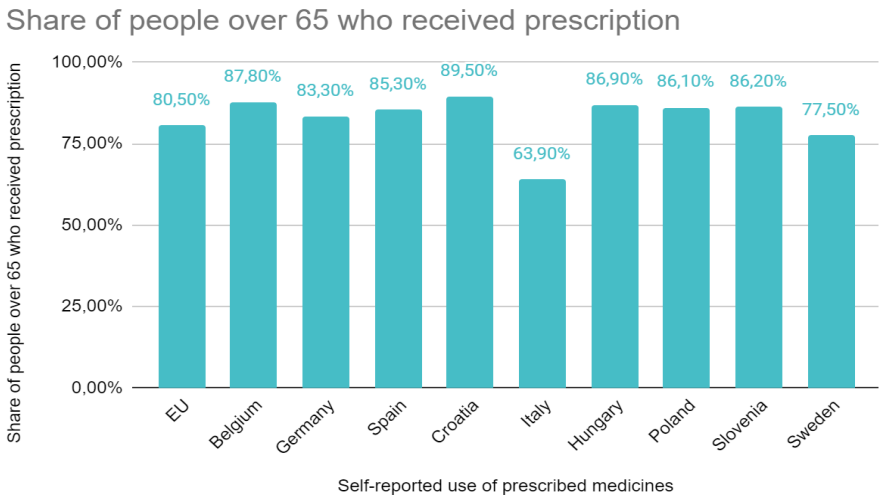
Figure 39 and Figure 40

	Arthrosis	Low back disorder	Neck disorder	Asthma	Chronic lower respiratory diseases	Heart attack	Coronary heart disease	High blood pressure	High blood lipids	Stroke	Cirrhosis of the liver	Urinary incontinence	Kidney problems	Diabetes	Allergy	Chronic depression
EU	39,4	35,8	24,8	6,5	8,7	4,9	9,3	50,2	28,5	4,3	0,7	15,6	6,2	18,5	14,3	8,5
Belgium	41,3	33,5	19,2	5,7	7,5	2,2	3,8	37,9	38,2	1,9	1,4	13,1	1,8	13,7	16	6,8
Germany	34,9	40,1	27,1	7,8	9,9	5,9	11,7	53,3	32,6	5,1	0,5	20,1	4,7	18,8	21,4	8
Spain	41,3	26,4	22,1	4,5	6,5	2,8	2	50,7	34	3,2	1,2	11,5	4,9	20,9	8,4	10,3
Croatia	24,9	58,3	46,4	6,7	9,7	8,2	20,1	67,9	33,2	7,7	1,2	30,2	12,4	24,1	15,6	18,7
Italy	48,1	32	29,1	5,8	11,2	5,2	6,3	47,7	25,1	3,7	0,6	13,2	8,1	17,1	12,7	11,5
Hungary	39,6	43,3	20,9	6,9	7,5	6	11,7	66,2	26	6	0,6	13,9	5,5	19,5	15,9	4,2
Poland	41,7	44,2	28,5	7,2	6,2	7,8	25,7	62,8	22	5,8	1,2	16,2	9,6	22,5	8,6	6,7
Slovenia	12,6	52,8	30,4	6,9	7,4	5,1	9,9	57,3	28,4	4,8	1,1	18,3	10,3	19,2	10,7	9,4
Sweden	34,9	22,3	15,1	7,6	5	3,3	3,8	40,1	16	2,9	0,5	17,9	3,4	15,5	13,3	6,1



SOURCE	EuroStat: Population on January 1, by five year age group, sex and other typologies, [URT_PJANGRP3]
DISCUSSION	Considering the frequency of occurrence of individual chronic diseases, cardiovascular diseases occur in every second person over 65 years of age living in the EU. Interestingly, in the case of mental disorders, only depression appeared on the list, which affects 8.5% of the EU population.
IMPACT ON DESIGN ASSUMPTIONS	If you want to address the chronic diseases, it is worth paying attention to the 5 most common diseases.

3.5.3. Taking Medications

DATA	The statistics below contain information on the use of prescription drugs. The specification was made for people of both genders in the **65+** age group. Data from **2019**. On average 80.5% Europeans take prescription drugs. Among the surveyed partner countries, all except Italy (63.9%) exceeded this indicator. The highest rate was observed in Croatia (89.5%).
Figure 41	
SOURCE	EuroStat: Self-reported use of prescribed medicines by sex, age and educational attainment level , [HLTH_EHIS_MD1E__custom_7257637]
DISCUSSION	Statistics show that the rate of prescription drug use is very high and remains constant at x>80%. The exception is Italy. Therefore, it is important to consider whether there is a real problem with prescription drug use by the elderly. The results do not include other drugs or supplements.
IMPACT ON DESIGN ASSUMPTIONS	There is no confirmation of a problem with failure to take prescription medications.

3.5.4. Causes of Natural Death

DATA

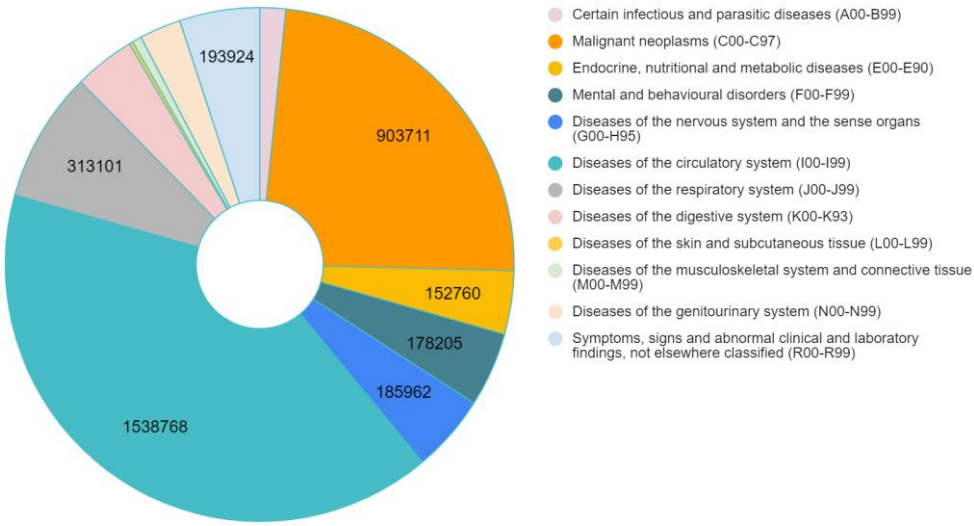
The data below contains information on the causes of natural death. All causes are summarized in the table below. The specification was made for people of both genders in the **65+** age group. Data from **2020**.

In Europeans, the most common causes of natural death are:

- Diseases of the circulatory system (I00-I99) **34.96%**
- Malignant neoplasms (C00-C97) **20.53%** Diseases of the respiratory system (J00-J99) **7.11%**
- Symptoms, signs and abnormal clinical and laboratory findings, not elsewhere classified (R00-R99) **4.41%**
- Diseases of the nervous system and the sense organs (G00-H95) **4.23%**
- Mental and behavioural disorders (F00-F99) **4.05%**

	All causes of death (A00-Y89) excluding S00-T98	Certain infectious and parasitic diseases (A00-B99)	Malignant neoplasms (C00-C97)	Endocrine, nutritional and metabolic diseases (E00-E90)	Mental and behavioural disorders (F00-F99)	Diseases of the nervous system and the sense organs (G00-H95)	Diseases of the circulatory system (I00-I99)	Diseases of the respiratory system (J00-J99)	Diseases of the digestive system (K00-K93)	Diseases of the skin and subcutaneous tissue (L00-L99)	Diseases of the musculoskeletal system and connective tissue (M00-M99)	Diseases of the genitourinary system (N00-N99)	Symptoms, signs and abnormal clinical and laboratory findings, not elsewhere classified (R00-R99)
Number of deaths	4400885	62489	903711	152760	178205	185962	153876	313101	146601	9164	22690	100357	193924
% of all causes		1,42%	20,53%	3,47%	4,05%	4,23%	34,96%	7,11%	3,33%	0,21%	0,52%	2,28%	4,41%

Figure 42 and Figure 43



SOURCE

EuroStat: Causes of death - deaths by country of residence and occurrence , [HLTH_CD_ARO__custom_7257672]

DISCUSSION	The data come from 2020, so they can be referred to as comorbidities of COVID-19. This does not change the fact that the two most common causes jointly responsible for almost half of deaths among the elderly, are cardiovascular diseases and cancer. In the case of the circulatory system, this coincides with the most common chronic diseases of the cardiovascular system.
IMPACT ON DESIGN ASSUMPTIONS	No direct impact

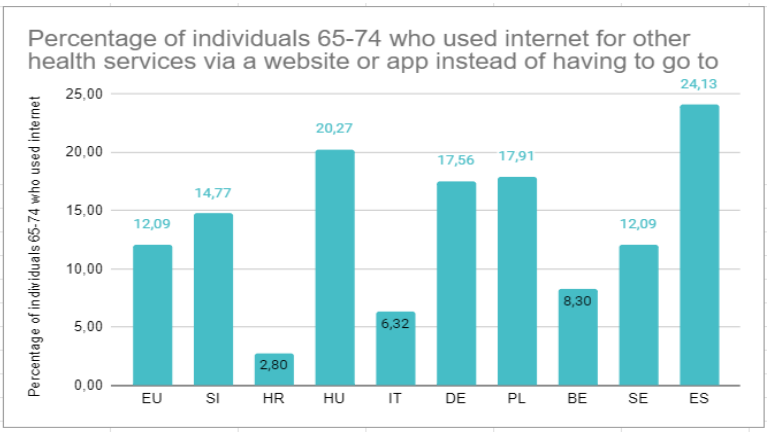
3.6. Elderly people - technology factors

3.6.1. Percentage of Individuals Aged 65-74 Who Used Internet for Other Health Services via a Website or Application instead of having to go to the Hospital or Visit a Doctor

DATA	The statistics below contain information on the use of the Internet to attend a remote visit or consultation instead of a physical visit to a doctor. The specification was made separately for people of the two genders in the **65-74** group. Data from **2022**. In the case of the EU, the average share of people who attended a remote advice or medical consultation via an Internet application is **12.09%**. Among the project partner countries, the largest share is found in Hungary (**20.27%**), Poland (**17.91%**) and Germany (**17.56%**). The smallest share is **2.8%** in the Croatian population and **6.32%** in Italy.

Figure 44

2022	Percentage of individuals 65-74 who used internet for other health services via a website or app instead of having to go to the hospital or visit a doctor
EU	12,09
SI	14,77
HR	2,80
HU	20,27
IT	6,32
DE	17,56
PL	17,91
BE	8,30
SE	12,09
ES	24,13



SOURCE	EuroStat: Individuals - internet activities , [ISOC_CI_AC_I__custom_7257756]
DISCUSSION	Data on remote visits/medical consultations conducted via the Internet application are relatively scarce, although as many as four partner countries exceeded the European average. There is also a strong variation in results, from 20.27% in Germany to 2.8% in Croatia. The results show some barriers to using mobile and web applications for this specific purpose.

IMPACT ON DESIGN ASSUMPTIONS	No direct impact

3.7. Carers - Total Addressable Market (TAM)

3.7.1. Share of Population Providing Informal Care

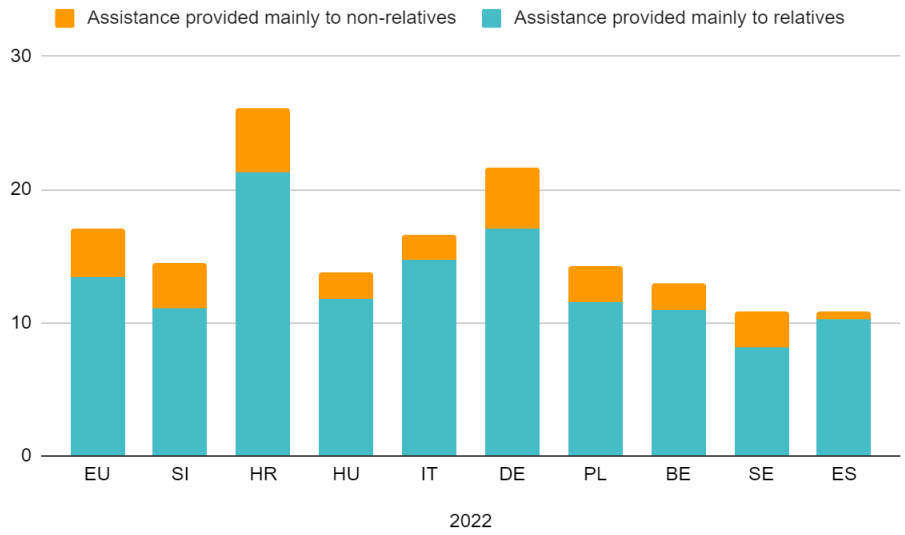
DATA

The presented data include information on the number of people providing informal care. The statistics also show the division into help provided to family members and that provided to strangers. The specification includes all people of both sexes in a given country. Data from **2019**.

In the EU, the average share of people who provide informal help is **17.1%**, of which **13.4%** is help provided to family members and **3.7%** is help provided to people outside the family. Among the project partner countries, the largest share of people providing informal help is found in Croatia (**26.1%**), of which **21.3%** provide assistance to family members and **4.8%** is provide help to people outside the family. The smallest share is found in Hungary (**13.8%**), of which **11.8%** is help provided to family members and **2%** is assistance provided to people outside the family.

Figure 45 and Figure 46

Share of population providing informal care			
2022	Assistance provided mainly to relatives	Assistance provided mainly to non-relatives	Total
EU	13,4	3,7	17,1
SI	11,1	3,4	14,5
HR	21,3	4,8	26,1
HU	11,8	2	13,8
IT	14,7	1,9	16,6
DE	17,1	4,6	21,7
PL	11,6	2,6	14,2
BE	11	2	13
SE	8,2	2,6	10,8
ES	10,3	0,5	10,8



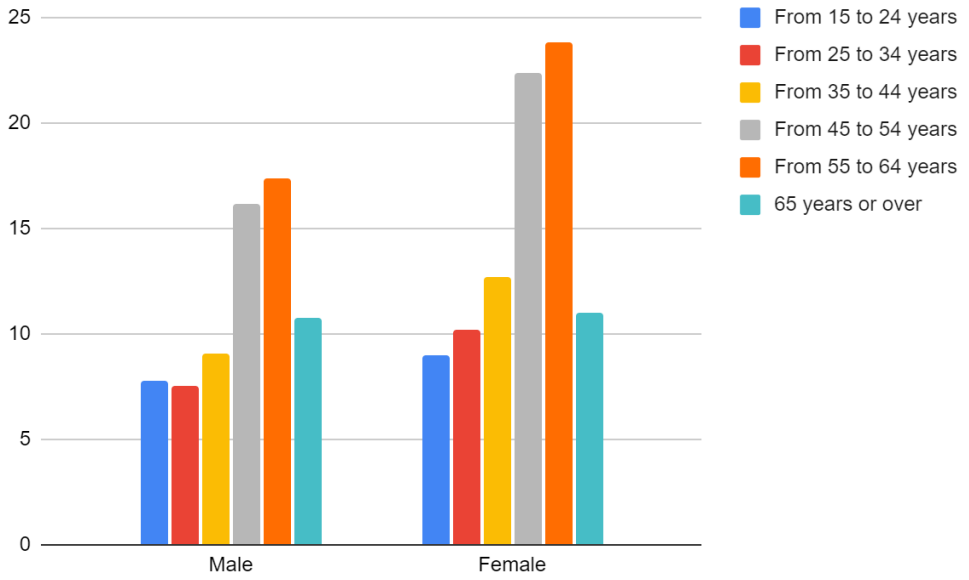
SOURCE	EuroStat: Persons providing informal care or assistance at least once a week by sex, age and degree of urbanization , [HLTH_EHIS_IC1U]
DISCUSSION	Statistics clearly indicate that informal help is much more often provided to relatives than to non-family members. With the exception of Croatia (which significantly exceeds the share of people helping their families informally), most partner countries achieve a similar level of people helping their relatives.
IMPACT ON DESIGN ASSUMPTIONS	▪ The market of caregivers helping families is larger than the market of informal caregivers who help strangers. ▪ The small share of people providing informal care to non-relatives may indicate niches to be exploited.

3.7.2. Age Distribution among People Providing Assistance

DATA	The statistics below contain information on the participation of people of different age in the provision of informal care. The specification was made separately for people of the two genders in the age groups presented in the table. The data come from **2019** and regard the entire population of the EU. The presented data demonstrate that the age group that most often engages in informal care are people aged 55-64 (**17.4% M; 23.8% F**) and 45-54 (**16.2% M; 22.4 % F**). The least involved group are people under 34 years of age. Women's participation in the provision of informal assistance is slightly higher in all age groups.

Figure 47 and Figure 48

	From 15 to 24 years	From 25 to 34 years	From 35 to 44 years	From 45 to 54 years	From 55 to 64 years	65 years or over
Male	7,8	7,5	9,1	16,2	17,4	10,8
Female	9	10,2	12,7	22,4	23,8	11



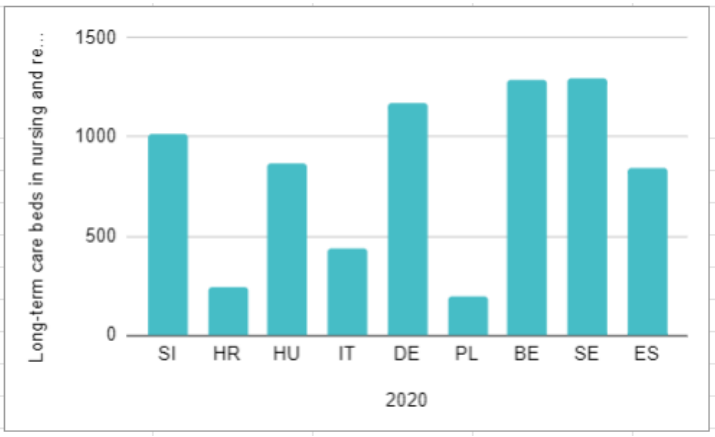
SOURCE	EuroStat: Persons providing informal care or assistance at least once a week by sex, age and degree of urbanization , [HLTH_EHIS_IC1U]
DISCUSSION	Statistics clearly indicate that people aged 45-64 are the group most frequently involved in informal help. This is important information defining the target group for solutions involving a stakeholder, other than the elderly person, being a caregiver.
IMPACT ON DESIGN ASSUMPTIONS	People aged 45-64 constitute almost half of informal caregivers. It seems reasonable to design value propositions to meet the needs of this group of caregivers.

3.8. Long-Term Care Beds in Nursing and Residential Care Facilities

DATA	The statistics below show the number of beds in dedicated centres providing care services. The figure is expressed per 100,000 citizens of the partner country concerned. The Information concerns the participation of people of different age groups in the provision of informal care. Data from **2020.** The presented data show that, in the project partner countries, the largest number of facilities providing dedicated care (expressed in the number of available beds) are found in Germany and Slovenia and offer ~1k beds/100k inhabitants. The fewest beds are available in Poland and Croatia.

Figure 49

2020	Long-term care beds in nursing and residential care facilities per 100 k people
SI	1014,12
HR	246,24
HU	868,57
IT	441,31
DE	1166,83
PL	194,42
BE	1289,23
SE	1292,83
ES	842,52



SOURCE	EuroStat: Long-term care beds in nursing and residential care facilities by NUTS 2 regions - historical data (1980-2021) , [HLTH_RS_BDSNS]
DISCUSSION	After making the calculations, it can be assumed that Germany and Slovenia have dedicated places for nearly 5% of people aged 65+, while in Croatia and Poland the rate is 1% of people aged 65+. This number of dedicated specialised facilities seems to be small. On the other hand, attention should be paid to the trend related to the increasing share of assistance provided at home and the large share of informal help provided by family members.
IMPACT ON DESIGN ASSUMPTIONS	No direct impact

3.9. Initial recommendations

Initial recommendations	Area
It is recommended to read the report on the adopted LTC strategies, which, according to the Commission's Recommendations, should be prepared in the second half of 2024.	2.1.1
It is recommended to constantly monitor the offered support at the European level, which may contribute to changing the business model, mainly in the area of monetization.	2.1.2
Customer segmentation should take into account both end users (b2c) and reaching institutions that decide on the granting of in-kind benefits.	2.2.2
The majority of households have access to the Internet	2.3.1
Nearly 40% of people aged 65-74 use a computer. This affects both the value proposition and the method of reaching the target group.	2.3.2
There is a risk/need to educate target users on how to use the tool - a computer	2.3.2
There is a risk/need to educate the target population on how to use the tool, if IoT is selected.	2.3.3
It is necessary to consider the use of IoT for which the technological barrier to entry is not so high.	2.3.3
Smart home IoT solutions (e.g. alarms) are used more often by people aged 65-74 than IoT wearable solutions (e.g. wristbands) - 8%	2.3.4

If the preferences of the users of the most capacious market (DE) are different from those of another, it will be justified to conduct a secondary analysis of a given issue.	3.1.1
In the 80+ group there are many more women than men for whom the value proposition should be adjusted.	3.1.3
Nearly every second woman aged 75+ requires help with daily care/household duties - this has a direct impact on the size of the customer segment in question.	3.2.1
The share of people who received insufficient assistance in Croatia exceeds 70%. It seems reasonable to verify the care model in Croatia in order to determine the detailed reasons for such a state of affairs.	3.2.3
The main reasons why people fail to receive assistance in the EU are financial issues.	3.2.4
The model should also take into account the issue of barriers to access and availability of services.	3.2.4
It is worth considering a model of in-kind support that will be provided at home (Scandinavian countries, Benelux region)	3.2.5
In the period from 2023 to 2050, the share of people over 65 years of age will increase from 21.2% to 29% of the total population.	3.3.1
The monetization model should take into account the income from potential customers' pensions. Germans have pensions that are over three times higher than Hungarians.	3.4.1
It should be considered to adapt the monetization model to the poorest citizens or diversifying the monetization model depending on the country.	3.4.1
Distinguishing between the area of residence seems to be difficult - the solution should be adapted to the capabilities of people living both in urban and rural areas.	3.4.2
In Poland, a large proportion of people aged 65+ (44% F, 43% M) live in multi-generational households, where the needs may be different from those of single people.	3.4.3
The value proposition should Include the clearly defined LTC needs regarding household chores and personal care constituting the data concerning this area.	3.4.4
The most common ailments in men are hearing problems (EU average 47.5%)	3.5.1
The most common ailments in women are problems with walking (EU average 48.5%)	3.5.1
If you want to address the chronic diseases, it is worth paying attention to the 5 most common diseases.	3.5.2
There is no confirmation of a problem with failure to take prescription medications.	3.5.3
The market of caregivers helping families is larger than the market of informal caregivers who help strangers.	3.7.1
The small share of people providing informal care to non-relatives may indicate niches to be exploited.	3.7.1
People aged 45-64 constitute almost half of informal caregivers. It seems reasonable to design value propositions to meet the needs of this group of caregivers.	3.7.2

4. Models of supporting the elderly care

4.1. Current state

Models of care for the elderly depend on the country, the mentality of its inhabitants, tradition, the level of wealth of citizens, state budget resources, and many other factors, but in general terms, four basic models can be distinguished in Europe[2]:

- Scandinavian (a model with the highest state involvement in the provision of care),
- Continental,
- Anglo-Saxon,
- Mediterranean (a model in which the family plays the main role in caring for the elderly – informal care).

Scandinavian model

Applied in Denmark, Sweden, Norway, Finland, Iceland and the Netherlands.

It is characterized by the most significant role of state structures. It assumes that the basic needs of citizens should be met by the state itself, offering free and universal social and health care. There is no established role for informal care.

Continental model

Applied in Germany, France, Belgium, Luxembourg and Austria.

As in the Scandinavian model, there is no established informal care and the state is primarily responsible for providing various types of support to people in need of care. The family can choose whether they prefer service provision or monetary support.

The Anglo-Saxon model

Applied in Great Britain and Ireland

It is characterised with few preventive measures, so it only works when a problem occurs. It is considered one of the most sustainable models in the long term because it encourages working and contributing as a way to ensure a decent life after retirement.

Mediterranean model

Applied in Greece, Italy, Portugal and Spain.

Informal care is of the greatest importance in this model. However, the state is becoming increasingly involved in supporting the care for the elderly, which is making this model more and more formal.

The opinion 'Towards a New Care Model for the Elderly: learning from the Covid-19 pandemic' (European Economic and Social Committee) clearly states that *"particular attention must be paid to the care for the elderly, requiring long-term care and, due to demographic changes, it must be considered a central element of EU policy development"*[3].

[2] https://wayalia.es/el-cuidado-de-ancianos-como-funciona-en-cada-pais/

[3] "Towards a New Care Model for the Elderly: learning from the Covid-19 pandemic"; European Economic and Social Committee, SOC/687, 2021

EU policy calls for meeting the demand for care for the elderly with less institutionalized forms, promoting autonomy and independence. However, such care requires the provision of more structured and effective health services delivered in the patient's home. The following changes in care have been noticed - from a caring concept to an integrated approach that takes into account not only health but also social issues. However, general social trends - the ageing society, an increase in the number of elderly people with mental illnesses (dementia, Alzheimer's disease) and the mass entry of women into the labour market, undermine the central role of the family in long-term care, forcing the need to increase the role of the state in the care for the elderly.

The Covid-19 pandemic has highlighted the shortcomings of the current systems of care for the elderly and has contributed to increasing public awareness of the challenge posed by the ageing society. It also highlighted the shortcomings of the long-term care pillar regarding caregivers and care workers. It employs approximately 6.4 million people and is expected to create another 7 million jobs by 2030. The pandemic also contributed to the development of a number of documents by European institutions regarding the elderly and long-term care, including: European Commission Green Paper on Ageing, Action Plan for the European Pillar of Social Rights, European Parliament resolution on the old continent growing older, EU Council Report and Conclusions on Integrating Ageing into Public Policy, Report of the European Commission and the Social Protection Committee on "*Trends, challenges and opportunities in an ageing society*", Committee of the Regions working document on "*A future plan for care workers and care services - local and regional opportunities in the context of a European challenge*", Proposal for a new European Care Strategy, presented by Commission President Ursula von der Leyen during her State of the Union speech in the European Parliament.

The opinion of the European Economic and Social Committee highlighted the lack of statistical data on elderly people, the need for greater common knowledge about social security and care models, which vary widely between Member States, the desirability of collecting and disseminating good practice across Member States and the need to investigate discrimination or violence against dependent elderly people and their prevention.

The European Commission highlights the increasing dependency rates with age (Figure 50)[4]:

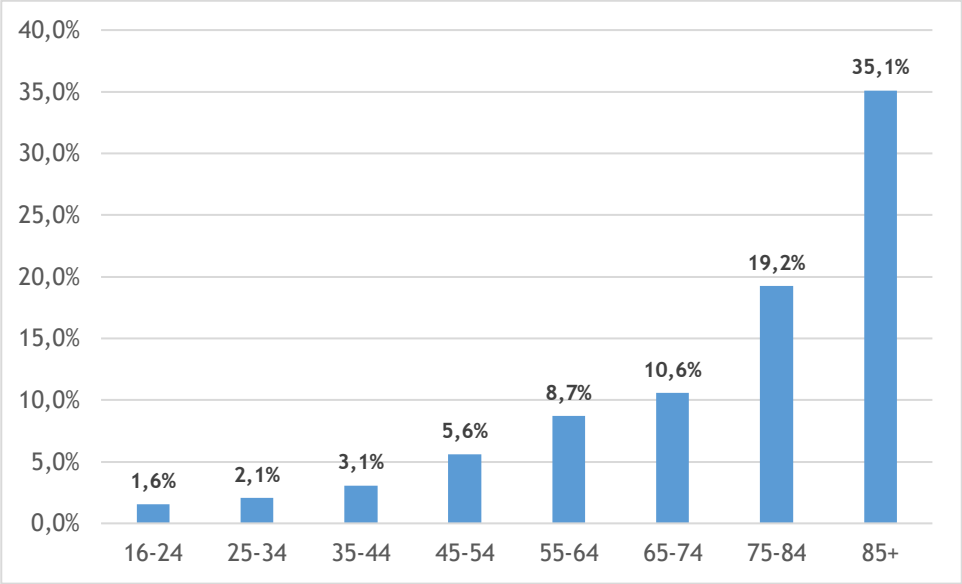


Figure 50. EU dependency ratios[5] increasing with age, 2015-2019

[4] "Green Paper on Ageing. Fostering solidarity and responsibility between generations", European Commission, 2021

[5] Dependency ratios are calculated as a five-year average of annual severe long-term limitation in normal activities due to a health problem perceived by an individual.

With age, elderly people become more and more dependent on long-term care, and the ageing society and the increase in average life expectancy make this problem ever more obvious. These factors increase the need to provide healthcare, other forms of care and support services. Currently, there are different quality standards and interpretations across the EU, and individual Member States are at various stages in ensuring the quality of long-term care. Community-based provision of services for elderly people in need of long-term care, including people with disabilities, can support their right to live independently in the community for as long as possible. On the other hand, residential or other services may provide care that goes beyond the capabilities of local communities.

A good example of the contribution of Member States to creating models of care for the elderly is the French plan to prevent falls in the elderly: "*Plan antichute des personnes âgées*"[6] was initiated in 2022 after it was found in France that falls among the elderly cause more than 100,000 hospitalizations and over 10,000 deaths each year. These falls have physical, psychological and social consequences and cause a break in regular lives of individuals and a loss of independence. The plan to combat falls among elderly people assumes reducing the number of fatal or disabling falls in people aged 65+ by 20% by 2024. The plan is based on five main themes and one cross-cutting theme:

1. Identifying threats
2. Adapting your home to avoid the risk of falls
3. Technical issues
4. Physical activity
5. Telecare
6. Cross-cutting topic: Informing and raising awareness

The main conclusions regarding long-term care in the countries participating in this project are presented in the "*Long-Term Care Report. Trends, challenges and opportunities in an ageing society*", European Commission, 2021[7]. They are presented below:

Slovenia

- In Slovenia, there is currently no uniform definition of long-term care or a unified long-term care system. There is no overarching legal act that would cover long-term care. Currently, services that can be classified as long-term care are provided within various social security systems: the healthcare system, the social welfare system, the parental care system, the pension system, the disability system, the education system and the disability care system. Policies are fragmented, contain segmented needs assessment procedures, do not ensure equal treatment, lack coordination and equal financing of needs.
- Due to the ageing of the population, the number of elderly people requiring long-term care is increasing. In 2019, 21.3% of the population aged 65 and older were receiving formal long-term care benefits in kind or cash. The percentage of people aged 65 and older who had difficulties with basic household activities was 38.8%.
- Total public spending on long-term care amounted to 1.0% of GDP in 2019. Long-term care spending has been estimated to increase even more by 2050, making the long-term care system financially unsustainable.
- The affordability of long-term care (assessed by comparing elderly people's incomes and care costs) has been deteriorating since 2007. The quality of long-term care is difficult to assess because, apart from monitoring and the minimum standards, there is no national level assurance of quality and safety.

[6] https://www.ars.sante.fr/plan-antichute-des-personnes-agees

[7] "Long-Term Care Report. Trends, challenges, and opportunities in an ageing society", European Commission, 2021

- The burden of care for dependent relatives results from an inadequate supply of formal home-based long-term care services and long waiting lists for home-based long-term care services. This care is provided mainly by informal caregivers, who are mainly women.
- The new draft law on long-term care was the subject of public debate by October 5, 2020. Currently, the project is being discussed by the Economic and Social Council of the Republic of Slovenia (ESC) (data of 2021[6]).

Germany

- The demand for long-term care will increase significantly in the coming decades. By 2050, the number of dependent people is expected to increase from the current 5.8 million to 6.6 million.
- Long-term care in Germany is organized according to the insurance principle. The entire population is obliged to pay compulsory health insurance contributions and is entitled to benefits from the long-term care insurance system. Even though entitlement to benefits is quite comprehensive, insurance may only cover part of the costs of long-term care. The remainder is covered by the people in need of long-term care themselves or - if necessary and under certain conditions - by immediate family members/other people or social security.
- The LTC market is dominated by private providers.
- The large majority of people in need of care are still attended to, and cared for, by their family members, mostly spouses, daughters and daughters-in-law.
- The latest reforms, adopted between 2015 and 2019, aimed to expand entitlement to benefits by reforming the definition of "person in need of care" and the associated assessment method, increasing the attractiveness of care professions and improving the quality of long-term care.
- The greatest challenge is recruiting enough professional long-term care workers, as staff shortages will continue to increase due to demographic and social changes. The shortfall is estimated at approximately 186,000 full-time jobs in long-term care facilities in 2030. To effectively address the shortage of professional staff, significant increases in wages and significant improvements in working conditions are required.
- Other important challenges include improving the quality of long-term care and reducing private care costs.

Hungary

- The Hungarian long-term care system is on the way to becoming a separate social security area and, despite important steps towards integration taken over the last few years, it still retains a dual structure of healthcare and social care systems. Both branches have their own legislation, funding mechanisms and services. They maintain parallel institutional networks in both inpatient and home care.
- Despite the rapid expansion of public home care services, the long-term care system remains focused on institutional care. The share of home care expenditure in total long-term care expenditure is 74% in the public sector, which is one of the highest rates in the European Union.
- Long-term care needs in old age are unevenly distributed.
- On average, a person with higher education becomes more dependent on care over a decade later than a person of the same age with secondary education.
- Total public spending on long-term care was 0.6% of gross domestic product (GDP) in 2019. In both sectors, Hungary is among the least spending countries in the European Union, although comparison of social care spending is limited because data is not available for many Member States. About half (53%)

of healthcare associated with long-term care is financed by government programs, and about a quarter (27%) relies on compulsory contributory health insurance. Of the remaining part, 14% are out-of-pocket payments made by households, and another 6% is financed through voluntary insurance schemes.

Croatia

- Croatia will face a large projected population decline by 2050, with the ageing population being the most striking socio-demographic trend. Ageing in the context of the recent intensive emigration of young people of working age means that elderly people are increasingly left alone, without direct family support.
- The long-term care system is fragmented and is one of the least developed parts of the health and social care system in Croatia. The management structure of long-term care is part of a clientelist political structure that is poorly coordinated with other private and civic entities.
- Care for elderly people in Croatia is mostly provided by families or relatives in the informal sector. According to MDFYSP statistics, less than 3% of the population over the age of 65 are cared for outside the family in organised forms of residential care, such as public and private homes for elderly people, or in community care such as family homes and foster care families.
- There is a need to build the capacity of stakeholders in the social care system to make reliable assessments of the demand for long-term care services. Accommodation prices in private facilities are twice as high as in public facilities of the same standard. Service quality is a real challenge for private providers of residential care services and for de institutionalization (e.g. expansion of family homes with relatively lower levels of quality standards).
- Public support for providing care for the elderly is not sufficient. The care for dependent elderly people has been left to the family and local community, which often do not have adequate support from experts or financial assistance from the state.
- There are clear regional inequalities in the coverage of the elderly population with home and community-based services. Croatia is experiencing a shortage of workers in long-term care because wages are much lower than in more developed countries.

Italy

- Italy is the EU-27 country with the highest share of people in 65+ age group and 75+ age group in the population. Healthy life expectancy at age 65 in Italy is 9.5 years, below the EU-27 average (9.9 years) and lower than in most EU-15 Member States. These latest figures show that the problem of frail elderly people is more significant than in many other countries.
- Italy has a relatively limited number of informal caregivers (around 5.8 % of the population – in the EU-27 the average is 10.3 %).
- The Italian market is characterized by a large number of immigrants providing care services in the homes of the elderly.
- Although public expenditure on long-term care is not low compared to the EU-27 average, the Italian public long-term care system is still heavily based on informal care and migrant care workers, often on irregular contracts, as well as the limited availability of home and residential care services.
- There are no national standards in home and residential care, and many decisions and evaluation criteria are delegated to regional and municipal levels. This situation results in extreme heterogeneity of assessment and access criteria.

- The most important long-term care system in Italy is the companionship allowance, which does not require beneficiaries to take any responsibility for how the funds are spent. More than half of Italian public spending on long-term care is therefore devoted to a program that, by its very nature, does not include any quality safeguards.
- The COVID-19 pandemic has dramatically demonstrated the weaknesses of such a system. For the first time in decades, the focus on long-term care in Italy has increased significantly due to the dramatic events surrounding the pandemic - and more specifically, the situation (and deaths) in nursing homes. The public long-term care system in Italy does not need much additional funding, but a better way of using the financial resources, strengthening services instead of focusing (mainly) on cash transfers.

Poland

- The increase in life expectancy combined with a low total fertility rate of 1.48 in 2017 contributes to the ageing population. The proportion of people aged 65 and over in the population was 17.7% in 2019 but is projected to reach 22.7% in 2030. The proportion of people aged 80 and over was 4.4% in 2019 and is projected to increase to 5.7% in 2030.
- In Poland, by law and by tradition, families are primarily responsible for the provision of care, with social institutions' intervening when families are incapable of undertaking adequate care measures. A substantial majority of care is provided by families.
- Long-term care benefits and services are available in the health and social care sector, addressed to various population groups (elderly people, disabled people, people unable to live independently). Home care covers 3.4% and stationary care 2.7% of the population aged 65 and over. Cash benefits covered 37.2% of the population over 65 years of age in 2019.
- Total public spending on long-term care was lower than in many other EU-27 countries, accounting for 0.8% of GDP in 2019. Due to the ageing population, spending is estimated to increase to 1.7% of GDP in 2050 (reference scenario) or to 3.1% of GDP (risk scenario).
- Employment in the long-term care sector is low compared to other EU-27 countries - 0.5 long-term care workers per 100 elderly people (EU-27 average: 3.8, data from 2016). There are inequalities in working conditions and remuneration between the health and social sectors. The number of caregivers is growing, but the ageing medical and nursing workforce will put additional pressure on providing adequate care.
- Process-oriented measures for ensuring the quality of care are applied in both care sectors, but especially in care services. Private institutions lack performance and quality monitoring.
- The government has introduced several programs aimed at increasing access to care services for the elderly, investing in community care and supporting people unable to live independently and at risk of poverty through cash transfers and introducing alternative care solutions. Closer coordination of health and social functions in long-term care is necessary.
- A good step to improve the long-term care system, although at the current stage it is far from being sufficient, is the government program Care 75+ and the "Senior Support Corps" program, the duration of which and the direction of development in the coming years are difficult to determine.

Statistics related to long-term care in the European Union are presented below:

Table 1.

People in need of LTC	2014	The latest	2030	2050
Number of potential dependants (in thousands), 2019		30816.1	33716.4	38072.1
Number of potential dependants 65+ (in thousands), 2019		17003.6 (total) 10857.7 (women) 6145.9 (men)	20451.6 (total) 12755.6 (women) 7695.9 (men)	26523.9 (total) 16445.1 (women) 10078.8 (men)
Share of potential dependants in total population (%), 2019		7.0	7.7	8.8
Share of potential dependants 65+ in population 65+ (%), 2019		19.0	19.2	20.8
Share of population 65+ in need of LTC (%), 2019***	27.3			

Notes. * data not available for all Member States; ** at least one severe difficulty in ADLs and/or IADLs

Table 2.

Access to LTC	2014	The latest	2030	2050
Share of population 65+ receiving care in an institution (%), 2019		3.6	3.6	4.4
Share of population 65+ receiving care at home (%), 2019		5.8	6.0	7.0
Share of population 65+ receiving LTC cash benefits (%) 2019		8.8	9.4	10.5

Share of potential dependants 65+ receiving formal LTC in-kind (%), 2019		46.0	48.8	50.3
Share of potential dependants 65+ receiving LTC cash benefits (%), 2019		46.0	48.8	50.3
Share of population 65+ in need of LTC lacking assistance in personal care or household activities (%), 2019***	51.8 (total) 53.2 (women) 48.4 (men)			
Share of population 65+ who used home care services in the past 12 months (%), 2019*	11.0 (total) 13.1 (women) 8.3 (men)			
Share of households in need of LTC not using professional home care services for financial reasons (%), 2016*		35.7		
Share of households in need of LTC not using professional home care services because services are not available (%), 2016*		9.7		
Long-term care beds per 100,000 inhabitants, 2017*				

Notes. * data not available for all Member States; ** at least one severe difficulty in ADLs and/or IADLs

Table 3.

LTC expenditure	2013	Most recent	2030	2050
Public spending on LTC as % of GDP (reference scenario), 2019	3.6	3.3	3.9	4.6
Public spending on LTC as % of GDP (risk scenario), 2019	3.6	3.3	4.3	6.3
Public spending on institutional care as % of total LTC public spending, 2019	48.5	52.6	53.4	56.4
Public spending on home care as % of total LTC public spending, 2019	47.9	44.7	44.3	41.8
Public spending on cash benefits as % of total LTC public spending, 2019	3.6	2.6	2.3	1.8
Government and compulsory contributory financing schemes as % of GDP, LTC Health, 2018	2.7	2.7		
Government and compulsory contributory financing schemes as % of GDP, LTC Social, 2018*	0.5	0.5		
Household out-of-pocket payment as % of GDP, LTC Health, 2018	0.2	0.2		

Household out-of-pocket payment as % of GDP, LTC Social, 2018*	0.0	0.0

Note. Break in series for DE and DK in the System of Health Accounts; A '-' shows that data is available in general, but not for this Member State; * data not available for all Member States.

The main conclusions

All available scientific sources and analyses indicate that the ageing population will lead to a strong increase in demand for long-term care, as the incidence of disability and the need for long-term care increase with age. Over the next 30 years, the number of people aged 65+ will increase by 41% - to 130.1 million. Thus, the number of people potentially in need of long-term care in the EU-27 will increase from 30.8 million to 33.7 million in 2030 and 38.1 million in 2050.

The Covid-19 pandemic has had a huge impact on the long-term care system. The analysis of the situation among seniors, both those requiring institutional care and those staying at home, clearly showed its weaknesses during this period. The pandemic has resulted in increased mortality among residents of long-term care homes, difficulties in ensuring continuity of care, and lack of opportunities to provide mental support to senior citizens.

There is a gender gap in both the long-term care sector and the elderly people: almost 90% of workers in the long-term care sector are women, and they also constitute the majority of informal caregivers. Additionally, 33% of all women aged 65+ need long-term care (among men the number is only 19%). The ability to provide long-term care is also influenced by the wage difference between men and women - women have lower incomes, including pensions, and are therefore potentially less able to afford professional care services. EU policies should therefore clearly place emphasis on adequate and affordable formal long-term care services, alongside policies to improve working conditions in this sector and to reconcile paid employment with caregiving.

On average, in the EU-27, only about 33% of people in need of help received home care. This leads to a conclusion that people in need of long-term care rely on informal care - by choice, lack of access to formal care, lack of financial resources or their needs remain unmet in this respect. In some Member States, public support is only available to just over 10% of all people aged 65+, while in others almost all people in this group receive home care, residential care or cash benefits. Social security in terms of long-term care (unlike health care) is often not sufficient - even taking the provided support into account, on average, almost 50% of elderly people requiring long-term care would fall below the poverty line once the costs of living are met. Therefore, informal care is currently of great importance in the long-term care system. Informal caregivers, mainly women, take over the responsibility of caring for elderly family members. The exclusive use of informal care varies from around 30% to around 85% across Member States. Sometimes care is a matter of preference, but often it may be the only option due to the lack of available and affordable formal care. However, the availability of informal care is likely to decline due the increased participation of women in the labour market, longer years of professional activity, greater geographic mobility and other demographic trends.

In the project partner countries, the dominant care system is based on informal care provided at home and mainly by women.

4.2. Trends in care in the era of digitalization

According to data provided in the official EU documents, the large-scale introduction of social and technological innovations such as e-health, mobile health, and telecare could significantly improve the efficiency of healthcare and long-term care systems. Remote monitoring-based health care models, particularly those that include patients and family members as part of the caregiving team, have demonstrated clear benefits for patients with chronic diseases[8].

Digital transformation also offers many opportunities. While technology cannot and should not replace the human interactions that underpin care work, innovative digital solutions such as ICT, assisting technologies, telecare, telemedicine, artificial intelligence and robotics can improve access to affordable high-care services quality and prove helpful in independent living[9]. They can also increase work productivity in the sector by taking over some of the labour-intensive or hazardous tasks of care workers, improving case management, improving health and safety, supporting remote monitoring of care users, and facilitating the training and recruitment of care workers. Investments in these technologies must also be accompanied by investments in digital skills, removing access barriers for people with disabilities and improving connectivity in rural and remote areas.

The European Commission supports a wide range of research and innovation in digital tools for active and healthy living and integrated, person-centred care. European policy promotes digital transformation, including the digitization of public services as part of Europe's digital decade, and digital public services that are inclusive and accessible to people with disabilities. The proposal to create a European Health Data Space[10] aims to enable individuals to share their health data with healthcare providers of their choice in order to obtain better healthcare. Although there is a wealth of effective practice and innovation in the sector continues to evolve, scaling up the use of innovative technologies and digital solutions in the area of care requires a framework to enable the transfer of good practice.

Today, there is a significant amount of technological and digital solutions supporting people at every stage of their lives, improving their home environment and supporting social ties[11].

5. Analysis of solutions currently used in the care for the elderly

5.1. Currently existing and applied solutions

The solutions related to the care for the elderly currently available on the market can be divided into different groups - depending on the type of solution, the need met, the sensors used, etc. It seems the most important use of IoT (Internet of Things) technologies, which are currently widely used. in every field, also to support the functioning of elderly people. The use of IoT can benefit the elderly by ensuring greater integration through the use of assisting devices, providing rehabilitation, monitoring the environment and vital signs. Possibilities of supporting the elderly through the use of IoT technology are listed below (Table 4) along with examples of the solutions used:

[8] *Transforming the future of ageing*, SAPEA, 2019

[9] "Communication from the Commission to the European Parliament, the Council, the European Economic and Social Committee and the Committee of the Regions on the European care strategy", 2022

[10] COM(2022) 197 final

[11] SAPEA, Science Advice for Policy by European Academies (2019), Transforming the Future of Ageing, SAPEA, Berlin

Table 4. IoT system support for the elderly and people with disabilities[12]

Condition	IoT support for the elderly and disabled population	Examples of publicly available systems/services
Chronic diseases	Remote monitoring of vital signs and automated delivery of medications	Abbott's CardioMEMS HF ™ system
Mobility impairments	Use of self-driving vehicles and/or systems to ride public transportations based on wearables and smart phones	Self-driving trolleys for the elderly in rural areas of Japan Ride hailing paratransit services for the elderly and senior citizens
Cognitive challenges and mental health	Treatment of certain types of mental health conditions (e.g., depression) via augmented and/or virtual reality Tracking of conditions and individuals (e.g., Alzheimer's disease)	VitaVita VR Kit for the elderly AngelSense GPS for Alzheimer's
Sensory and communication/voice challenges	Speech aid Hearing aids	Sonantic AI voice platform Oticon Opn™ and other
HandTalk	Mobile/wearable devices and applications to translate sign language in real-time	
Emerging infectious diseases/pathogens	Contact tracing and remote monitoring of vital signs	Covid Shield mobile application
Safety, wellness, and entertainment	Gait monitoring and automatic fall detection/recognition	Lifeline™ fall detection system and service

IoT solutions can also be classified in the following way:

Wearables are lightweight, sensor-based devices which are worn close to and/or on the surface of the skin, where they detect, analyse, and transmit information concerning several internal and/or external variables to an external device and, in some cases, provide immediate biofeedback to an athlete[13]. Some authors include smart phones and applications using smart phone sensors in this category. Mobile applications that do not use sensors but collect data for remote monitoring via the user typing on the mobile application (e.g., to collect physiological data) could be included in this category, as without their use the elderly or disabled person could not be monitored for certain conditions using self-reported health forms.

Smart infrastructures: these devices are statically deployed in buildings/dwellings with the goal of simplifying a consumers' life from the perspective of safety, security, comfort, and entertainment. This

[12] A review of IoT systems to enable independence for the elderly and disabled individuals; A. Perez et all, Internet of Things 21 (2023) 100653

[13] Düking P, Hotho A, Holmberg H-C, Fuss FK and Sperlich B (2016), Comparison of Non-Invasive Individual Monitoring of the Training and Health of Athletes with Commercially Available Wearable Technologies; Front. Physiol. 7:71. doi: 10.3389/fphys.2016.00071

category may include Internet-connected toys and robotic systems deployed at homes, nursing homes, museums, or hospitals.

Mobile IoT: this category encompasses bicycles, smart cars, drones, and others that people use either for transportation, comfort, or leisure.

IoT tools can, as shown in Rysunek 1, collect data from various sensors and sites, and then perform the analysis of the data and/or recognize patterns based on AI/ML algorithms and connect to other devices to provide feedback to the user or a third party.

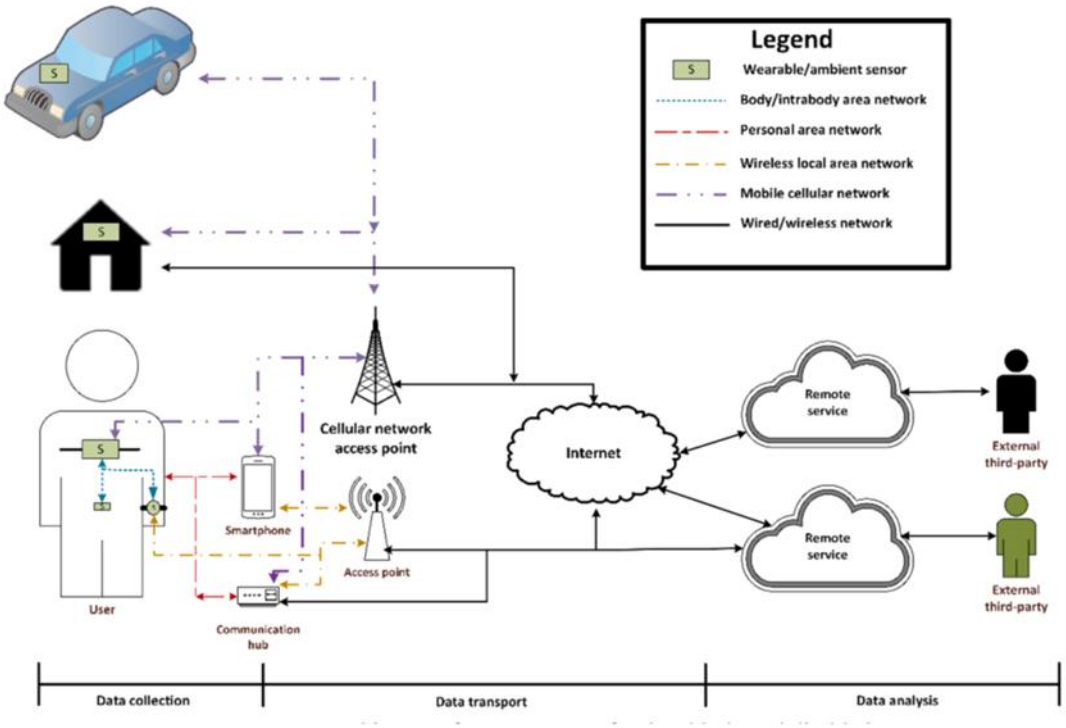


Figure 51. An architecture for IoT systems for the elderly and disabled[12]

Mobile applications developed for smart phones or other wearables are included as part of IoT systems even if they do not collect data automatically, but require manual input by the user, because without them the user does not have access to health services/health analyses/the ability to notify caregivers/healthcare professionals. In a 2005 report by the International Telecommunication Union, the definition of IoT devices included smart phones as IoT devices[14]. Additionally, some types of monitoring applications do not require physical sensors to assess health status.

IoT technologies and systems/solutions aimed at helping the elderly/disabled include the following:

1. IoT solutions for chronic diseases

Most IoT systems applied in the case of chronic diseases are wearable IoT devices and mobile applications for smart phones that can help elderly people and their caregivers monitor their health and notify them if they exceed established parameters. Chronic diseases whose parameters can be measured using IoT systems include:

[14] K. Ashton, That internet of things thing, RFID J. (2009) 4986

Hypertension – the oscillation method is used to perform the measurement with an iPhone by means of just a pressure sensor on the smart phone screen and the CCD camera sensor, without the need to use external sensors[15].

Cholesterol - cholesterol level testing can be performed by analysing the composition of blood drops and saving the test results in a mobile device (e.g. FORA Total Cholesterol Test Kit, LipidPlus) or non-invasively using IoT/wearable sensors by means of Near-InfraRed (NIR) light, which can be coupled with CCD sensors.

Heart disease – in this area, there are a number of solutions that measure various parameters using various methods. Heart rate measurement is often used, similar to many fitness solutions, and is performed by measuring changes in the absorbed light emitted by the sensor. A camera can also be used to track facial changes over time.

Diabetes – IoT devices are used for continuous and sporadic measurement of glucose levels and analysis of the results.

Depression and mental health - depression (and other mental health) monitoring systems can track three types of signals: behavioural, physiological and social[16]. Data related to these signals may be collected via wearable sensors, smart phone cameras and/or external IoT devices (for tracking facial and eye features that can be used to detect depression, such as micro expressions), mobile phone data, and data/ web search/navigation meta data (e.g. text messages, duration and frequency of phone calls, websites visited). The sensors, combined with intelligent algorithms, can then detect changes in the user's mood.

Alzheimer's disease/dementia - IoT solutions for people suffering from Alzheimer's disease or dementia can be used to help locate them. Additionally, continuous environmental monitoring can help track a patient's current physical and emotional condition. IoT systems are also used to diagnose Alzheimer's disease and dementia.

2. IoT solutions for mobility impairments

Many elderly people (40% in the USA) suffer from motor impairments, including both gross motor skills (moving/walking) and fine motor skills (e.g. manipulating objects). IoT solutions support them in three areas:

- Outdoor/long distance – self-propelled strollers, easier use of public transport;
- Indoor/short-distance – wheelchairs, walkers, orthopaedic devices;
- Activity support for manual activities - e.g. the Liftware intelligent spoon.

3. IoT solutions for sensory and communication/voice challenges

In this area, we can distinguish, for example, mobile/wearable devices that perform sign language translation in real time using AI/ML algorithms.

4. IoT solutions for emerging infectious diseases/pathogens

Dynamic development of this type of solutions took place during the Covid-19 pandemic, where not only the physical problems faced by elderly people were indicated, but also discussion began about the impact of social isolation on the mental condition of elderly people. IoT solutions were used during the pandemic to track patients and interpersonal contacts, as well as remotely monitor their health and communication.

[15] A. Chandrasekhar, K. Natarajan, M. Yavarimanesh, R. Mukkamala, An iPhone application for blood pressure monitoring via the oscillometric finger pressing method, Sci. Rep. 8 (2018)

[16] S. Abdullah, T. Choudhury, Sensing technologies for monitoring serious mental illnesses, IEEE. Multimedia 25 (2018)

5. IoT solutions for home safety

The idea of smart homes has been developing for a long time, and home automation systems based on IoT allow you to control home parameters, use voice control, save energy, etc. Currently, a number of solutions dedicated to elderly people have also become available. One such example was described by Suzuki et al[17]. The proposed system uses a Raspberry Pi IoT device with motion, temperature and humidity sensors. The purpose of developing the system was to provide the elderly with maximum privacy, hence the lack of use of cameras and microphones. The system can send messages to relatives in the event of anomalies such as long bathing time, too high room temperature, or the appearance of strangers.

Hua i in[18] proposed a monitoring system that intelligently tracks the activities and movements of an elderly person at home. The system is based on the Intel Edison platform and consists of three sensors (temperature, heart rate sensor and accelerometer) to measure body temperature, heart rate and acceleration values to detect various types of movements, including falls. Pinto et al[19] developed an IoT-based system called "We-Care" that collects data and monitors the elderly in their homes. The basic framework of the system includes three components: the We-Watch band, the We-Care platform and the cloud platform.

Robots used to interact with patients have also appeared[20] but research in this area is still very limited.

The Table 5 presents examples of scientific research describing the use of IoT technology in smart home solutions.

Table 5. Examples of IoT systems for smart homes to support the elderly and disabled[12]

IoT system	Services	Technologies	Evaluation of efficiency	Literature
Watch-Over system	Tracks the safety of elderly at home	Motion, temperature, and humidity sensors, Raspberry Pi, Bluetooth Low Energy (BLE), BLE beacons, Twitter	Model evaluated for efficiency	H. Suzuki et al., An updated watch-over system using an IoT device, for elderly people living by themselves[17]
IOT cares for elderly (ICE)	Tracks actions and movements of the elderly at home, provides secure entrance door access to guests	Intel Edison platform, temperature sensor, pulse sensor, accelerometer, WiFi	Model evaluated using real hardware was found to be 98.90%, 98.49% and 90.0% accurate for the measurement of body temperature, pulse rate and fall detection respectively	N.D. Chung Hua, et al., Internet of things (IOT) monitoring system for elderly[18]

[17] H. Suzuki, Y. Kiyonobu, T. Mogi, K. Matsushita, M. Hanada, R. Suzuki, et al., An updated watch-over system using an IoT device, for elderly people living by themselves, Proceedings of the 3rd International Conference on System Reliability and Safety, ICSRS 2018, 2019

[18] B.D. Chung Hua, H. Fahmi, L. Yuhao, C.C. Kiong, A. Harun, Internet of things (IOT) monitoring system for elderly, in: Proceedings of the International Conference on Intelligent and Advanced System, ICIAS 2018, 2018

[19] S. Pinto, J. Cabral, T. Gomes, We-care: an IoT-based health care system for elderly people, in: Proceedings of the IEEE International Conference on Industrial Technology, 2017

[20] C. Lee, S. Park, Y. Jung, Y. Lee, M.J. Mathews, Internet of things: technology to enable the elderly, in: Proceedings of the 2nd IEEE International Conference on Robotic Computing, IRC 2018, 2018, 2018-January

We-Care prototype	Tracks physical movements and vital signs	Sensors, CC2650 MCU SensorTag, Bluetooth Low Energy 4.0, 6LoWPAN over the IEEE 802.15.4, Contiki-OS	Model evaluated using real hardware	S. Pinto et al, We-care: an IoT-based health care system for elderly people[19]
IoT Android application	Monitors safety and well-being of home residents, provides front door access using facial recognition, tracks sanitation conditions in the home	Raspberry Pi, sensors, servo motors, Firebase Cloud Messaging (FCM) server, open source computer vision, and Node.js web server, Android application	Model not evaluated for efficiency	C. Lee, et al, Internet of things: technology to enable the elderly[20]
Robotic environments	Support for navigation, companionship, and various forms of interaction with human beings	Assisting robots with sensors and actuator. Sensors include a camera, touch sensors, infrared and stereo sound. The robots have four legs, a moveable tail, and a moveable head	The model was evaluated for efficiency with the conclusion that active communication with a robot using a human face instead of devices (e.g., keyboard) improves the learning ability of the robot and enables better response to human users	MHeerink Broekens, H. Rosendal, Assistive social robots in elderly care: a review, Gerontechnology[21]
IoT based home automation	Home automation system for controlling home appliances	Arduino Mega board, rain sensor, temperature sensor, Light Dependent Resistor (LDR), WiFi module, relays, LCD display, buzzer, servo motor, L293D motor driver IC, MAX 232 and light bulb	Model not evaluated for efficiency	P.S. Nagendra et al, An IoT based home automation using android application[22]

[21] MHeerink Broekens, H. Rosendal, Assistive social robots in elderly care: a review, Gerontechnology 8 (2009)

[22] P.S. Nagendra Reddy, K.T. Kumar Reddy, P.A. Kumar Reddy, G.N. Kodanda Ramaiah, S.N. Kishor, An IoT based home automation using android application, Proceedings of the International Conference on Signal Processing, Communication, Power and Embedded System, SCOPES, 2017

Automated curtain system	Home automation system for easy and independent living	Microcontroller MSP-430, light and motion sensors, Universal Asynchronous Receiver Transmitter (UART), IEEE 802.15.4, IPv4, IPv6	The model was evaluated using real hardware and demonstrated suitable mechanical performance and minimal energy consumption	L.C. Souza et al., An IoT automated curtain system for smart homes[23]

However, scientific literature indicates the following limitations in the use of IoT solutions to support the elderly[12]:

- Difficulty in understanding GIU interfaces on smart phones and controllers, problems remembering voice commands, speech disorders/slurred speech, fine motor problems making it difficult to use interfaces
- The need to ensure constant power supply to IoT devices
- Security and privacy issues – not all IoT systems feature appropriate security measures
- Incompatibility of systems and devices – the lack of appropriate protocols and standards often makes it difficult or impossible to use IoT devices from one supplier with the systems from another
- Understanding context - the use of AI/ML algorithms makes IoT solutions "intelligent", giving them the ability to make decisions based on data from sensors. However, many IoT services cannot dynamically adapt to the environment and respond to changes in the context of a specific person. The development of contextual tools will allow for better adaptation of services to the elderly and their individual needs
- Concerns about providing long-term support – many IoT solutions have been developed by start-ups. Due to the need to perform, for example, a long-term certification process, some users may not receive support in the event of bankruptcy of the entities implementing the solutions.

In practical terms, competitive solutions can also be divided into:

1. E-health solutions that allow you to monitor users' vital signs, save data, analyse them, and draw conclusions about the patient's health status. This group includes both "life bands" that monitor user parameters and comprehensive telemedicine platforms/systems that, in addition to monitoring, provide data analysis and communication with professionals.
2. "Smart home" solutions, allowing for more or less comprehensive monitoring of the user in the home environment.
3. Mobile applications promoting well-being and games with mental exercises
4. Predictive solutions enabling early detection of dementia
5. Hybrid solutions that introduce tools enabling holistic care for the elderly

[23] L.C. Souza, J.J.P.C. Rodrigues, G.D. Scarpioni, D.A.A. Santos, V.H.C. De Albuquerque, S.K. Dhurandher, An IoT automated curtain system for smart homes, in: Proceedings of the International Conference on Advances in Computing, Communications and Informatics, ICACCI 2018, 2018

For the purposes of this analysis, the groups were divided as follows:

1. **The successful existing hybrid solutions for adults (+ 55 years old) and elderly people in your country.** By hybrid solutions we mean solutions that combine digital (technical) aspect with personalised approach and come with the organizational model (holistic solution).

Table 6. Sample of successful existing hybrid solutions for adults from the European market:

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. Parameter 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, they 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 application for elderly people	Social	Magda is the first Slovenian mobile application for elderly 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. It's 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

2. Cognitive impairment prevention in the home care setting

Table 7. Sample of cognitive impairment prevention from the European market

Solution	Main area, additional area	Brief description
BRAINER, PROFESSIONAL BRAIN TRAINER	mobile games; physical decline prevention 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.
Neocogita 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: • Completing proverbs • Guessing fairy tales • Recognising sounds • 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.

3. Physical decline prevention in the home care setting

Table 8. Sample of physical decline prevention solutions from the European market

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 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 a smart, autonomous 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 on 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, 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 a textile technology that allows the system to be integrated into 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 a 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 smart phone Emergency call using 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 him 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
Alarm system Halo help	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 the 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.

4. Social isolation prevention in the home care setting

Table 9. Sample of social isolation prevention solutions from the European market

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. With 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.

Within each group, it was also indicated whether the solution was based on hardware elements collecting data from external sensors. Below, you can find an in-depth description of the representatives of each group, while a full analysis of all solutions is attached as Appendix 1 to this document.

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

5.1.1.1. KWIDO

https://kwido.com/

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.

Kwido platform consists of 3 complementary modules:

Figure 52. Kwido solution

- **Kwido health**: telemedicine software for remote monitoring of health variables in elderly people in residential facilities or at home. It includes alerts, following up patient's compliance, direct connection with family members and therapists through multi-device video calls. There is also an application for mobile phone or tablets where professionals can obtain daily daily health data updates.
- **Kwido Mementia**: multi-device cognitive stimulation platform designed to combat and detect cognitive deterioration of the elderly, even from home. The platform enables the therapists to complement the exercises provided in written form with a more dynamic and stimulating method, reducing costs of therapies. There are thousands of cognitive exercises at their disposal, which can be adapted to the cognitive level of each user. Exercises influence various cognitive functions and abilities: attention, calculation, executive functions, language, memory and orientation. Therapists get real-time information about patients' training in an intuitive and visual form. They can access a multitude of data, such as the evolution of the general cognitive index, emotional state, user evaluations of the exercises, and much more. Moreover, it allows to analyse their progress and compare it to that of other users. Also, professionals can create their own personalized games incorporating their own resources into the platform, including photos and references from the family environment. The platform works in both independent (the system analyses the initial cognitive level and offers full training plan) and professional mode.
- **Kwido Home**: home monitoring system. It is a network health solution that transforms homes into smart homes that monitor and facilitate better care for the health of elderly people. Kwido Home offers monitoring possibilities, both inside and outside of home, according to the provider's needs. It uses an autonomous non-invasive sensor system: a central device and a series of sensors and beacons are attached to a range of everyday objects and/or household furniture, as appropriate. The system works in a predictive way: these devices send data on behaviour and routines to an intelligent system that analyses them and sends alerts in unusual situations that deviate from the established pattern. The system can detect irregular physical activity, unusual presence, frequencies of use (e.g., toilet, refrigerator), changes in habits. In addition, it can be adapted to different needs according to the degree of dependency. It also involves family members through an advanced alert system.

The collected information is analysed and unnecessary interventions by caregivers are avoided. The system ensures the independence of the patient and greater efficiency in the service of the care provider, avoiding hospital admissions and interventions.

Kwido Health offers:

- Teleconsultation

- General reminders, compliance control, tasks, agendas, messages
- Alert system
- Health parameter monitoring: weight, blood pressure, heart rate, temperature, glucose, cholesterol, oxygen
- Video calls
- Image, video, music sharing. Link to websites and message systems

Kwido Mementia offers:

- Games for cognitive stimulation targeting various cognitive functions
- Definition of a general cognitive index, assessment of emotional state, self-evaluations
- Incorporation of personalized games/resources
- Automatic assessment of the initial cognitive level and full training plan
- Real time results and performance monitoring

Kwido Home offers:

- Behaviour monitoring and tracking
- Detection and alerting of abnormal behaviours

Target group:

- Elderly people: all modules are created for elderly people at home or in residential care facilities. Therefore, they can use the application for teleconsultations with professionals, monitoring health parameters and taking advantage of the cognitive stimulation platform. Thanks to the possibility of adding personalized exercises for cognitive stimulation and adapt the level of difficulty, the platform can be used by healthy elderly people, people with age-related memory loss, people with slight cognitive impairment, and people with moderate cognitive impairment.
- Professionals: video consulting, health parameter monitoring, cognitive performance monitoring, behaviour abnormality detection, alert for abnormal behaviours, access to progress monitoring in real time.
- Informal caregivers: video calls, health monitoring, cognitive monitoring, behaviour pattern monitoring

5.1.1.2. DIPAS

https://www.care4u.it/it/

Care4u has been developed by 4 companies to implement medical solutions. Care4u is highly specialised in the IT sector, and it is aimed at providing the community with technology and experience to improve and promote well-being. It also offers ad hoc innovative solutions for the digitisation and optimisation of various business processes through the development of customised software.

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.

The system allows to monitor people through the use of special sensors and software indicating a person's health status, detecting the exact location of the person, as well as emergencies, with a special alarm

system that notifies a mobile and fixed (monitor) device about the need to intervene. The system can also provide home teleassistance, providing useful social and health support in the treatment of chronic diseases.

Sensors include pressure and humidity sensor for bed, contact sensor for doors and windows, Bluetooth Low Energy Beacons and BLE scanner for the detection of nearby BLE Beacons facilitating geolocalisation, and bracelet with integrated pulse detection and pedometer. Thus, sensors can detect entering/leaving the room, movements in bed, falls, enable geolocalisation, and pulse measurement.

Iot Platform is used to manage, monitor and control devices. It allows to access information, user profile, send notifications and alarms to mobile devices. The mobile application is compatible with Android and iOS.

For home care, the solution integrates Digital Health Coach platform, a class II medical device developed by Ageing Tech S.r.l. company. Therefore, in addition to behaviour and environment monitoring, it is possible to integrate devices to monitor health parameters, such as oxygenation, temperature, glucose, weight, blood pressure and heart rate. Moreover, the platform allows to access a list of services and keep in contact with physicians through videocalls and remote monitoring. The system also allows to create a proximity network to interact with other people, and volunteers.

Functions:

- alarm system
- teleassistance from home
- movement in bed
- exiting/entering rooms
- fall detection
- pulse detection
- geolocalisation
- integration of digital health coaching platform

Target group:

- elderly people at home or in residential facilities
- professionals monitoring the health status of elderly people

5.1.1.3. TICURO REPLY

https://www.reply.com/it

https://www.reply.com/ticuro-reply/it/

Xenia Reply is the Reply group company dedicated to hospitality and telemedicine services and products, created to respond to the challenges of the new post-pandemic healthcare and anticipate both the trends in the technological and organizational evolution of the services provided in the new hospital-field healthcare ecosystem. Xenia brings together and takes advantage of the operational and consultancy synergy, developed by the Reply network in public and private healthcare within over 15 years of experience, to accompany healthcare structures in the digital transformation of personalised care pathways (Patient Journey) and access to the service (Service Design) with public and private stakeholders and with the orchestration of interoperable services with the National Health Service.

Xenia Reply has taken part in some European projects, such as InCASA project funded by the European Commission that aims to improve the quality of life of the elderly dependants and reduce periods of

hospitalisation, thanks to an innovative system for monitoring clinical parameters and creating a profile of frail individuals' daily routines.

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.

Ticuro Reply is a platform for telemedicine and telemonitoring. It integrates more than 50 devices offering various functionalities:

- Telemedicine: professionals and users can share health records and information in a safe way. People can access their health information on-line. Data gathered from other devices are transferred automatically to the platform. Professionals can collaborate by sharing documents directly via connected devices. The solution can be used both in desktop mode and on mobile devices. Secure Audio/Video connection between professionals and people with real-time data exchange.
- Behavioural analysis: through environmental sensors, the system can learn person's habits and identify abnormal situations. For instance, the system can analyse resting hours, use of services, entering/exiting. When needed, the system automatically generates alarms that are sent to professionals and carers. Professionals can use data collected to intervene in the case of unhealthy behaviour and prevent decline.
- Vital signs monitoring: data are acquired through wireless medical devices, following telemonitoring plan defined by a physician. If a measured value goes beyond a predefined threshold, an alarm is generated automatically. Measurement of parameters can be performed independently or via Point of Care established at various locations, e.g., pharmacies.
- People involvement: a notification system alerts the patient when a specific activity must be performed (e.g., pill to take, measurement to take, exercises to perform).
- Personalization of care: starting from specific information about the person, telemonitoring, rehabilitation training, pharmacological therapy can be personalized by professionals. The platform analyses lifestyle and proposes goals to achieve by stimulating the person to carry out the activities required by plans defined by specialists (e.g., taking medicines, performing measurements, exercises, etc.).

Functions:

- Telemedicine
- Behavioural analysis
- Vital sign monitoring
- Notification system
- Personalization of care

Target group:

- elderly people: timeliness of response to clinical/health needs, prevention and centralized control of health data
- Professionals

5.1.1.4. Silver technologies

http://www.silvermonitor.care

Silver technologies develop and market easy-to-use consumer technology products and services - Silver monitor, designed towards improving the lives of the senior population. Silver monitor smart watch, a biometric mobile data and voice communications device, in combination with the Silver monitor web application, allows remote monitoring of blood pressure, heart rate, activity, and geolocalisation in real-time. It provides a tightly integrated system enabling interaction between the seniors, caregivers, and healthcare professionals.

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. Parameter measurements are collected every 15 minutes. They enable us to achieve a precise understanding of senior's overall health status.

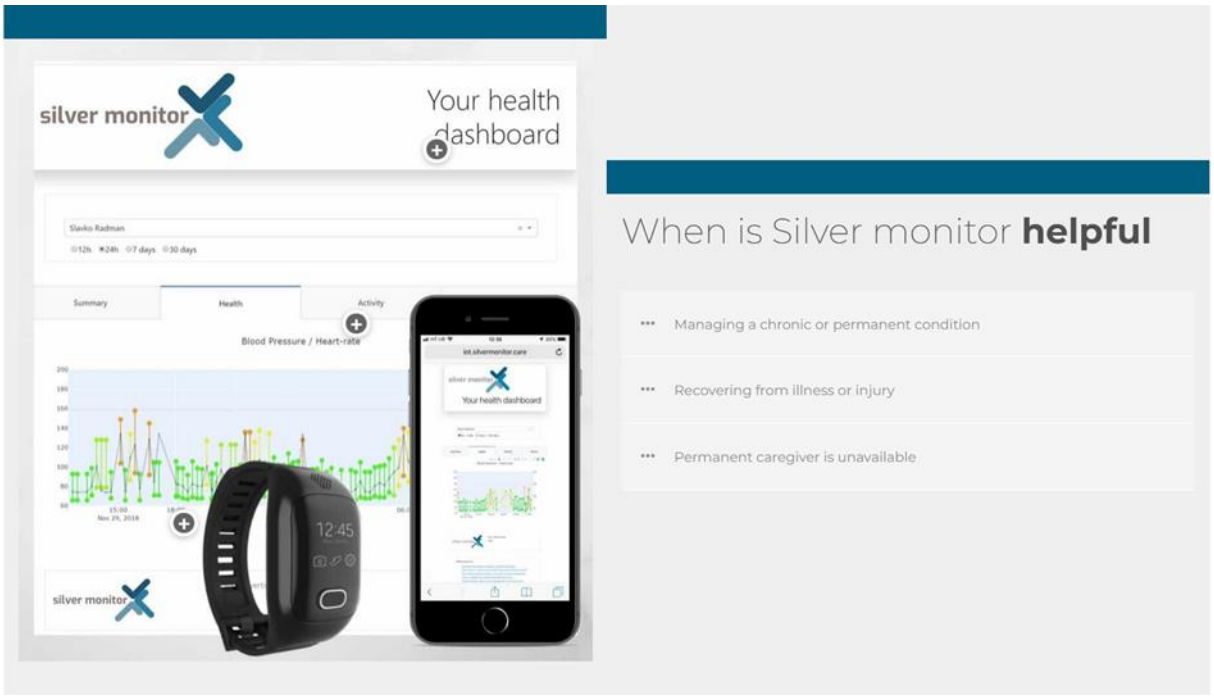


Figure 53. Silver Monitor[24]

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, they will be certified as a medical device.

Functions:

- Continuous heart rate monitoring.
- Continuous blood pressure monitoring.
- Continuous activity monitoring.
- SOS alarm activated in case of an emergency.
- It can be used under water for 30 min.
- Location finder helps if a senior gets lost.
- It activates alarm if the person leaves a designated area.

[24] https://silvermonitor.care/

- Detects falls and activates an alarm.
- Records a voice message and sends it via a device.

Target group:

- seniors and less mobile population living alone or in remote areas

5.1.1.5. E-Oskrba

https://www.telekom.si

E-oskrba is a social service that enables all-day connection via a personal telephone alarm - remote protection.

The main objective is to increase access to social telecare or tele-guarding services with a 24-hour connection via a telephone alarm. The primary aim is to provide the elderly, chronically ill, and disabled people with a higher quality of life and the longest possible independent stay in their home environment, to relieve families from the constant care of their relatives and, therefore, to relieve chronically overcrowded and understaffed institutional care facilities. An added value of the service is the 24-hour assistance centre, which responds to calls for help and provides appropriate action (first aid or family call).

The basic E-oskrba package includes:

- A security phone with a call-for-help button

Figure 54. E-oskrba security phone

A security phone is a device you use to communicate with the assistance centre for a hands-free conversation via a speaker and microphone. The phone is connected to any accessories you have chosen to use.

- A bracelet with a call-for-help button

Figure 55. E-oskrba bracelet

The bracelet is a portable device that can always be worn and can be used to call for help remotely. It is connected to a security phone. If you need help, press the blue button on the bracelet, and a call for help will be made to connect you to the assistance centre. You speak to the assistant via the speaker and microphone on your security phone. It is waterproof, so you can wear it even when showering. It is designed for use inside your home (signal range of up to 100 metres).

- SIM card with direct connection to the assistance centre.
- Assistance services 24 hours a day.

How it works:

Figure 56. E-oskrba functioning

Additional equipment:

- Mobile motion detector on a pendant to call for help

Figure 57. E-oskrba mobile motion detector

In case you need help, press the blue button on the pendant, and a call will be made to the assistance centre. You speak to an assistant via the speaker and microphone on your security phone. Unlike the bracelet, the pendant has an additional fall-detection function. In the event of a fall, a call for help to the assistance centre is triggered automatically.

** The premium accessory (motion sensor and door sensor kit) is currently unavailable due to supply disruptions or shortages in the global market.*

- Smoke detector

Figure 58. E-oskrba Smoke detector

The detector sounds an audible alarm to warn of a higher concentration of smoke, which can indicate a fire and trigger a call to the assistance centre.

- Switch with a string to call for help

Figure 59. E-oskrba Switch

The switch allows the user to initiate a call for help via the security phone by pulling the string attached to it. The pull cord switch is normally installed in the bathroom.

- Carbon monoxide detector

Figure 60. E-oskrba Carbon monoxide detector

A carbon monoxide detector is a sensor that detects an increase in the concentration of carbon monoxide in a room and automatically triggers a call to the assistance centre via the security phone. It also alerts the user with an audible warning. It shall be installed in the room where the combustion units are installed.

- Water leak detector

Figure 61. E-oskrba water leak detector

Detects large amounts of water, alerts the user with an acoustic signal, and calls the assistance centre.

Target group:

The main target groups are the elderly, chronically ill, and disabled people and their carers. In particular, people aged 65 or older who, as a result of illness, frailty, injury, disability, lack or loss of intellectual capacity, have a limited capacity for self-care or spend most of the day alone and do not benefit from all-day forms of institutional care.

What does it offer to users?

- 24-hour security.
- Independent or less dependent living in own home.
- Smoke (fire safety) and water leakage (flood safety) detection.
- Calling for help even when they cannot initiate a call themselves.
- Easy to use and install without drilling or special wiring.
- Quick adaptation to changing needs of the user thanks to extended functionality.

What does it offer to their carers?

- Constant contact with relatives and a sense of security.
- Easier coordination of daily tasks.
- Quick notification in case of a call for help.
- Professional support from trained staff in the assistance centre.

5.1.1.6. MAGDA - Mobile application for elderly people

https://simbioza.eu/digitalne-resitve/magda

Magda is the first Slovenian mobile application for elderly 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.

Figure 62. MAGDA - Mobile application for elderly people[25]

The MAGDA application combines the following functions:

1. important contacts (SOS numbers) that seniors can access with the call button within the application,

2. News from a wide variety of fields (Current news, Health, Digital, ...),

3. Info point with the possibility of reviewing public, non-commercial and commercial service providers according to the user's location,

4. Classroom with text and video lessons from various fields for learning new skills (Using a computer, Using the Internet, Using smart phones, Cooking , ...),

5. Gym with text and video exercise programs, prepared by the experts from the Fitness Clinic with the aim of enabling seniors to be active and have fun in the comfort of their own home, 6. Events with current reviews

Target group:

[25] https://simbioza.eu/digitalne-resitve/magda

- Elderly people

5.1.1.7. DECT teleoskrba

https://teleoskrba.eu/

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.

DECT Teleservices provides the possibility to call for help when it is necessary and urgent. In the event of sudden weakness, a fall or other unexpected situation, a telecare pendant can help to communicate with loved ones or outside help. The pendant is simply worn around the neck so that it is always close at hand. It is connected via a DECT signal to your telephone base station or router such as Gigaset or Fritzbox.

You can also enter various reminders into the telecare pendant, which the pendant plays independently at a certain time. When a call is made, the pendant tells us the number of the person making the call, and if the person making the call is stored in the phone book, the pendant also tells us who is calling.

As the entire process is conducted via voice messages and with one main button and 2 auxiliary buttons, the pendant is also suitable for use by the blind or people with partially impaired vision.

Figure 63. DECT pendant worn

Teleservices

Smoke alarm detection: DECT Teleservices reliably detects smoke alarms from all types of smoke detectors and activates a sequence of calls for help. A voice assistant informs the contacted person about the smoke alarm and its location. Additional information can be added, such as home access information. You define what information is announced in case of a fall or smoke alarm. DECT Tele-Supply monitors the situation until the smoke alarm is switched off.

Time reminders: You can set reminders on your DECT device, for example, to make sure you don't forget to take certain medicines. You can set up to 5 such notifications per day, according to time and content. The integrated voice assistant reads these instructions loudly and clearly, indicating the current time.

Fall detection: At the touch of a button, you can designate the people to call for help with everyday problems. Set 3 numbers to call in case you activate an emergency call. The integrated voice assistant provides information on the status of calls and the people you are currently calling. This contributes significantly to reducing tension in panic situations. An intelligent "call manager" ensures that the sequence of calls is carried out in safely.

Daily contact with family and friends: DECT makes it easy to take or receive personal calls. The integrated voice assistant is particularly valuable here: it reads the names from your individually created phone book. To make hands-free calls with high sound quality and volume, you only need to press the central call button.

Voice assistant: A special feature of the DECT device is the integrated voice assistant (iVA), which is also available in Slovenian. Voice support is very useful, especially for elderly people. It also ensures that there is no panic in emergency situations. For outgoing and incoming calls, the names associated with the phone number are read out. In an emergency (fall, smoke), personal details and information can be forwarded to the number called. iVA also gives valuable tips for everyday use, including, of course, the need to charge the battery and much more.

Target group:

The DECT Pendant is particularly suitable for:

- elderly people living alone
- elderly people with visual impairment
- people with dementia
- blind people
- and also for all those who:
- need a comfortable telephone for home use
- need a good quality conference phone
- talk a lot and need their hands free

5.1.2. Cognitive impairment prevention in the home care setting

5.1.2.1. Brainer – Professional Brain Trainer

https://www.brainer.it/

Brainer was founded in 2006 on the impetus and vision of Dr Giancarlo Bertoldi, a neurologist, founding partner and current president of the company. In 2010, Brainer received renewed impetus and vigour when Sandro Sartor, the current CEO, joined the company. Sartor, a successful manager in multinational contexts, introduced managerialism and strategic vision. Further impetus and solidity came in 2015 thanks to collaboration with Integrated Solutions. an IT consulting company, IS, a partner of Italy's most important industrial group, provides technical and managerial support.

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.

Brainer ecosystem is composed of:

- *Brainer professional*: 77 exercises targeting 5 cognitive functions (attention, executive functions, learning and memory, language, perceptive-motor skills). There are 3 levels of difficulty and, on average, 5 exercises for each level. Each exercise does not take more than 3 minutes. There are various stimuli included: images of animals, food, daily life objects, figures, colours and sounds. Users receive feedback about the correctness of responses. Touch screen devices must be used.

- *Physiotherapy videos*: 138 videos lasting from 90 to 120 seconds. 7 categories of videos: coordination, cues, balance, preparatory exercises, postural, sequences, exercise mat. They can in turn be broken down into subcategories that refer to the position assumed when performing them: sitting, supine, standing, exercise mat. Thanks to the demonstration videos, the patient is assisted in mimicking the recommended movements. At the end of each video, the patient is asked to carry out a self-assessment to determine the difficulty encountered in performing the exercise.
- *Stories*: 2 stories consisting of different exercises in which the user has to perform tasks that reflect what happens in real life. The proposed situations depict concrete everyday problems (remembering to perform actions in a certain order, making decisions, organising information, etc.). The various phases of this type of exercise are closely linked to each other and are based on the principle of cause-effect.
- *Real-life games*: sets of exercises that target specific cognitive functions. Exercises are strongly contextualised in three distinct environments: home, supermarket and station. The process the user performs is as follows: they visualise the environment in which they can 'look around' by 360° rotation of the point of view. They choose and click the path referring to the direction in which they want to proceed. They advance along the chosen path and arrive at the destination, in the area chosen at the start of the 360° navigation (e.g., fruit and vegetables) Within the area, they clicks on a focal point to start the planned exercise.

The tool offers:

- Cognitive exercises targeting different cognitive functions to be performed in the presence of a professional
- Cognitive exercises targeting different cognitive functions to be performed at home
- Real-life games
- Physiotherapy videos
- Medical record
- Personalized programs of cognitive exercises
- Progress and result analysis

Target group:

- Neuropsychologists: Brainer can be a tool to provide patients with a variety of cognitive exercises, personalized cognitive rehabilitation programs, and monitor progress.
- Older people: prevention of decline
- People with rehabilitation needs

5.1.2.2. Mensana

https://mensana.brainer.it/index.php

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.

Web-based application that consists of exercises presented in the form of 'games' with different stories and settings. Each game represents a specific cognitive function (memory, attention, concentration, reasoning, speed of thinking, planning and organization, etc.).

Exercises are culture-free, independent of cultural knowledge.

The platform allows to independently choose exercises a person thinks are the most appropriate based on 5 levels of difficulty. It is also possible to follow a “personal trainer” that uses one's cognitive profile to recommend the exercises to perform to ensure constant improvement. From time to time, it will evaluate progress and determine the mix of exercises on the level of difficulty most appropriate for an individual.

The platform allows to challenge friends and relatives on cognitive activities, to find the level of cognitive reserve and, if there are exceptional results, it is possible to be included in a regional and/or national ranking which, in relation to age and the level of education, recognises the most brilliant people.

Target group: people aged 55 on average

5.1.2.3. Neocogita system

http://www.neocogita.com

Neocogita's mission is to guide people to reach increasing levels of well-being, through the power of exponential technologies. It aims at enhancing people’s well-being through the combined use of neurotechnologies, Artificial Intelligence and information and communication technologies, while exploiting the natural human propensity to adapt to changing and complex life.

Areas of expertise: Cognitive training, Cognitive industrial applications, Brain wellness, Leadership, Neuroleadership, Mindfulness, Wellness, HR Training, Human Resources, Training, Meditation, Biofeedback.

Neocogita is part of AliasNet Holding (Italy) that focuses on specialized market and industry knowledge, operating according to an innovative vision.

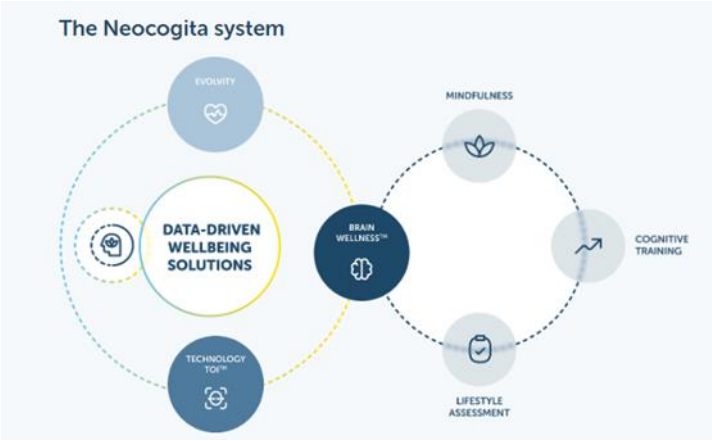


Figure 64. The Neocogita system

- 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. The company administrator (typically the CHRO) has access to aggregated and anonymous data indicating the level of well-being.
- 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. Neocogita’s Lifestyle Assessment is a biofeedback sensor that allows to assess the quality of lifestyle by correlating it with well-being and performance. It offers audio-guided meditation courses to concentrate on relaxation and focusing techniques. Neocogita’s Cognitive Training is composed of targeted and adaptive computer-based exercises specifically designed to enhance attention levels and intellectual abilities. All the educational games are the result of decades

of research and have been developed by Neocogita on the basis of scientific protocols. Brain Wellness™ platform can be accessed from all devices.

- TOI™ Technology: The innovative, patented Transdermal Optical Imaging (TOITM) technology allows users to get a report of their physical and mental health in just 30 seconds. The technology is based on a face scan that uses advanced image processing and machine learning techniques to capture changes in facial blood flow using a standard camera found in any smart phone. TOI™ technology is based on the fact that human skin is translucent, and the subcutaneous tissue contains blood vessels and melanin. The subcutaneous layers reflect different wavelengths (e.g. RGB). The facial blood flow data (only the data, not the images taken) is then sent to a cloud server to be processed by an engine that applies advanced artificial intelligence models to predict physiological and psychological conditions. It measures: general parameters (general well-being index), vital signs (heart rate, irregular heartbeats, respiratory rate, systolic and diastolic blood pressure), physiological parameters (heart rate variability, cardiac workload, vascular capacity), mental parameters (mental stress index), physical parameters (waist-to-height ratio, body shape index, body mass index), general risk (risk of cardiovascular disorders, risk of stroke, risk of heart attack, risk of hypertension), metabolic risks (risk of hypertriglyceridemia, risk of hypercholesterolaemia, risk of diabetes) psychological parameters (anxiety, depression, mental fatigue).

Functions:

- Health status monitoring (physical, mental and psychological)
- Mindfulness
- Cognitive Training
- Lifestyle Assessment
- Face scan to predict physiological and psychological conditions

Target group:

- Companies
- Employees
- General public

5.1.3. Physical decline prevention in the home care setting

5.1.3.1. HTN Telemedicine

https://www.e-htn.it/

An application containing all the user's health information, accessible at any time. It also records the patient's biological parameters. The application allows users to monitor numerous biological parameters (blood pressure, glycaemia, transcutaneous monitoring of oxygen, body weight, physical activity, electrocardiogram) in real time and save the values in their personal health records.

All data can be visualized and analysed at any time or presented to the GP, who can use it to optimize his/her indications to improve patients health and lifestyle.

If necessary, the user or the GP can ask a pharmacist of the national pharmacies network Federfarma HTN to provide them with a user name and password for accessing the health records and include further clinical

information, health services, laboratory analysis, diagnostic images therapies or any other information that can be useful as medical history in a single archive, always available and immediately accessible.

Upon payment it is possible to receive a report signed by a HTN specialised physician summing up all saved information, with a comment on all the available data, values, correlation and evolution over time.

Figure 65. HTN Telemedicine[26]

Target group: Adults above 18 years of age

5.1.3.2. eLifeCare Telemedicine platform

https://www.exprivia.it/en-tile-elifecare-telemedicine-for-the-doctor-patient-relationship/

eLifeCare is a telemedicine platform that offers a set of solutions and services provided by Exprivia for Teleconsulting, Telereporting, Telepresence and Telemonitoring to support all operators involved in the care and monitoring of a patient at home.

The eLifeCare platform radically changes the approach to patient's home care by providing the technological infrastructure and all the services necessary for the complete and integrated management of all the health care processes and services, available and usable on any device:

- Remote monitoring
- Telemedicine and Teleconsulting

[26] https://www.e-htn.it/

- Monitoring of drug supply
- Reporting and filing systems
- Patient's medical history in electronic folders

The platform is based on a web application used by the Control Room operators to monitor and manage all patients in real time, by acting as an operating intermediary between the patient and the medical team or specialist who is treating the patient. The same application can also be used on a smart phone or a tablet by specialists who can access the platform to consult the clinical record data concerning the therapy, vital signs, etc. and, if necessary, modify the treatment by sharing specific therapeutic protocols as well as consulting any reports to support the therapy.

The clinical folder designed by Exprivia is based on a single clinical management system, referred to as eFolder, for all care episodes, at the service of all clinical operators. The eFolder set of clinical functions (diaries, pharmacotherapy, measurements, graphics, alerts) is supplemented with the specific functions of the operating environments, but the clinical data are stored in a single cross-episode database. The Exprivia folder, therefore, supports all episodes at the service of the various clinical operators and in different settings.

The eLifeCare platform offers specific mobile applications for patients that support active participation of the patients themselves, the care giver or the home team, and allow remote management of:

- Provision of patient's home care on the basis of the Care Plans.
- Measurement of vital signs.
- Videoconsulting sessions.
- Patient geolocation.
- Administration of pharmacological treatment.
- Request for supply of medicines.

RadFlow is a module of the eLifeCare platform that supports medical teleconsulting and the related document flow, which includes reports, images, films and biometric parameters of the patient, made up as follows:

- Network for the management of requests and provision of Teleconsultation services.
- Wide range of supported files (PDF and XML/CDA2 documents, Dicom and non-Dicom images and videos, ECG, etc.)
- Flexible setup environment for creating request and report forms
- Alert systems in case of emergencies (sms, email)
- Digital signature for requests and reports as well as complete tracking
- Full compliance with the IHE standards (Dicom, XDS)
- Integration with diagnostic (CT, RM, etc.) and/or PACS Direct equipment systems (CT, MRI, etc.)

Target group:

- Healthcare professionals: Personalization of care

5.1.3.3. Howdy Senior

https://comftech.com/en/

https://comftech.com/en/project/monitoraggio-da-remoto/

In collaboration with universities and specialized companies, ComfTech has developed HOWDY SENIOR: a wearable monitoring solution designed for adults, without age limits, 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 a textile technology that allows the system to be integrated into users'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 a special conductive yarn that guarantees full and long-lasting comfort.

Figure 66. HOWDY Senior system

The system consists of:

A) HOWDY SENIOR electronic unit, class IIb medical device: it is the electronic component of the system that detects and sends the parameters to the application for displaying. There are two types of the device that differ according to the physiological parameters they are able to detect. - Bluetooth connection

The COMPLETE device detects: Heart rate, real-time ECG, breathing rate, body position. The BREATH device detects: Respiratory rate, Inhalation and exhalation times, chest/abdomen amplitude variations, Body position. The devices can be combined with specific textile units and applications to form ComfTech® monitoring systems.

B) Sensorised garment, class I medical device

C) HOWDY App for data reading: developed for use by healthcare professionals. It allows to visualize the detected parameters, their variation over time and to generate reports that can be easily shared.

Figure 67. HOWDY SENIOR functioning.

To facilitate the management of multiple patients, ComfTech has also developed software to display the parameters measured by several devices on one central monitor. The system can also be integrated with compatible thermometer and pulse oximeter, with the data being displayed in the HOWDY App or on the central monitor.

Once the HOWDY SENIOR electronic unit is attached to the smart garment, the parameters detected by the textile sensors are processed and transmitted to the App.

The system's ease of use ensures that it can be used independently and without difficulty even by the frailest users. The system can also be integrated with telemedicine platforms to ensure continuous assistance during therapy or rehabilitation.

Measurements:

- heart rate
- real-time ECG
- respiratory rate
- body position and movement
- temperature
- saturation

ComfTech offers several possibilities to visualise the data collected during remote monitoring:

- Report: Created by the user or caregiver directly in the App and easily shared via a pdf file. The report includes data collected for a specific monitoring period.
- Dashboard: Viewable by doctors, specialists or remote operators. All collected data are presented in the form of graphs to visualise trends and easily assess the progress of monitored parameters. Thanks to telemedicine services, the data can also be sent remotely directly to the medical staff, who can then obtain the overall picture of the patients and constantly monitor the evolution of their health status.
- The system can communicate with third-party applications and platforms to integrate into telemedicine services.

Target group:

- Elderly people: wearing the device for parameter monitoring
- Doctors: parameter monitoring through the application and dashboard
- Carers: application

5.1.3.4. CareTech

https://secom.plc.uk/

SECOM is a leading company in the areas of security, fire protection and care technology.

Elderly Care Solutions:

- CareTech Solutions

- Personal Alarms
- Pendant Alarms
- Care Hub
- Care Hub Plus
- Care Go
- Fall Alarm

- Smart Independent Living
- Key Safe

SECOM Smart Wellness is designed for independent living and home care for the elderly. It's the complete package to provide support and peace of mind.

Non-intrusive sensors and technology provide real-time updates, directly to your phone, alerting you of any unusual activity. And with the addition of bespoke video cameras, you can always check in to see how the person is doing.

	SECOM Smart Wellness	Care Hub (Personal Emergency Response)	Care Go (Mobile Personal Emergency Response)
Sends activity notifications even when an emergency response button can't be pushed	✓	✗	✗
Provides real-time updates	✓	✗	✗
Works before an emergency	✓	✗	✗
Monitors daily routines and provides meaningful insights	✓	✗	✗
Delivers customised notifications	✓	✗	✗
Monitors night time activity with an integrated bed sensor	✓	✗	✗
SECOM monitoring	✓	✓	✓
App notifications	✓	✓	✓
Provides alerts outside of the home	✗	✗	✓
Automatic fall detection	✗	✓	✓

Figure 68. Comparison among SECOM solutions functionalities.

5.1.3.5. Comarch WristBand

https://opaskazycia.comarch.pl/

https://www.comarch.com/healthcare/products/remote-medical-care/remote-care-services/wristband/

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.

Functions:

- 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

Three large buttons make it easier for the elderly to use the device:

The button marked with a red cross and Braille is used to make emergency calls to an assigned number or rescuers.

The function button with the circle serves to end voice calls and play voice messages: about the battery status, the current time and the number of steps taken.

The handset call button is used to make and receive calls.

Figure 69. Comarch WristBand

Lightweight wristband: 53 grams. It has also been adapted to be worn while sleeping - the silicone band adheres to the senior's arm and allows accurate measurement of heart rate, but does not cause unpleasant indentations.

The available notifications:

- device battery low

- device on
- device switched off
- device on
- device removed
- SOS button pressed
- call button pressed

Kod towaru	WRISTBAND H002AV2 (WHITE_BLUE)
Podatek VAT	23%
EAN	5901764723493
Czas Ładowania	2 h
Karta SIM	nie
Kraj Pochodzenia	Polska
Obsługiwane Częstotliwości	900 MHz, 1800 MHz
Pojemność Akumulatora	400 mAh

Figure 70. Comarch WristBand technical specification.

Mobile application

The application allows access to the data collected by the device.

The application allows the creation of:

- Carer profile, i.e. a person monitoring the device holder
- the profile of a Nearby Person, i.e. a user assigned to a specific device.

The functions of the Comarch WristBand application:

- Visual monitoring of a loved one's heart rate
- Insight into the activity of the device user - e.g. checking the number of steps taken
- Determining the current location of a loved one
- Making voice calls directly to the wristband
- Sharing your loved one's profile with other carers
- Checking the charge level of the device battery
- Displaying important notifications, enabling an immediate call for help (SOS button)

Target group:

- Elderly
- Dependent
- Chronically ill

5.1.4. Social isolation prevention in the home care setting

5.1.4.1. ČVEKIFON

https://simbioza.eu/digitalne-resitve/cvekifon

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.

5.2. Application of ML/AI algorithms for early detection of symptoms of cognitive decline

Predictive models using artificial intelligence (AI) and machine learning (ML) algorithms have gained great significance in the recent years both among the medical community and other social groups. These types of algorithms can analyse large data sets and find hidden relationships among often complex medical data. MML-based models have been successfully applied in various studies related to the prediction of disease onset and course[27], as well as in the detection of dementia and Alzheimer's disease[28][29][30]. Various types of tests have been commercialized (or are in the process of commercialization) and a number of tools enabling early diagnosis can be found on the market.

5.2.1. Accexible

https://accexible.com/

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).

[27] Ahsan MM LS, Siddique Z. (2022) Machine-learning-based disease diagnosis: A comprehensive review. Healthcare (Basel) 10, 541

[28] Mahendran N, Vincent PDR, Srinivasan K, Chang C-Y (2021) Improving the classification of Alzheimer's disease using hybrid gene selection pipeline and deep learning. Front Genet 12, 784814

[29] Na K-S (2019) Prediction of future cognitive impairment among the community elderly: A machine-learning based approach. Sci Rep 9, 3335

[30] Danso SO, Zeng Z, Muniz-Terrera G, Ritchie CW (2021) Developing an explainable machine learning-based personalised dementia risk prediction model: A transfer learning approach with ensemble learning algorithms. Front Big Data 4, 21

- Accexible's screening tests take from 30 to 60 seconds and have a sensitivity of more than 90%. Accexible's tool reduces the cost and the diagnostic error.
- Accexible's mood tracker allows the health professionals to monitor the emotional well-being of patients over time.
- Accexible's platform allows remote detection and monitoring of diseases. It establishes a warning system that can complement other telemedicine services.

Target group:

Elderly people

The tool allows efficient detection and monitoring of mild cognitive impairment and dementia. Healthcare providers, Medicare advantage plans, and nurse care centres can use this tool to detect dementia and combine the obtained results with integrated health programmes.

5.2.2. Winterlight Labs

https://winterlightlabs.com/

Winterlight Labs allows you to monitor cognitive disorders on the basis of speech. The platform has created tools that will allow for accurate tracking, examination and prediction of the initial stages of diseases. The solution uses tablet-based technology that assesses cognitive health (including memory, thinking and reasoning) by analysing hundreds of linguistic markers from short snippets of speech - Winterlight has developed a tablet-based assessment that allows for quick and objective analysis of speech itself. This makes it possible to detect cognitive disorders associated with dementia and mental illness. The assessment can be used in scientific/clinical research and in the care for senior citizens.

Therapeutic areas

Speech and language analysis can be used to detect symptoms in many therapeutic areas. In neurodegenerative disorders, this includes Alzheimer's disease, frontotemporal dementia, ALS, Huntington's disease, Parkinson's disease, hepatic encephalopathy and other diseases. In mental disorders, it facilitates the detection of depression, anxiety, schizophrenia and bipolar disorder.

5.2.3. BrainCheck

https://braincheck.com/

The BrainCheck platform for healthcare providers is designed specifically to assist physicians in quick and easy assessment of a patient’s cognitive function.

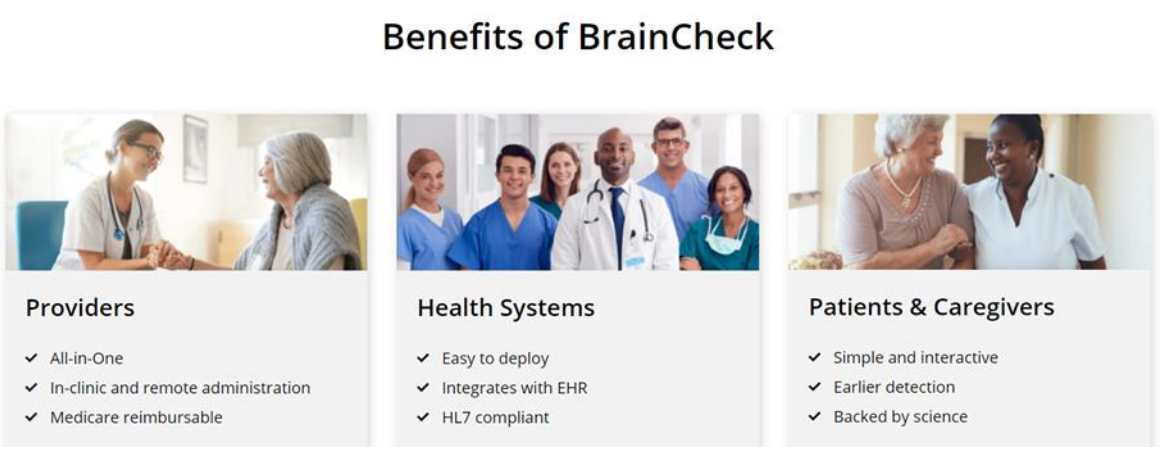


Figure 71. Benefits of BrainCheck

BrainCheck has been clinically validated. It has been demonstrated to improve early detection and specificity of cognitive disorder diagnosis. The assessment takes about 15 minutes and the tests can be performed by medical technicians, simplifying the process and allowing healthcare professionals to devote more time to patients.

BrainCheck is a US Food and Drug Administration (FDA) Class II Medical Device (SAMD) software that can be easily scaled for use in hospitals and healthcare systems of any size. BrainCheck assessments can be performed by medical assistants or caregivers, either in the clinic or remotely, improving efficiency and increasing access while providing savings for clinics and hospitals. With a wide range of screening tools and comprehensive cognitive assessment, the BrainCheck platform helps objectively and accurately detect even the most subtle changes in patients' cognitive functioning. BrainCheck tracks changes in memory, attention, executive function and other activities, giving patients and their healthcare providers timely access to useful information on their cognitive abilities.

Functions:

- Depression and anxiety scanners - depression and anxiety can often constitute symptoms of cognitive impairment - and the other way round. The BrainCheck platform includes digital versions of the PHQ-9, Geriatric Depression Scale and GAD-7 questionnaires.
- Stress and PTSD - stress may contribute to cognitive disorders. The BrainCheck platform includes the Perceived Stress Scale questionnaire as well as the PCL-5 post-traumatic stress disorder (PTSD) check-list.

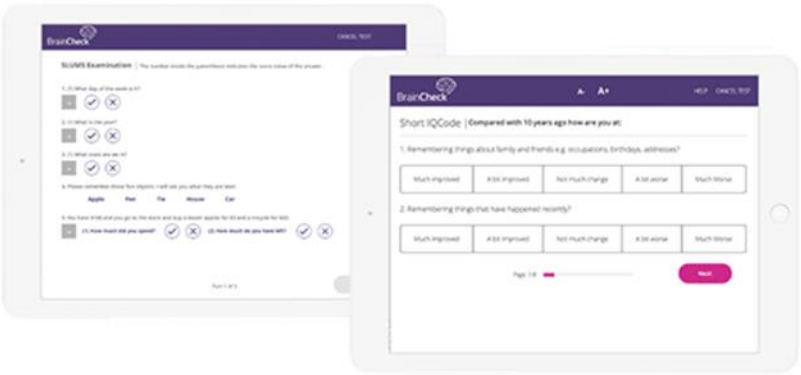


Figure 72. The BrainCheck platform.

- ADHD Symptom Survey - the BrainCheck platform includes an 18-question survey with questions that predict symptoms consistent with ADHD and follow-up questions that provide further context for these symptoms.

- Opioid Misuse Scanner - the platform includes a brief, self-reported screening tool to assess the risk of misuse of opioids prescribed to patients to treat chronic pain.

Advanced digital cognitive assessment

When screening tools indicate possible cognitive problems - or when patients have subjective memory problems - the BrainCheck platform helps healthcare providers quickly and accurately assess their cognitive function.

Patient module

Cognitive care planning tools built into the BrainCheck platform help patients and providers identify specific cognitive and behavioural issues, as well as areas of difficulty in patients' daily lives.

Identification and assessment of caregiver needs

The caregiver survey modules included in the BrainCheck platform are designed to identify areas where caregivers may need education and support to provide patients with better care. These modules can also provide additional information on the severity of cognitive impairment in patients.

5.2.4. Savonix

http://www.savonix.com

Savonix has developed a mobile platform for the assessment of neurocognitive function and brain health. A clinically validated platform used by patients, physicians and insurers around the world allows end-users to conduct cognitive tests directly from their mobile devices. Developed specifically for mobile devices, it delivers precise millisecond response times, which ensure more accurate cognitive data. Tests performed using Savonix have found application in thousands of studies around the world as they allow to predict the development of dementia and track symptoms associated with memory and executive functions in other disorders, such as depression or diabetes. The platform integrates clinically important cognitive tests, data analysis, clinical decision support and care planning tools.

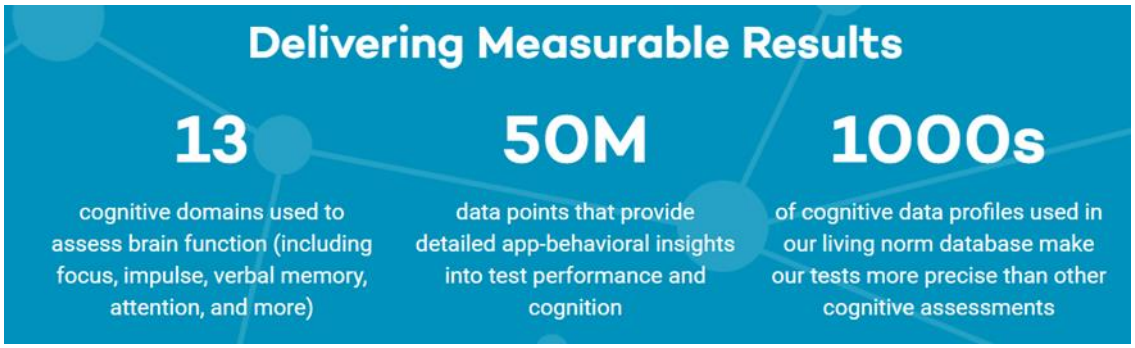


Figure 73. Savonix Results.

The Savonix mobile application is an easy-to-use cognitive assessment tool that can be used on any mobile device to test one's cognitive abilities. Test results are made available immediately after completion. Micro tests at frequent intervals take up to three minutes to complete, while the fully integrated assessment of 12 cognitive domains, such as concentration and memory, takes up to 30 minutes to complete.

Savonix Mobile assesses some or all of the following cognitive domains:

- instant verbal memory;-
- delayed verbal memory;
- impulse control;

- concentration;
- attention;
- identification of emotions;
- information processing;
- instant spatial memory;
- delayed spatial memory;
- visual learning;
- flexible thinking;
- working memory;
- executive functions

Because part of the assessment is a lifestyle questionnaire, the platform is able to help the patient understand the results by categorizing behaviours (e.g., smoking, exercise, sleep, alcohol consumption) according to the level of risk they pose to cognitive function.

Figure 74. Savonix Mobile

5.2.5. Neurotrack Technologies

https://neurotrack.com/

A cognitive health platform that gives patients direct access to tools and technologies to assess, strengthen and monitor their cognitive health.

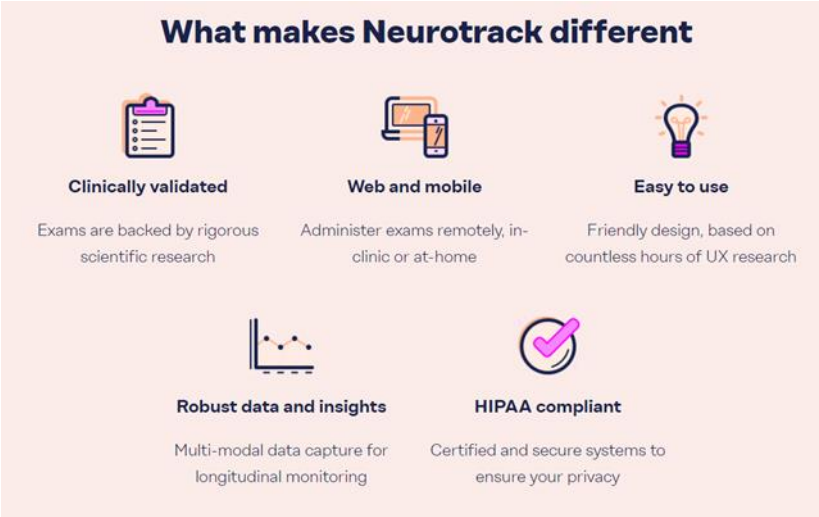


Figure 75. Neurotrack characteristics.

Neurotrack tests – cognitive domains:

- Processing speed - the speed at which the patient absorbs new information, evaluates it and formulates a reaction;
- Recognition memory - the ability to recognize previously encountered events, objects or people;
- Associative learning - the process of recognising connections between objects and concepts;
- Associative memory - related to associative learning, it is the ability to remember relationships between objects;
- Inhibition - the ability to control one's thoughts and actions;
- Attention - the ability to process information;
- Executive function - the ability to perform tasks.

A study performed using Neurotrack:

- The FINGER study (The Finnish Geriatric Intervention Study to Prevent Cognitive Impairment and Disability) was a long-term study conducted on a group of 1,200 adults at risk of cognitive decline. People who participated in the intervention that addressed multiple aspects of lifestyle, including diet, exercise, and cognitive training, demonstrated improvements in cognitive performance.

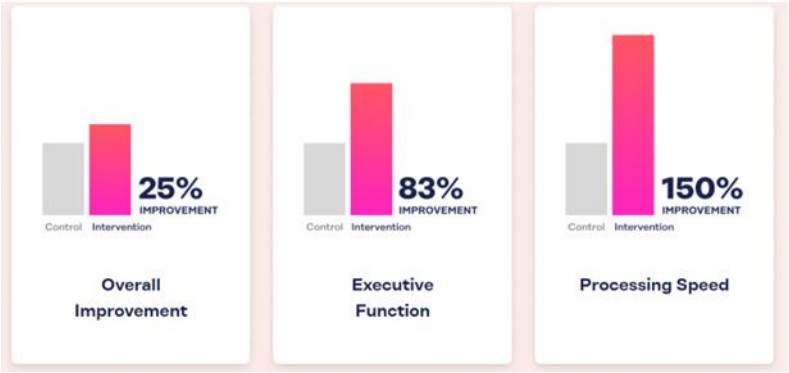


Figure 76. FINGER Study performed using Neurotrack: participants' improvements after the intervention.

- The Cognitive Health Program is modelled on a multi-domain intervention, the effectiveness of which was confirmed in the FINGER study. The program addresses six lifestyle domains, all of which are considered modifiable risk factors for dementia and Alzheimer's disease:
    1. Stress management
    2. Social involvement
    3. Nutrition
    4. Cognitive training
    5. Sleep
    6. Exercises

Cognitive assessments

Neurotrack uses the latest achievements in neuroscience and technology to develop digital tests that reliably and remotely assess the current state of cognitive functions. Cognitive tests have been designed to be convenient and easy to use, making it possible to perform them remotely at home or in a clinic.

Eye tracking technology

Using the computer camera, eye-tracking technology captures multimodal data to reveal important information about cognitive processes and detect changes early.

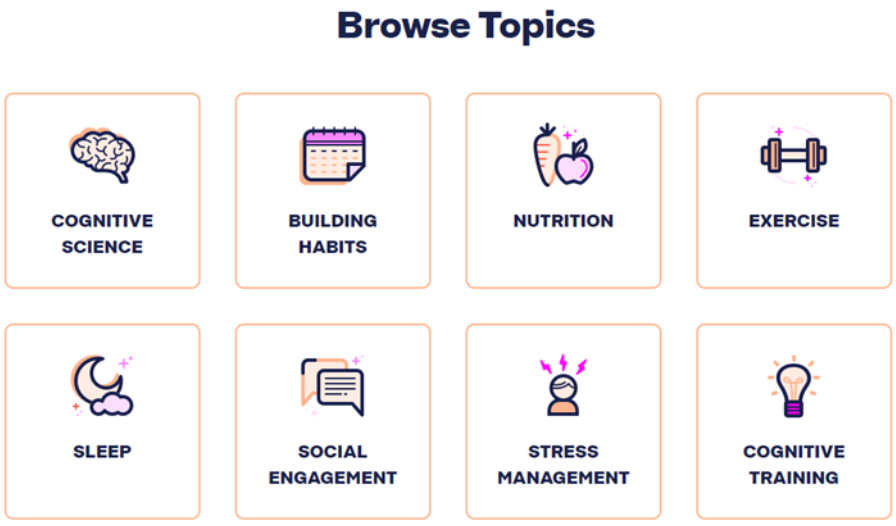


Figure 77. Neurotrack Cognitive Health Program.

5.2.6. Cogstate

http://www.cogstate.com

Cogstate provides rapid, reliable and highly sensitive computer-based cognitive tests.

Figure 78. Cogstate solution: areas of usage

Computer-based assessment of cognitive abilities

Each Cogstate test provides a measurement of different cognitive functions. The tests are culturally neutral, not limited by the participant's educational level, and are designed to be conducted repeatedly. The tests increase the sensitivity and specificity of measuring human cognition and can detect subtle drug-related changes in cognition.

Figure 79. Cogstate tests characteristics.

Cogstate tests, each designed to measure a specific cognitive area, are combined into sets tailored to the unique requirements of the study design and population.

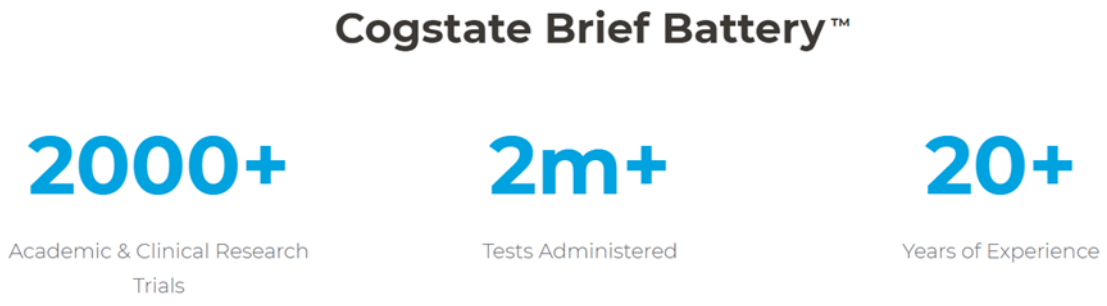


Figure 80. Cogstate in numbers.

Cogstate and the Eisai Co Ltd. pharmaceutical company. have entered into a global collaboration to develop and commercialize digital brain assessment tools for individuals and physicians. Under this partnership, Cogstate constitutes a strategic investment of Eisai Innovation, which focuses on digital solutions and diagnostics in the field of neurology and oncology to improve healthcare.

5.3. Multi-criteria analysis of currently used solutions

The successful existing hybrid solutions for adults described in the above section are specified in Table 10. The following most significant features of the solutions were indicated:

- The number and types of areas covered by the solution;
- Implementation of AI/ML algorithms supporting the effectiveness of the solution (e.g. in the prognostic area);
- Comprehensiveness of the solution;
- Providing a possibility to contact a doctor and/or caregiver;
- Use of hardware elements in the solution;
- Solution developed specifically for elderly people;
- Geographic scope.

Table 10. Successful existing hybrid solutions for adults

Solution	Area	AL./ML	Comprehensiveness (score 1-3, where: 1 - single area 3 - multiple areas)	Ability to contact the solution/caretaker	Hardware element (dedicated, except smart phone)	Target group (dedicated to seniors)	Coverage
KWIDO	Health Mementia Home	Yes	3	Yes	Yes	Yes	Spain, United Kingdom, Portugal, Italy, Austria, Luxembourg, Austria, Romania, Poland
DIPAS	Health Home	Yes	2	Yes	Yes	Yes	Italy
TICURO REPLY	Health Home	Yes	2	Yes	Yes	Yes	Italy, probably other countries
Silver technologies	Health	Yes	1	Yes/No Device records and sends a voice message	Yes	Yes	Worldwide
E-OSKRBA	Safety	No	1	Yes	Yes	Yes/No elderly, chronically ill, and disabled people and their carers	Slovenia

MAGDA Mobile application for elderly people	Social	No	1	No	No	Yes	Slovenia
DECT teleoskrba	Safety Social	No	3	Yes	Yes	Yes	Slovenia

Among the hybrid solutions existing on the market, the Kwido system seems to be the most remarkable. It provides the most comprehensive care for the elderly. It is the solution that ensures supervision over the safety of senior citizens in the home environment with the capability to monitor their vital signs and the cognitive sphere.

The tools for cognitive prevention in the home care setting are specified in Table 11. The following most significant features of the solutions were indicated:

- Comprehensiveness of the solution;
- Mobile application;
- Solution based on scientific foundations;
- Ability of on-line performance monitoring;
- User-tailored tasks (AI/ML algorithms);
- Target group (dedicated to seniors);
- Geographical range.

Table 11. Solutions for cognitive prevention in the home care setting

Solution	Main area, additional area	Comprehensiveness (score 1-3, where: 1 - single area 3 - multiple areas)	Mobile application	Scientific basis	Ability of on-line performance monitoring	User-tailored tasks (AI/ML algorithms)	Target group (dedicated to seniors)	Coverage
BRAINER, PROFESSIONAL BRAIN TRAINER	mobile games; physical decline prevention the home care setting	3	No	Yes	Yes	Yes	Yes/No	Italy
MENSANA	mobile games	2	No	Yes	No	No	Yes	Italy
Neocogita system	mobile games physical decline prevention in the home care setting	3	Yes	Yes	Yes	Yes	No	Italy
DAK Memory Coach	memory exercises	1	Yes	n/a	No	No	Yes	Germany

GRADYS	cognitive function training	2	No	Yes	Yes	Yes	Yes	Poland not commercialized
Accexible	Prognostic system - mild cognitive impairment	1	No	Yes	Yes	n/a	No	USA
Lumosity	mobile games	1	Yes	Yes	No	Yes	No	USA, Spain, Germany, French, Poland, …

The physical decline prevention tools for the home care setting were specified in Table 12. The following most significant features of the solutions were indicated:

- Comprehensiveness (rating 1-5, where: 1 - single measurement, 5 - many parameters)
- AI/ML algorithm, prognostic;
- Ability to contact the solution/caretaker;
- Hardware element (dedicated, except smart phone);
- Target group (dedicated to seniors);
- Geographical range.

Table 12. Physical decline prevention tools for the home care setting

Solution	Area	Comprehensiveness (rating 1-5, where: 1 - single measurement 5 - many parameters)	AI/ML algorithm, prognostic	Ability to contact the solution/caretaker	Hardware element (dedicated, except smart phone)	Target group (dedicated to seniors)	Coverage
HTN Telemedicine	e-Health	5	Yes	No	Yes	No - adults above 18	Italy
COMARCH REMOTE MEDICAL CARE	e-Health	5	Yes	Yes	Yes	No	Italy, Poland, …
SEREMY	e-Health Safety	5	No	Yes	Yes	Yes	Italy, Poland, …
HOWDY SENIOR	e-Health	5	No	Yes	Yes	No	Italy, probably other countries
LINDERA	e-Health	1	Yes	No	No	Yes	Germany, Brazil
Procarement	e-Health	2	No	No	Yes	No	Germany
Sleep Cycle	e-Health	1	Yes	No	No	No	Germany
Instant heart rate application	e-Health	1	Yes	No	No	No	Germany
LOLA	e-Health	2	No	Yes	No	Yes	Germany
Medipee	e-Health	1	Yes	No	No	No	Germany

Kaia Health	e-Health	1	No	No	No	No	Germany
MEDISTANCE Smart Tools	e-Health	3	No	No	Yes	Yes	Hungary
Šola zdravja	e-Health	1	No	No	No	Yes	Slovenia
VEŠ KAJ JEŠ	e-Health	1	No	No	No	No	Slovenia
Comarch WristBand	e-Health	5	Yes	Yes	Yes	Yes	Poland
Sidly	e-Health	5	Yes	Yes	Yes	Yes	Poland
eLifeCare Telemedicine platform	e-Health	5	No	Yes	Yes	No	Italy
Halo help alarm system	Safety	1	No	No	Yes	Yes	Croatia
Neuroforma	e-Health	1	Yes	Yes	Yes	No	Poland
CareTech	SmartHome/Safety	5	No	Yes	Yes	Yes	UK
InteliCare	SmartHome/Safety	5	Yes	Yes	Yes	Yes	Australia
ElderOn	SmartHome/Safety	2	No	No	Yes	Yes	Slovenia
TESI eViSuS®	e-Health	4	No	Yes	Yes	No	Italy

The most numerous solutions are those that allow the monitoring of physical parameters - heart rate, temperature, etc. Among the solutions dedicated to elderly people, manufacturers also pay attention to the possibility of reading the GPS signal (location of people, especially with dementia) and fall sensors. The group of Smart Home solutions is also strongly represented, containing a number of sensors enabling the monitoring of senior citizens in their homes, while maintaining the maximum possible degree of their privacy. The solutions available on the market differ slightly in the type of sensors used, the measured parameters, and prognostic capabilities of the AI/ML algorithms, but in general they are very similar and it is difficult to identify a clear leader among them.

6. Conclusions, recommendations

The analysis of the guidelines and recommendations of European Union institutions and the legislation of partner countries, demographic data, trends and forecasts regarding long-term care for the elderly and the existing solutions supporting both this social group and its caregivers clearly indicates the existing need to strengthen the area of long-term care and the need to design and implement new solutions. Among the conclusions drawn from the analyses, the following seem to be the most important:

- The ageing society across Europe requires the creation of new models of long-term care and the implementation of innovative solutions, supported by investment by Member States, constant analysis of the existing good practices, the creation of new partnerships and cooperation between various stakeholders.
- When developing new solutions, the need to meet the diverse needs of care recipients (elderly people, their caregivers, including informal ones, and the financial capabilities of all groups involved in the ecosystem) should be taken into account.
- It is important to emphasize the need to implement solutions focused on the recipients and ensure the possibility of ageing with dignity.
- There are two main forms of long-term care in the EU: home care services and residential care. The home care services, which are the most widespread, include, among others: shopping, laundry, house cleaning, personal care support, cooking, etc. Home care should be provided by professionals and complemented by informal care. The social policy of the European Union countries is guided by the principle of subsidiarity, i.e. the role of the state begins when the family cannot fulfil its obligations towards its members. Therefore, the role of the state should primarily be limited to supporting the independence of the elderly staying in their own environment. It should be taken into account that institutions providing 24-hour care services often replace the family in caring for senior citizens, which leads to their alienation.
- The psychophysical limitations of the elderly force the developers of new solutions and models to ensure that they can use the offered tools without any problems by adapting the interfaces, communication methods and functionalities to their needs and capabilities.
- The analysis of technological solutions in the LCT area indicates the lack of significant barriers related to both Internet access and technical means enabling the use of this type of tools.
- Many existing organizations (including Caritas) promote services using digital technologies in long-term care, especially in terms of access to such care by people living in areas distant from large agglomerations in order to eliminate geographical barriers .
- The number of people affected by neurological diseases and mental disorders increases every year. The ageing of the society and civilization changes make mental and neurological disorders more and more prevalent.

- Among the solutions supporting care for the elderly identified on the European market, there is a very large number of e-health tools - both in the form of telemedicine platforms and solutions containing various types of sensors, enabling continuous monitoring of their users' health status. These tools are often supported by AI/ML algorithms, which allow for the identification of potential threats. The dynamic development of this segment of tools and their similar functionalities eliminate them from further multi-criteria analysis/expert evaluation, because they prove that the needs of the recipients are met. In this area, only business models are analysed, allowing conclusions to be drawn and good practices established in order to develop and implement a solution in the scope of this project.
- The second large group of currently existing tools are smart home/safety solutions that allow remote monitoring of elderly people in their homes. As in the e-health area, these solutions are largely similar to each other, being based on a number of different types of sensors. For reasons analogous to those in the case of e-health solutions, they were eliminated from further multi-criteria analysis/expert assessment.
- Solutions in the areas of "cognitive impairment prevention in the home care setting" and "social isolation prevention in the home care setting" constitute a smaller group. The forecasted exacerbation of problems related to dementia or the increase in the incidence of Alzheimer's disease prompt the expansion of analyses related to solutions that allow the provision of at least partial support for elderly people and their caregivers in this area.

7. Appendixes

7.1. Market and target group analysis in project partner countries

Appendix 1_Market and target group analysis in Poland

Appendix 2_Market and target group analysis in Italy

Appendix 3_Market and target group analysis in Slovenia

Appendix 4_Market and target group analysis in Croatia

Appendix 5_Market and target group analysis in Germany

Appendix 6_Market and target group analysis in Hungary

7.2. Good practices and competitive analysis in project partner countries

Appendix 7.2_Best practices and competitive solutions