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Abstract

A number of 155 elderly (15 Poland, 10 Romania, 130 Hungary) and 27 caregivers (15 informal Poland, 4 informal Romania, 5 formal Hungary, 2 informal Hungary) from 3 countries have provided feedback following their participation. Pilots are implemented in 4 countries but IZRIIS, the self-funded end-user organization, will provide the users' feedback in the end of the tests in D1.3b.

The overall feedback was positive and users were appreciative about the INCARE platform with several of them exhibiting improved health monitoring and activity during the pilots. Based on the users' feedback, health monitoring was the most popular components of the INCARE solution. Out of the 4 tested medical devices, the most appreciated one was the blood pressure meter. This was also supported by the health data acquired during the pilots. There were 105 seniors who tested the medical devices until midterm and 97% of them used regularly the blood pressure meter. The overall opinion was that it was easy and fast to use, had a comfortable cuff and a large screen.

Several robotic platforms were presented to the users either in life demos or as digital experiences. In Poland, 12 senior participants took part in a study dedicated to evaluating the INCARE robotic. Even though the idea of using robots to support people with reduced mobility and physical illnesses was seen as positive, most respondents considered that a robot can offer limited support and it cannot

replace a caregiver. Nevertheless, more than 70% of the people participating in the study would accept the robotic platform in their daily life. In Romania, 13 users the functionalities of the robots interesting but were reluctant when it came to having a robot in their proximity. The most appreciated features when it came to robots were the ability of lifting and carrying objects around the house and to detect falls and alert the caregivers (Tiago), the ability to keep company to the lonely seniors and entertain them (Pepper). The disadvantages pointed out by the seniors were the size and appearance of Tiago, which is too big to be comfortably kept in an apartment, the lack of hands or any ability to help with house chores of Pepper, but also its inability to maintain a more complex conversation, and the lack of apparent sturdiness of Turtlebot. In Hungary, similarly to Poland and Romania, the seniors were reserved when it came to having a robot in their homes. Despite this, they liked the idea of a robotic assistant or companion. They believed that Pepper could be a decent companion if it would be able to hold a longer and more interesting conversation.

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ABBREVIATIONS

AAL	Active Assisted Living
INCARE	Integrated Solution for Innovative Elderly Care

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1. Midterm evaluation – general information

- **Scope**

According to the research assumptions, the INCARE pilot study lasted 6 months. **At 2.5 months after the start of the test, a midterm evaluation was carried out**. During this evaluation, we focused on the first impressions of the users who have tested the platform: its strengths and weaknesses, perceived usefulness of specific components as well as difficulties noticed during use.

- **Methodology**

The INCARE solution was tested in 4 end-user countries (Poland, Hungary, Slovenia and Romania) with 3 types of users:

- **Individual primary end-users** - elderly (seniors) living in an independent apartment (alone or with their caregiver and/or other family members). They took part in an in-home pilot study.

- **Institutional primary end-users** - elderly (seniors) living in a facility*. They were engaged in pilot study in institutions.

- **Secondary end-users** (caregivers of the elderly participating in the pilot study):

  › informal (mostly family members) - engaged in an in-home pilot study

  › formal (employees in facilities) - engaged in a pilot study in a long-term or in a day-care institution. Facility could be a seniors' nursing home (providing long term 24/7 care) or day care institution (where seniors spend up to several hours a day). Facility can be public or non-public (private).

The feedback from all types of users from Poland, Romania and Hungary was collected by a structured individual interview and a semi structured interview conducted by an expert from an end-user organization on every stage of the research (pretest, midterm, post-test). The Slovenian users will provide their feedback in the end of the pilots because of limited resources of the self-funded organization IZRIIS.

In addition, informal feedback was also provided during individual discussions initiated during the testing by either the users or the personnel of the end-user organizations. The users were usually contacting the personnel of the end-user organizations when needing help or additional information. The latter were checking regularly on the users.

In order to measure a change in such research areas as quality of life, technology acceptance and caregiver burden, we applied reliable and widely used tools suggested by the INCARE project evaluators (the WHOQOL short version questionnaire for elderly people, 14-item Senior Technology Acceptance index proposed by Chen (2020)[1], Burden Scale for Family Caregivers- short version[2]).

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[1] Chen K, Lou VWQ. Measuring Senior Technology Acceptance: Development of a Brief, 14-Item Scale.Innov Aging. 2020 Jun 27;4(3):igaa016. doi: 10.1093/geroni/igaa016. PMID: 32617418; PMCID: PMC7320876

[2] https://www.psychiatrie.uk-erlangen.de/index.php?id=11049

Additionally, the report contains users' feedback on a robotic platform gathered through Focus Groups Interviews guided, in some countries, by questionnaires.

- **Organization of the deliverable**

The results are presented in the current D1.3a report which contains:

- characteristics of the participating users in every end-user country,
- summary evaluation of specific components of the INCARE solution and an evaluation of its utility from the perspective of different types of users on the end-user country level,
- recommendations for optimization the INCARE product (suggested by users testing the INCARE)

2. Midterm evaluation on the end-user country level

2.1. Poland

The midterm evaluation of the INCARE product was carried out with two types of users: individual users (seniors and their caregivers testing out the solution at home) and institutional users (formal caretaker).

According to the assumptions in D1.2b, the main user of the INCARE solution in the case of an institution is a formal caretaker appointed by the institution, who is tasked with evaluating the system's usefulness in the everyday operations of the institution in which they work and organizing tests with the institution's patients. Therefore, it is the caregiver – as the person who can provide the broadest feedback on the product - who the midterm evaluation focused on during the test.

Additionally, the robotic platform evaluation was conducted with Focused Group Interviews (FGI), according to a discussion guide agreed on earlier. In every meeting, respondents were shown two videos presenting two different features of the robotic platform (fall assist, transporting objects). After these were shown, respondents participated in a conversation regarding the three main research problems: how the robot looks, how it communicates, usefulness of the presented features, strengths and weaknesses of the solutions presented, and approval of the solution shown.

2.1.1. Sample description

2.1.1.1. Individual testing

Individual users testing the solution in their homes took part in the study (15 seniors and 15 caregivers). Both groups met the recruitment criteria of the project. Presented below are the main characteristics of the research participants.

2.1.1.1.1. Seniors

- **Demographics**

All the individual seniors taking part in the test were over 60 (the age criterion for INCARE test participants in Poland). The youngest participant was 69 and the oldest was 79. The average age of the participants was 70 years old. There were 10 women and 5 men participating in the test.

Seniors participating in the test mostly had secondary education, 4 people had higher education. A vast majority of the respondents had general education or are educated in humanities. Only 3 participants studied science.

Education level of seniors
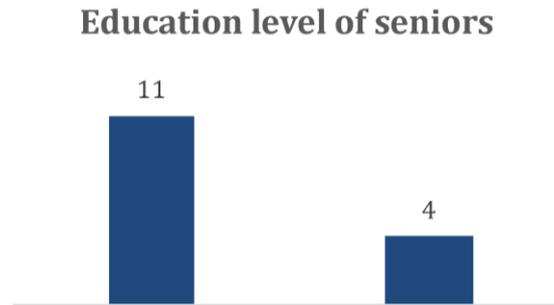
Figure 1 - Pretest - seniors, n=15

All the test participants lived in Warsaw on a daily basis (city with over 500k residents).

- **Digital skills**

Nearly all of the seniors had prior experience with using new technologies, with 13 out of 15 seniors also experienced in using touchscreen devices. However, these experiences most often meant usage of smartphones. Tablets (the device that was part of the tested INCARE sets) had been used before by only 5 participants of the tests. However, the usage of the tablet is not significantly different from the usage of a smartphone and has the additional advantage of exhibiting a larger screen.

It needs to be stressed that the fact that seniors had some experience in using technologies does not translate into high tech savviness. Based on the course of the study and the difficulties some respondents had using the devices given to them (described in the rest of the report), we determined that their digital competences were mostly quite basic.

- **Health condition**

In accordance with the recruitment criteria, each senior participating in the test needed to regularly test her/his health parameters (minimum one of the following: blood pressure, sugar levels and saturation levels). Research participants were recruited in such a way that their health monitoring needs corresponded with the type of devices which were given in their INCARE test set. Each set contained a blood pressure monitor and 1 to 3 additional devices, depending on the needs of the respondent (pulse oximeter, glucometer and thermometer).

Therefore, the people recruited for the tests needed to monitor their blood pressure (all respondents). At the same time, 14 people declared to be checking their blood oxygen saturation levels, and 5 people were measuring their blood sugar levels. Apart from the mentioned parameters, most of the recruited seniors declared a need to check their body temperature.

Health parameters that need to be monitored
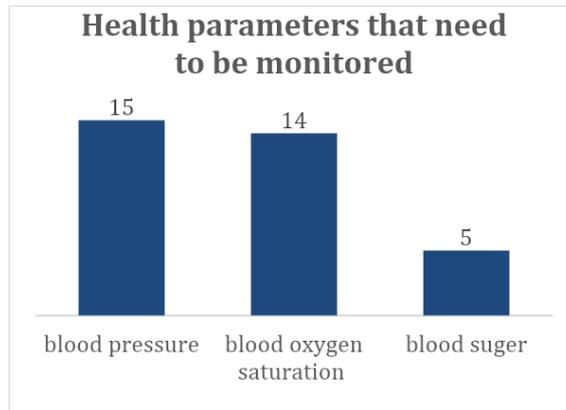
Figure 2 - Recruitment screener, seniors, n=15

The necessity to regularly control the above-mentioned health parameters was due to the respondents' chronic somatic conditions. They most often suffered from cardiovascular diseases, hypertension, and diabetes. Moreover, the ongoing coronavirus pandemic has resulted in the participants checking their oxygen saturation levels more often. Despite the requirement to regularly monitor their health, seniors had mixed success in fulfilling that responsibility before they took part in the test. Only a little over one third of them declared that they did so regularly. Other respondents admitted that before the test started, they monitored their own results only from time to time, or less often than that.

Do you monitor your health?
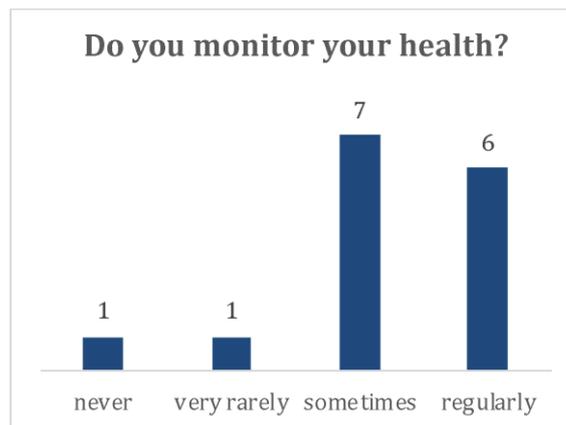
Figure 3 - Pretest - seniors, n=15

Due to their health, nearly all seniors participating in the test needed to regularly use medicine. Respondents were much more diligent in regard to medicine than with respect to health monitoring. However, over two-thirds of the participants admitted that they sometimes forgot to take the medicine at the time they were supposed to do so.

Do you forget to take your medication?
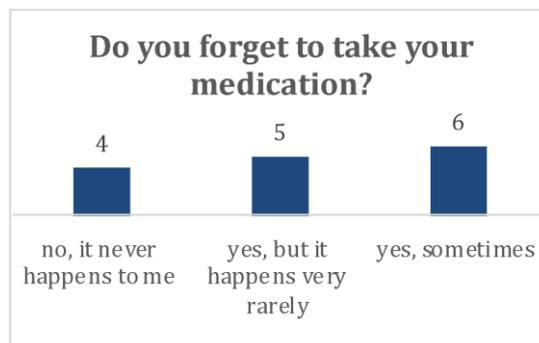
Figure 4 - Pretest - seniors, n=15

- **Seniors' independence**

According to the research assumptions, the seniors participating in the test were intended to be relatively independent. INCARE is intended to make the seniors independent for longer by engaging them in self-monitoring their health and allowing their caregivers to remotely monitor the seniors' condition and intervene promptly.

All seniors participating in the study met the independence criterion. Each test participant was able to move on his own and perform simple at home activities, such as cleaning. A vast majority were also able to do their own shopping and prepare their own meals. Seniors most often declared they need some support from the caregiver with regards to preparing medicine, but they are mostly able to use them at a specific time of day by themselves.
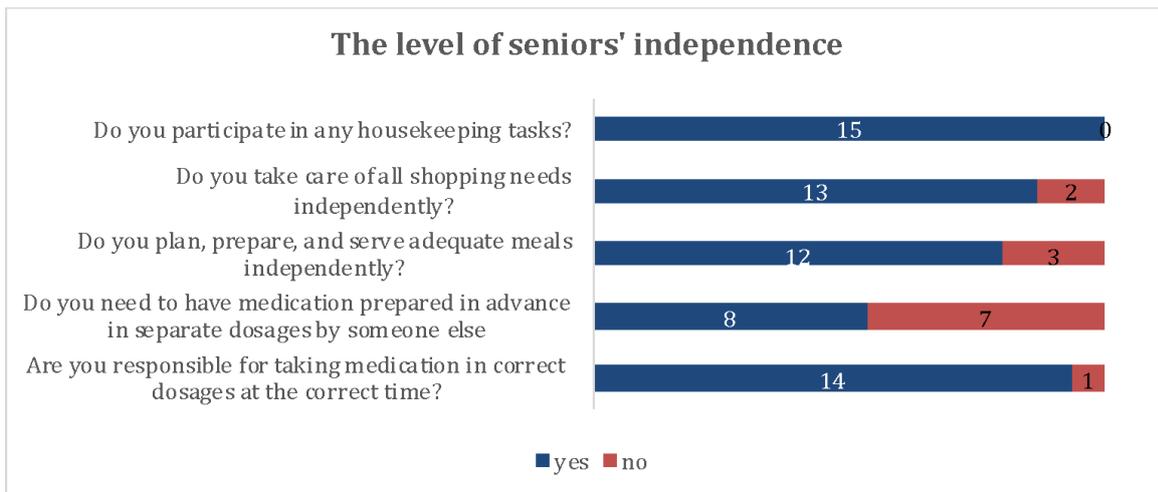
Figure 5 - Pretest - seniors, n=15

Caregivers of the seniors also rated their independence on a quite high level (4 or 5 scores on a five-point scale in several areas). The area in which they most often saw deficiencies of independence was health monitoring.

2.1.1.1.2.   Informal caregivers

Based on the research design, seniors with their informal caregivers were invited to the tests. Caregivers are the people who provide seniors with unpaid and informal support to a degree that corresponds with their needs and their self-reliance levels. The group of caregivers participating in the study included 10 women and 5 men. They were members of the seniors' families (most often their children), or close friends of the family. Caregivers were most often between 30 and 50 (average age is 42 years old).
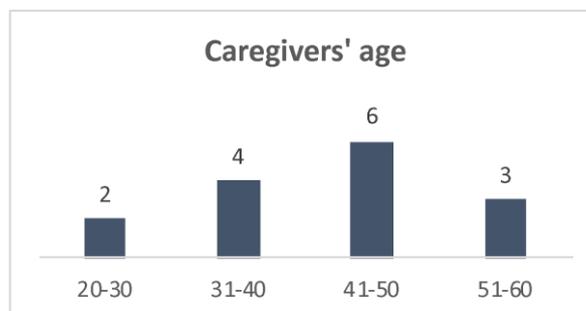
Figure 6 - Recruitment screener, n=15

A vast majority of the caregivers were not living with the senior – only two of the fifteen pairs participating in the study were living together. This corresponds with the research assumptions, because INCARE is among other intended to enable caregivers to remotely monitor the seniors' situation. However, all caregivers were living in the same city as the seniors (which enables a quick response in the event of an emergency).

The support of the caregivers turned out to be dependent on the health and needs of the seniors. Caregivers most often support seniors in areas such as health (setting up doctor's appointments, taking them to the doctor, buying medicine, care when they are ill) and everyday responsibilities (first of all shopping, much less often cleaning and cooking). Some of the caregivers helped seniors with formalities (taking care of legal matters, organizing a sanatorium stay, paying bills online) and also supported them in using new technologies. Part of the caregivers' support is also to give seniors company (spending time together, going on walks).

Apart from providing help in specific activities, caregivers generally oversaw the seniors' situation (they were in regular contact with them, reacted in emergency situations, i.e., if the senior was feeling poorly, if there were problems in the apartment).

Caregivers declared that they spend about 8 hours a week helping the seniors (for less than two-thirds of them, helping the seniors takes 4 to 8 hours, whereas for the others – 1 to 3 hours per week).

2.1.1.2. Testing in a care institution

2.1.1.2.1. Seniors

The test included 10 seniors (patients of the center) chosen for testing by a formal caregiver. The formal caregiver chooses seniors with varying levels of health for the test (different physical and cognitive health levels), but only the ones who could consciously participate in the test of the solution.

According to the profile of the care home, all people involved in the testing required ongoing, all-day-long care due to their health. This was both due to advanced age as well as other underlying conditions (often multiple ones). These included hypertension, diabetes, coronary disease and atherosclerosis. Four research participants also had diagnosed neurological disorders (Alzheimer's or dementia). Half of the participants had severe mobility limitations (needed support when walking or getting up from bed). All respondents regularly used medicine.

Seniors from care homes participating in the tests usually had very little experience with new technologies. Most of them only used a traditional mobile phone (no touch screen, often a version dedicated to seniors). This was different to the seniors living independently who used more advanced devices, such as the smartphone or tablet, as outlined above.

2.1.1.2.2. Formal caregiver

The formal caregiver is an employee of an institution recruited to participate in the study. Their everyday duties include care over the institution's patients. The institution where the test toke place was a private care home, which offers in-patient care to persons who do not require intensive care hospitalization but require the use of all-day or partial care-medical services. The institution had no experience using new technologies in caring for seniors, but the director declared to be open to such solutions (notices potential advantages with respect to increasing efficacy of the care provided).

2.1.1.3. Robotic platform evaluation

12 participants took part in a study dedicated to evaluating the INCARE robotic platform – 6 people aged 60-70 and 6 people over 70. All of the respondents lived alone or with another elderly persons. Every meeting was dedicated to a separate age group, but there was an equal 50% mix of men and women in every group.

2.1.2. Evaluation of specific components of the INCARE solution (application)

2.1.2.1. Health panel

Recording health monitoring results in the INCARE app is one of the most often listed advantages of the tested solution. Using this feature does not require – according to the respondents – any particular effort and it is relatively easy, because the data is recorded automatically, right after taking a measurement with the devices. For this reason, individual app users stopped writing down the results on a piece of paper or in a notebook, and they were only using the app. Automatic recording of the results and their accessibility had also increased some of the respondents' sense of safety. Most users also stated that having INCARE at home, but also the requirements tied to participating in the study, motivated respondents to more regular tests and they started to show above-average interest in their health. However, with respect to this benefit, one has to keep in mind that what impacts the seniors' motivations to some degree is also the situation of the test itself (respondents committed to participate in the tests and to convey useful feedback).

Despite the noticed advantages, the respondents (caregivers and seniors) also expressed a number of critical remarks, as presented below:

- Despite the training organized at the start of the test, not all the seniors were able to find the "results' panel" on their own and to read their results with the app by themselves. For about 1/3 of the seniors, even turning on the tablet was an issue in itself (including – giving the PIN) and logging on (the tablet did not always detect the NFC tag). In such situations, as well as in the case of technical issues, some seniors were concerned that they would break the device. Such people preferred not to check the results at all, or they decided to ask the caregiver for help, instead of trying to solve the problem by themselves. Caregivers also pointed out that the freedom to use the tablet and the app largely depends on the seniors' experience with new technologies. The people who had used a computer or smartphones before for entertainment (i.e., playing solitaire, other games) were able to operate the devices they were given more easily.

- Showing results of the tests using dots on the x/y axes (point graphs) was described as illegible. Seniors considered the dots and their markings too small. What some would consider much better would be to use bar graphs, or to show results in the form of a table with dates and values of the measures. It would be better for the app to enable choosing the method for presenting the results (table or graph).

- In the case of the blood pressure monitor, the results of a single test (systolic, diastolic and heart rate) are shown alongside one another, in a small distance, making them illegible. Moreover, the results sometimes overlapped, i.e., in the case of blood pressure, the systolic value may be the same as the pulse. In such a case, the points with the results overlap.

- On the other hand, in the case of the pulse oximeter, it was not clear when one should stop the test. The first values of the readout were usually much lower than the ones that appearing after several seconds. In the meantime, the device was sending results to the app in a continuous manner and showed them alongside one another on a graph. As a result, even a dozen dots were shown (with different results), and all come from one test – as a result, it was unclear which result should be considered final.

- Some seniors also did not understand the abbreviations of some parameters, i.e., SPO$_2$, BTM.

- The panel does not allow highlighting and comparing the results from a longer usage period. The graph showed only the 2-3 last tests, which were connected with a trend line, which was usually not useful – following the trend line would be relevant if there were more results.

- The icons and numbers were shown in a too small font, which also made it harder for seniors to "hit" the right place on the screen.

- The purpose of the colors is unclear – some results display in red, others in green or black and it was unclear what a given color depends on (one of the respondents was wondering if the color informs how much a given result deviates from the norm, which is not what the authors intended). Respondents also could not understand the colors of the arrows in the part that presents the findings thus far (color gray wrongly suggests that they are inactive).

- Seniors lack a feature that allows saving results in a file, which could later be sent and/ or printed out (i.e., in order to show it to a doctor).

- For the different tests from different devices to save, one has to leave the "conduct test" tab every time and enter it again. Otherwise, (if both measures are done one after another), only the first result is saved. This is not intuitive and extends the time needed for making the tests.

2.1.2.2. Games

Some respondents were happy that the app allows playing games, which they found entertaining, something to practice their thinking and memory. On the other hand, many users found them too simple and childish. **Therefore, based on the research materials, we are unable to evaluate this component single-mindedly positively.** However, one can declare with all certainty, that what is missing according to the seniors and caregivers, was **more variety of the levels of the game, depending on how advanced the player was. Another missing element was clear information which games will require the user to be tech-savvy.** Because of these limitations, and the small number of games (6) and their short playtime (some games take from several to a dozen minutes), some respondents were quickly bored trying them out. On the other hand, there were also situations in which the respondents were discouraged by the games, as they considered them too ambitious (i.e. the" Number jigsaw" game), or too fast (for agility, like "Collecting objects" or "Maze"). To some users, the objects shown in the games (which you need to collect) were also too small and too blurry. Sometimes, just navigating the board was challenging. It seems that the "Memory" game was the least controversial among the respondents. Individual people also pointed out that it would be more attractive if they could also have games such as Sudoku or classic crosswords.

One caregiver responsible for testing games in the care home also expressed concerns that patients of a nursing home may see games as childish entertainment, intended for kids. Therefore, the caregiver was hesitating about offering them to the respondents. She also stressed that the mental and physical

condition of the patients means they would have issues managing the games offered by the app. The only game that the caregiver had no doubts about was "Memory".

2.1.2.3. Medical devices

Most of the users were positive about the choice of devices that go with the app – they believe the devices are modern and convenient. This especially applied to the respondents who never had such devices before, or had much less tech-advanced devices (i.e., a mercury-based thermometer, which was considered much less convenient than an electric thermometer, or a classic charger that was replaced with a magnetic cord charger used for the needs of the test). Individual respondents pointed out that the NFC tag is too small. As a result, seniors had problems locating the tag.

2.1.3. App functioning

At the start of the test, some participants experienced difficulties due to the app not functioning properly. In some isolated cases, after these respondents clicked on "conduct test", instead of the desired picture, they would see the picture from the camera. Some users did not see the results of the tests from all of the devices, or they only saw results from some. Some also had problems logging into the system with the NFC tag or with turning on the tablet after it had discharged earlier. All of these problems were resolved whenever they appeared, but some of them, like the problems logging in or the issues transferring data from the devices to the apps, still sporadically happen to some trialists. This is why one of the first reservations about INCARE reported by some respondents during the test concerned insufficient smoothness and reliability of the used solution.

The respondents also mentioned they would need to connect the senior app with the caregiver app, which would enable sending alarming information directly to the caregiver of the senior.

2.1.3.1. Usefulness of the INCARE solution

Users (seniors as well as caregivers) had differing perceptions regarding the usefulness of INCARE. Some users noticed clear benefits of the system, whereas others thought they are minimal or even wholly absent. However, one has to stress that the test took place at a time when a caregiver-dedicated app was not yet available, which is a key feature from the perspective of caregivers. What also impacted the perception of usefulness was the technical condition of the app (among others: some errors appearing, problems with graph legibility) described in the previous chapter.

Individual users identified the following benefits of the INCARE solution:

- **The INCARE solution motivates seniors to regularly monitor their health condition.**
  Thanks to INCARE, there were seniors who began to monitor their health regularly or they started doing so more often. According to the users, this is also influenced by the fact that the system automatically saves the results (more convenience) and because there are modern test devices added to it. Changing some habits related to testing one's health increases the sense of safety in seniors and their caregivers, it also calms them down, assuring them that the senior will notice any issues if there are irregularities and will react accordingly).

- **Using INCARE can help train cognitive skills**
  The games added to the INCARE app are intended to help seniors stay intellectually capable. The benefits of this feature are difficult to evaluate, because any changes resulting from cognitive training take time and are usually subtle. Nevertheless, some caregivers described the games as a

potentially valuable addition to the system, which they feel can really help cognition of the seniors and can help bring variety to their free time. Some seniors had a similar opinion. They saw the games as an interesting and useful pastime.

- **Using the INCARE system increases the seniors' new technology skills and their general acceptance of new technology**

Some caregivers clearly stated that using INCARE helped improve the digital skills of the seniors they are looking after (they are now more confident using the tablet and using the app's features). Moreover, according to some caregivers, the positive experiences of using the app also translate into a changed perception of technological solutions among the seniors – they began viewing them as useful and valuable. This makes them more open to using technology (i.e. one of the caregivers said that his father using INCARE started expressing a desire to use a smartphone, something he never accepted before).

Benefits from using INCARE from the perspective of the institutional user:

- **INCARE could be useful as a central record of health parameters of patients in the care institution**

A formal caregiver sees potential in INCARE to develop a central registry of the patients' health records, which could replace the paper documentation. It would need to be implemented on a central level for all the patients and would need to be used by all of the medical staff, not as an extra system. In the test conditions, using the system only doubles the work that has been done – the caregiver needs to write down the results on a paper patient card and in the digital system.

It needs to be added that even though the caregiver sees potential in using INCARE as a central system for keeping records on patients' health, there are many concerns tied to this. These concerns are tied to the system's reliability (during the test phase, there are situations when the system doesn't work properly – difficulties logging in), necessity to provide a good Internet connection (there are places in the nursing home where the Internet signal is poor), and motivating the staff to learn to use the new technologies (according to the caregiver, not all employees are open to such solutions, they have their habits and they may refuse to change them).

2.1.4. Evaluation of the robotic platform

2.1.4.1. Acceptance of the robotic platform

The main criterion for evaluating the robotic platform that was used was the acceptance level of the proposed solution. The anticipated value of this indicator in the project was set on 70-75%. This means, that for the criterion to be met, 70-75% of the respondents evaluating the robotic platform should declare they would accept using such a solution in their daily life (now or in the near future). This is why at the end of the interview (after a detailed discussion of what the robot looks like with its specific features) participants were asked the following question:

> *If you needed extra support in different life situations that you saw on the video, would you be willing to use the solution presented here?*

Respondents were asked to answer on a 1 to 5 scale, where 1 meant "I would definitely not want to use that solution", and 5 meant "I would definitely like to use such a solution". Participants justified their choice.

According to the research results, 50% of the people participating in the study[3] would accept the robotic platform in their daily life. On a scale of 1 to 5, they awarded scores of 3, 4 and 5. Therefore, the 50% KPI set for the project was reached. At the same time, as many as 50% of respondents declared they don't accept the proposed solution, or accept it on a low level (1 and 2 scores).

What enables us to interpret these results are the justifications for the ratings formulated by the respondents and the doubts they expressed during the study.

First of all, the seniors participating in the FGIs gave a positive opinion on the theoretical idea behind the presented solution – they admired the idea of supporting older people who (due to their age and disease) presently have limitations in their functioning. At the same time, each of the presented features of the robot – transporting objects, support in the event of a fall (through conversation) and connecting with the caregiver – they all made respondents have more doubts than positive feelings. There was a range of single-mindedly negative feelings about the external design of the robot and how it communicates (more on that in the rest of the report). Respondents were also concerned about the robot malfunctioning, making it impossible to trust the machine and the belief that a person is irreplaceable when it comes to providing care:

> *I can't really picture this caring for me, helping me at all, it's just unreal (…). NO, I don't trust it at all. (FGI, Seniors 70-80)*

> *I'm talking to the machine, answering the machine, but how much can it do? People react differently in such situations. I would not be able to trust this machine, it's just a mechanism after all. It could malfunction. People act quickly, call neighbors, give help. What does a machine do? (…) No machine can replace a human being. (FGI, Seniors 60-70)*

On the other hand, respondents identified only a few benefits that (potentially) having such a device in their apartments could offer and that could make them evaluate it positively. The actually only benefit they see to having the robot was in case of falling (or fainting) while being alone. In that case the possibility to connect with the caregiver provides a higher sense of safety than being left without any help. This is why individual people declared potentially openness and a desire to use such a solution in future. However, these declarations were also based on the top, that their health and living conditions will "allow" that, and that the robot will be more advanced than it is at the moment.

> *I'd be willing to use such a device, assuming that it has all of these features that we discussed before. That's because it would be better than if I were just alone and forced to cope with it on my own (…) first and foremost, it gives me a sense of security. That would be most important, I guess. Assuming that I am intellectually sound of course and I can figure out how it works (…) I mean, this could be smaller (…) I gave it a four, because I have no idea about the state of my mind the moment, I wanted to use the robot. (FGI, Seniors 60-70)*

According to some seniors, the robot itself can provide some variety and can be interesting in itself. People who crave such "novelties" state that it could be a sufficient driver to having such a solution:

> *I gave it a five. I'd have no problems with this thing moving around the apartment. (…) It offers some variety. Obviously, it's just better to have a car and TV than not to have either of these. (…) (FGI, Seniors 60-70)*

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[3] n=12 people

There is a group of people who… even if they don't need it, they say: gosh, I need to win this! Because it's just something new. (Seniors 70-80)

However, most respondents state that such a robot may offer limited support. Seniors pointed out that for the robot to really deliver the benefits intended by the makers, it would require conditions that are artificial, not really fitting with the conditions that the elderly live in. This would concern the apartment itself (large enough space, no thresholds, narrow passageways, etc) as well as proper health of the senior using the solution (more on that below, in the part evaluating specific features of the robot). What is also important is the limited range of actions that the robot can offer at the current development stage. Indeed, it can call the caregiver, but it won't open a locked door to the medical staff, who don't have the proper keys. It will also not prepare a warm meal and won't move it from the kitchen counter to the tray. It will not pick up a person laying down. In the end, it seems essential to have an actual caregiver or another person, for the senior to receive relevant support.

Particularly the 70-80 group seemed to have high expectations with regards to the support they would receive in the event of a crisis (falling or fainting). Concerns about the robot's reliability, its limited capabilities and its high price made them dislike the very thought of their welfare (or the welfare of their dear ones) depending on the robot. Some respondents also stated that the actions undertaken by the robot can be replaced with solutions already found in the market – which are cheaper and more discreet. Therefore, they did not believe that the robot alone offers any added value.

A useless gadget. (FGI, Seniors, 70-80)

It can't do this or that, it can actually only do very little. I just wonder how much it would cost... (FGI, Seniors 70-80)

As a result, according to the tested seniors, the presented solutions do not meet their needs. A vast majority of the respondents stated that the presented solution would be more useful in medical or care institutions – places where it could support the staff in their basic tasks (such as moving things).

2.1.4.2. Evaluation of the usefulness of the presented functionalities of the robot

2.1.5. Evaluation of the fall assist functionality (robot moves to the senior, talks and then connects to the caregiver)

There were many emotions tied to the video in which a robot assists a person laying down after a fall. It seems that one of the reasons that explains the respondents' reactions was the belief that a fall at home is a real danger for an elderly person at home. This is why our respondents recalled the experiences they had in this area when commenting on the video presented (i.e., resulting from their caring for elderly parents) or stories they heard from friends. They became emotionally involved, as the memories made them feel afraid, but also made them want to be safe against these situations occurring. Respondents would evaluate the feature shown to them from this perspective. They listed the following limitations of the robot and mentioned their doubts:

1. **If the goal of the feature is to take action when a person living alone is in danger, then the robot should connect with the caregiver immediately (or the emergency services) without talking to the senior.** Older people may have different medical conditions and may be unaware

that the robot is talking to them. The robot may also misunderstand them. Intervention needs to be immediate in the event of a crisis.

Because let's say an 80-something person is lying down… believe me, people at that age are rarely active and their minds are not as sound, they won't understand some things. (Seniors 60-70)

2. **perhaps the robot should connect to a local clinic, doctor, or local nurse, hence it can be part of the healthcare system – most likely private healthcare.** Not all seniors have caregivers or family living in the area. There is also the risk that the caregiver will be out of reach at the moment of the senior's fall (out of mobile phone reach, with their phone turned off, etc.).

It would be more rational, but unrealistic in our conditions, for such a robot to connect with a healthcare cell, maybe the ambulance. (FGI Seniors 70-80)

If the patient had a relevant insurance plan, if they could afford it, then it would be possible to connect all these elements. (FGI Seniors, 60-70)

3. **if the goal of the feature is to take action when a person living alone is in danger, the robot should be able to open the door and let emergency rescue teams into their home** (if it calls an ambulance which doesn't have access to the keys)**.**
4. **the robot should be able to get to any place in the apartment – move over the thresholds, get to a locked restroom (if the senior falls there)**
5. **the low acceptance level for new technology among the seniors is a strong barrier to using the robot.** Therefore, it could be a solution for the future generations.
6. **robot maintenance (turning it on, charging, etc.) could be too complicated for the seniors.**

Such a robot needs to easy to use… you know, pressing buttons, turning it on, everything like that… consider the fact that my father for example, he never even wanted a cell phone.

You mean that it cannot be difficult to use.

It must not be difficult to turn on and to use. (FGI, Seniors 60-70)

7. **repairing the robot may require much organizational effort** (it is unknown whether repair points for such devices will be readily available) **and too much financial investment**
8. **buying the robot will be probably too costly compared to other, cheaper solutions with similar features present in the market.**

Lady, they can go ahead and test these things at NASA, but now in Poland. First of all, Poles can't afford it. The government needs to give pensioners extra pensions so they don't starve and die, so what are we talking about here? (FGI, Seniors 60-70)

All you need is just install a motion or noise detector that reacts in the same way as this one does, but it won't move, it won't have these lights and all these costly gimmicks, I don't believe that something like this will ever be really launched. (FGI, Seniors 60-70)

Evaluating of the item transporting functionality

As one of its features, the robot may use a tray placed on it, to carry objects that the senior needs. This feature requires the senior to interact with the robot and requires uttering a specific

command (i.e., "bring me tea"). The objects that the senior asks for at a given moment need to be prepared in advance by the caregiver and laid on the tray by the robot.

Respondents had the following doubts about the presented feature:

1. **research participants pointed out that placing objects or items on the robot requires the presence of a caregiver**. The caregiver may prepare a given item before leaving the senior's apartment and they can place it on the robot, or perform that activity in response to a senior's command uttered directly to the robot. According to the respondents, it would be much simpler if the provider places the objects directly in the senior's reach. Using the robot for that activity, especially as the robot would not prepare or pick up a meal from the counter, was described as excessive and useless. This comment was made in particular in relation to a situation in which the caregiver of the older person is in the next room. In such a situation, respondents pointed out it would be faster and more convenient if the caregiver brought them the objects they need. Using the robot for that activity does not contribute any extra value in their opinion.

2. according to the respondents, **the robot presented is not suitable for working with people with limited awareness and communication capabilities.** Such a person may take the medicine from the robot, but may not swallow it (or use too much). In such cases, the robot cannot replace the caregiver

3. **according to the respondents, it takes too long for the robot to give an object that the person needs**

4. **the robot cannot take off a tray with food from the counter by itself, meaning that the caregiver's assistance is possible in such a case.**

5. **much like in the case of the previous feature, there are solutions that can provide the same type of assistance at a lower cost. In the case of medicine, they can be using boxes that also specify how often and when they are to be used. As for tea, one can place a thermos next to the senior.**

   You know what, as for the drugs, I just prepare the batch of medicine in a special box when leaving in the morning... the boxes don't always work as the hands tremble and sometimes they fall out... that is a problem to resolve, but you don't need a robot to be giving out medicine at home. (Seniors 60-70)

As a result, respondents had doubts about who the presented feature is for. On one hand, it seems that people who are bedridden, grounded, should benefit the most from the presence of such a robot. On the other hand, such people still need a caregiver and they first need to prepare objects and products that the robot will bring. This creates the question whether such limited functionalities warrant the purchase of a costly robot. Another concern respondents had was that the robot could simply break, which would have particularly unpleasant consequences in the case of bedridden people. Therefore, they postulated that few people would be willing to leave the seniors alone with a machine.

   You never really leave bedridden people alone and reliant only on a machine. Unfortunately, people are unreliable, let alone a machine! I'd be afraid that a malfunction could occur, as these occur anywhere. For example, the robot could give the patient something other than drugs... it could create life-threatening situations for these people, (Seniors, 60-70)

Respondents were also convinced that the robot would not be helpful for people who are independent at least to some degree. Moreover, it could make them lazy.

2.1.5.1. Evaluation of the TIAGO robotic platform

Part of the meeting with the seniors was dedicated to evaluating the Tiago robotic platform in terms of its design, movement and communication. As far as that's concerned, Tiago was met with a single-mindedly negative response. One has to consider that robotic devices are new to the seniors and this is why they could be generating many concerns, which end up creating barriers to acceptance of the device. It seems that the Tiago robot presented (due to its attributes), not only failed to dispel the respondents' concerns, but further exacerbated them.

- **Tiago's appearance**

The Tiago robot sparked a range of negative emotions due to its design. First of all, these concerns were connected to its size. Tiago is a large device, which would take up much room in the apartment and which cannot be discreetly hidden in it. A robot like Tiago, if there was any room for it in the apartment, would dominate the space and lower the comfort of using it.

> *Please, not that size! It's too big for our apartments… they should come up with something different. (FGI Seniors 60-70)*

> *One corridor with a bathroom and such a huge robot. What about me? I would not fit in anywhere. (FGI Seniors 70-80)*

Secondly, the robot has a boxy, cumbersome shape, it is made from materials that are cold and unpleasant to the touch. As a result, it is seen as a machine that is unfriendly and not inviting any contact. It sparks concern, antipathy, in some cases it causes disgust.

> *It is so bulky. (FGI Seniors 60-70)*

> *Disgusting... (FGI Seniors 70-80)*

> *I prefer things that are warmer, friendly. But this robot is just… looks cold and unpleasant. (FGI Seniors 60-70)*

- **Communication with Tiago**

Respondents declared that voice communication (via voice commands) would be the desired and the most convenient form of communication with the robot for them. They would not like to be using an interface on a tablet or any buttons on a remote control for it.

> *It's definitely easier to say things than using a remote. (FGI Seniors 60-70)*

However, they had a range of negative feelings about the voice that the robot uses to communicate with users. They described it as unnatural, mechanical and monotonous. Respondents expect the robot to communicate using a voice that is more similar to a human one, with a warm, gentle tone.

> *I mean, it just sounds artificial. (FGI Seniors 60-70)*

> *If it was constantly using that monotonous voice, like robots do… then each of us, not even the ladies would be able to take that for long! If it kept buzzing with the same, monotonous, formal voice. (FGI Seniors 60-70)*

To many, the way the robot named the activities and confirmed that it had accepted the command seemed unnatural and excessive. However, this could be due to the formal and mechanical voice.

> *Because every activity needs to have a command and confirmation. That would be annoying. (FGI Seniors 70-80)*

However, respondents different in their opinion on the robustness of the interactions between the robot and the human being. Some would expect the possibility to have longer conversations with the robot, at times even initiated by the machine. Others preferred communication limited to the essential minimum.

> *Communication with the robot reminded me of something you can create with a human being… it needs to be made more spontaneous, that robot needs to talk. It cannot only react. (FGI Seniors 60-70)*

Regardless of the scope of the interaction, most respondents prefer for the tone of the voice and communication style to be as close to a natural conversation between two people as possible.

- **Tiago moving**

Respondents also expressed concerns about how the robot would move in the apartment. They pointed out that there are many potential barriers in their homes, such as carpets, thresholds, narrow passageways that Tiago could not cross.

> *Well, it moves just like these round vacuums. It needs to have smooth floors, no thresholds, no carpets, no anything on the floor. It needs open space. And that's something you don't have in Polish apartments. (FGI Seniors 60-70)*

Respondents had difficulty expressing their preferences with regards to such interaction details as the side that the robot should approach the person from, or the distance that it should move the person to. Seniors only pointed out that the robot moves too slowly.

However, one has to keep in mind that these aspects of interactions with the robot can be reliably evaluated only when being directly exposed to the device, for example during live demo sessions.

2.1.6. Recommendations for optimization the INCARE solution:

Based on the interviews with the respondents, the following recommendations have been formulated regarding INCARE solution in the future:

INCARE application

- The INCARE app should be connected to a senior-dedicated app and it should send information to this app about the measures and tests that had been done, but also about any results that are out of norm.

- The INCARE app could remind the user about the need to monitor their health.

- The app should inform the senior when their result deviates from the norm or their results thus far.

- The app should be able to save the results in a format that can be later sent via email and printed (i.e., for the purpose of a doctor's appointment).

- We recommend replacing the NFC Tag with a card, which seems more convenient to use due to its larger size.

- The font of the symbols used in the app and in the games should have larger sizes.

- The results of the tests should be displayed in the form of tables, bar graphs or they should look like a hospital medical records' card – to make it easier to interpret the results.

- One should eliminate any technical difficulties: recording too many tests sent from the pulse oximeter, overlapping results of blood pressure and heart rate, difficulties coming up with logging in or health measurements.

- The number of available games (and the difficulty levels in each of them) should be increased and it should also have classic forms of entertainment, such as solitaire, crosswords or sudoku

- The games should be divided into areas (i.e., for testing the memory, reflex or for relaxation), but also varied when it comes to difficulty levels

Design and functionality of the robotic platform

- A robot directed to seniors should have a smaller size (more compact), so that it doesn't take up too much room in a small apartment

- The robot should look friendly and seem kind and warm. It should have delicate, streamlined shapes and needs to be built from warm materials that are pleasant to the touch. We recommend considering adding something the seniors know well (Perhaps it should resemble a human or animal more, etc.)

- The robot should communicate with a voice that is as similar to the human voice as possible. The voice should be warm, with a gentle and informal tone. At the same time, seniors may differ with respect to their preferred voice (i.e., some prefer a male, others a female voice). It would be good if the user had a chance to choose a preferred voice, i.e., several available voices.

- The default form of communication with the robot should take place via voice commands.

- The robot should move freely around the apartment – should move across any possible thresholds, should open closed doors (inner doors, but also the door to their apartment).

- In future, we recommend considering connecting the robot to the public or private healthcare system, so the robot can also contact medical staff (useful especially when the senior is not cared for by anyone close to them). In health-hazardous situations, the robot should be able to notify the emergency services.

- The robot should be able to give objects.

- The robot platform should be introduced into the senior's apartment with a simple, but exhaustive instruction manual, as well as a set of answers to the senior's most frequent questions, regarding i.e., charging, its reliability and the place where it can be given out for repairs or where one can ask for assistance.

2.2. Romania

The midterm evaluation of the INCARE product in Romania was carried out by CITST with two categories of users, i.e., seniors living at home and informal caregivers. They are called individual users. Their input and feedback were gathered during the testing period via individual discussions which were initiated either by users who required help or additional information, either by the CITST staff who was checking on the users. In addition, the questionnaires in the ANNEX were used to collect the final answers. The questionnaires were initially designed in Word format (.docx) and then converted to Google Form format. Because of the limited digital skills of our participants, but also because we wanted the answers to be more elaborated and provide more input for the INCARE consortium, the questionnaires were administered by a member of CITST. After we gathered the data, we analyzed it by the use of Google Forms and exported charts to be used in this report.

2.2.1. Sample description

We had a number of 14 participants in our study, 10 seniors and 4 of informal caregivers for 6 seniors, i.e., two of the informal caregivers were helping pairs of seniors. All of our participants met the recruitment age and health related criteria defined in D1.1.

2.2.1.1. Seniors

- **Demographics**

All senior participants were retired, so they were over 65 years old. The ages of the participants were between 65 and 93 years old, with the average age at about 78.3 years old. Thus, we can say that we had representatives for all the 3 main age groups recognized in Romania: groups: elderly (65-74 years), old age (75-90 years) and longevity (over 90 years).

The gender of the seniors was almost balanced, having 6 males and 4 females participating in our study. They all lived in the urban area, in either medium-sized cities (2 out of 10 participants) or large cities (8 out of 10 participants). The medium-sized cities have a population of 100 000 to 500 000 residents, while the large city, in this case Bucharest, has a bit over 1.8 million residents. All seniors had tertiary education, and were specialized in a variety of fields (see Figure 7).
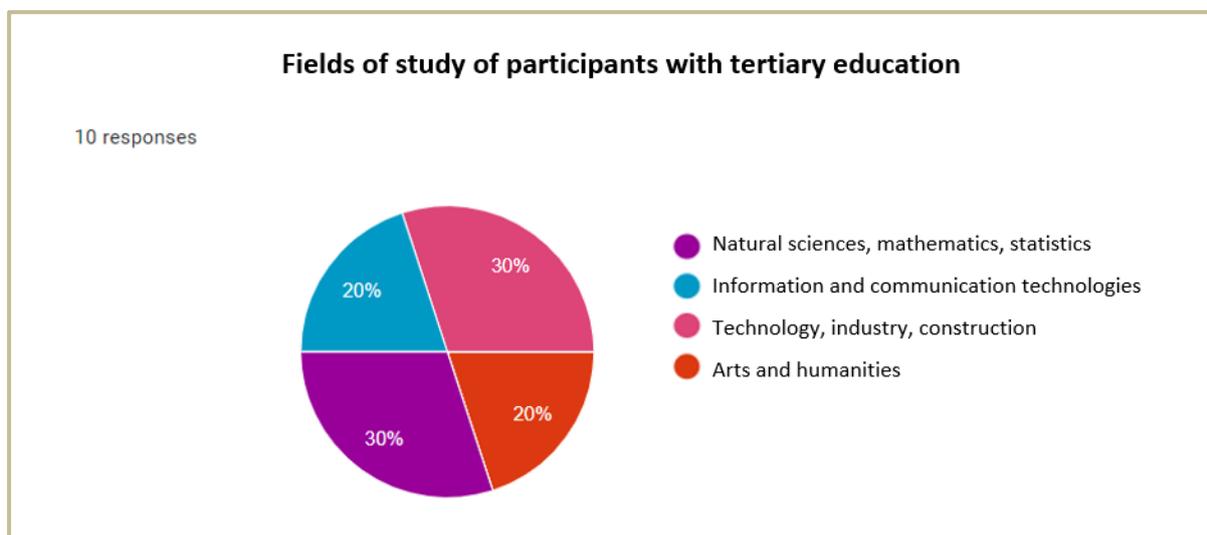

Figure 7 - Fields of study of senior participants with tertiary education.

Given this information, we were able to draw a couple of conclusions, one of the most important ones being that the majority of our elderly participants either had constant contact with technology or worked with technology on a regular basis. This was further investigated in the questionnaire.

- **Digital skills**

Even though technological literacy was not a criterion for the participants in the INCARE project, the majority of our seniors used either a smartphone, a laptop, or both on a regular basis. Their preference regarding the usage of technology is presented in Figure 8.
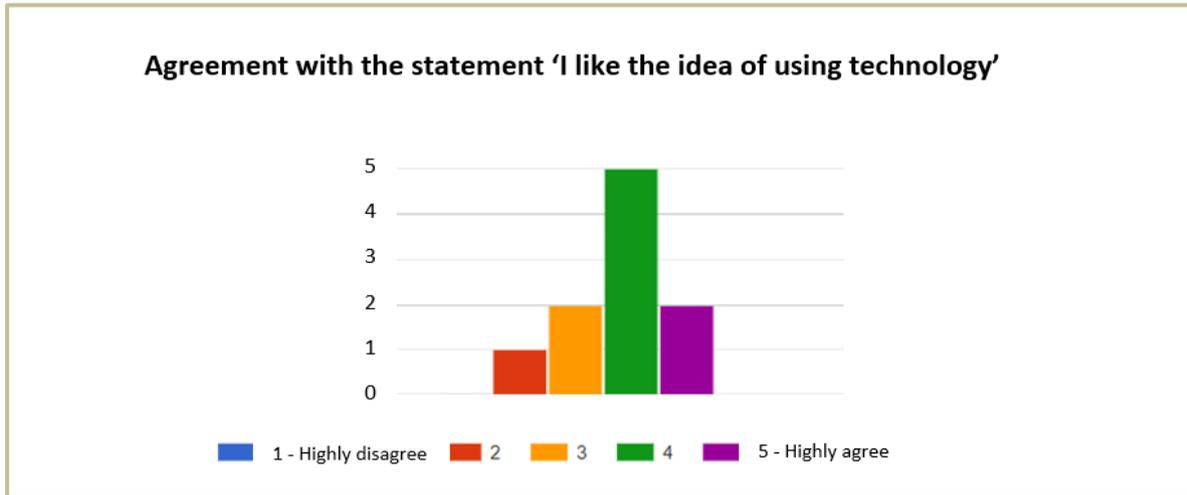

Figure 8 - Level of agreement of senior with the statement 'I like the idea of using technology'.

As we can see, 7 of 10 participants liked the idea of using technology, because they believed it to be useful. Being asked about the effectiveness of technology in their daily activities, the seniors were either neutral or pro technology, considering that it would increase their efficiency in completing daily tasks. More than half of the participants also agreed about the utility of technology in everyday life and its accessibility for them. Financial situations did not seem to be a reason why the elderly did not use technology more.

Hesitation and fear of using technology did not seem to be an issue among the majority of our respondents, who believed that any mistakes they might make involving technology can be easily solved. But, regarding the skills needed in order to perform certain activities with the use of technology, the seniors were not very confident, more than half of them believing they might not have the needed skills even if someone is willing to show them how to do it.

- **Health condition**

The senior participants had one or more physical conditions or disorders. The most encountered conditions were diabetes and cardiovascular diseases, followed closely by hypertension. Diabetes is a condition from which 5 of our participants suffer, one of them being in constant need of insulin shots. Cardiovascular diseases also affected 5 of the participants, and hypertension affected 3 of the seniors. Other physical disorders mentioned by the seniors were metabolic disorder, cancer, scoliosis, arthrosis, spinal deformity, cataract and reduced mobility because of a broken leg bone.

An important factor that can preserve, or even improve, health, is the level of everyday physical activity.
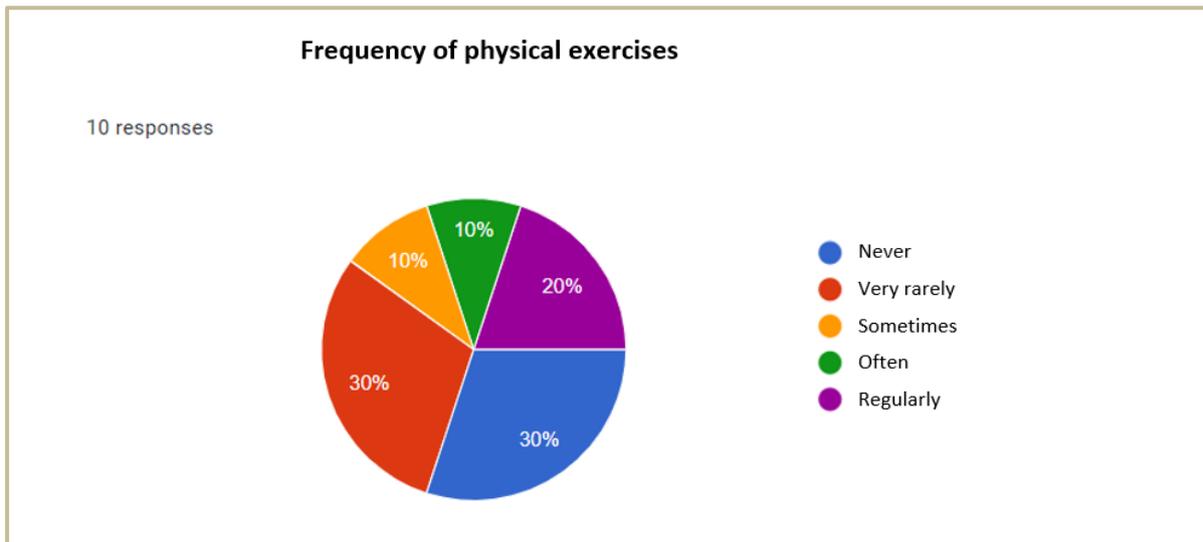
Figure 9 - Frequency of seniors doing physical exercises.

Even though the seniors' answers were divided in this matter, with more than half of them considering that they don't do enough physical exercise, all of them mentioned physical routines that improve overall health. Examples are: work inside the house and in the garden, walking in the park or to certain places where they have to perform routines, such as the market or the doctor and gymnastic exercises.

Mental conditions were not as encountered as physical ones, 6 out of our 10 seniors having no mental impairments or issues. One of our participants had depression, a fairly usual issue among the elderly, and the rest of them had a condition that leads to decline of cognitive ability, such as dementia or Parkinson's disease. In order to see how the seniors preserved their cognitive functioning, we asked about cognitive games. We discovered that the majority of our participants, 8 out of 10, play some kind of cognitive game or exercise to keep them busy. When we inquired about their kind, most of the elderly mentioned Sudoku, but other activities were also popular: crossword puzzles, Scrabble, reading books and computer games.

Regarding issues that can be perceived as disabilities, one of our older participants mentioned advanced arthrosis and Parkinson's disease, another mentioned hand arthrosis, one mentioned deformity and compression of the spine and the last one mentioned insulin dependency in order to survive. The rest of our participants considered that they had no disability.

In order to function on an everyday basis, the majority of the seniors said they need to follow a certain long-term medical treatment, which always consisted of medicine. The medicine mentioned was used to treat the illnesses specified earlier. With regards to taking the medicine, most of the respondents said that they very rarely forget to take it.

In an effort to preserve their health, all of our respondents monitor their health, although the frequency varies.
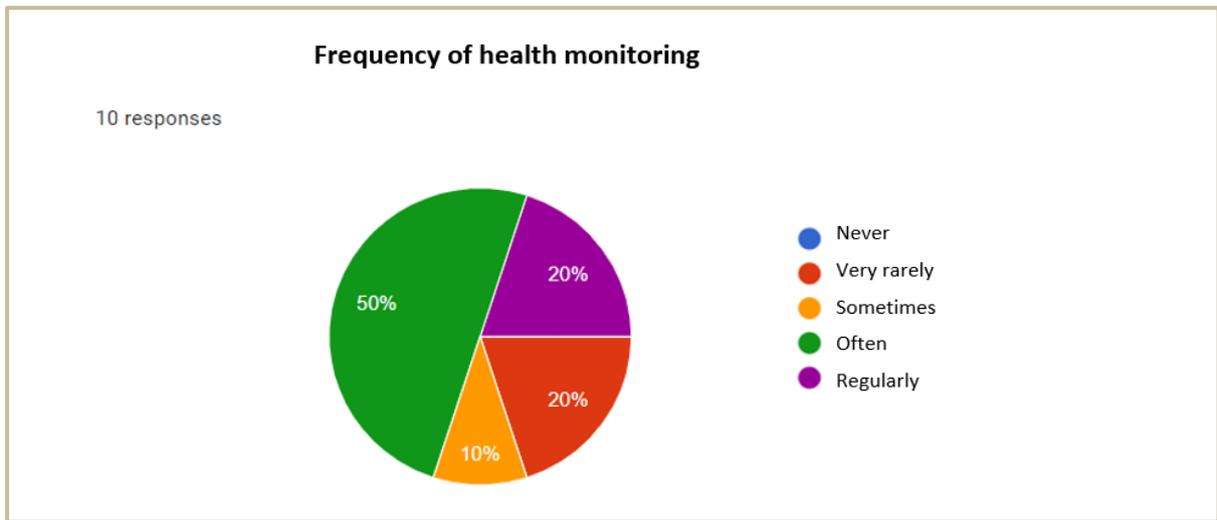
Figure 10 - Frequency of seniors monitoring their health.

Most of them do it often or regularly, using devices such as the blood pressure meter, the glucometer, the scale or the pulse oximeter. Not one of our participants mentioned the thermometer, as, in our country, it is usually used when someone has a cold or the flu, not on a regular basis. The seniors' need to constantly monitor their health parameters stems from, just as in the case of medical treatment, the various health problems they have to live with.

- **Independence**

Independence is composed of several different elements, some of which we managed to quantify during our study. Mobility is one of the most important ones. The mobility levels of our participants were divided into 2 categories: able to go outside the house by themselves and able to get out of bed with help.
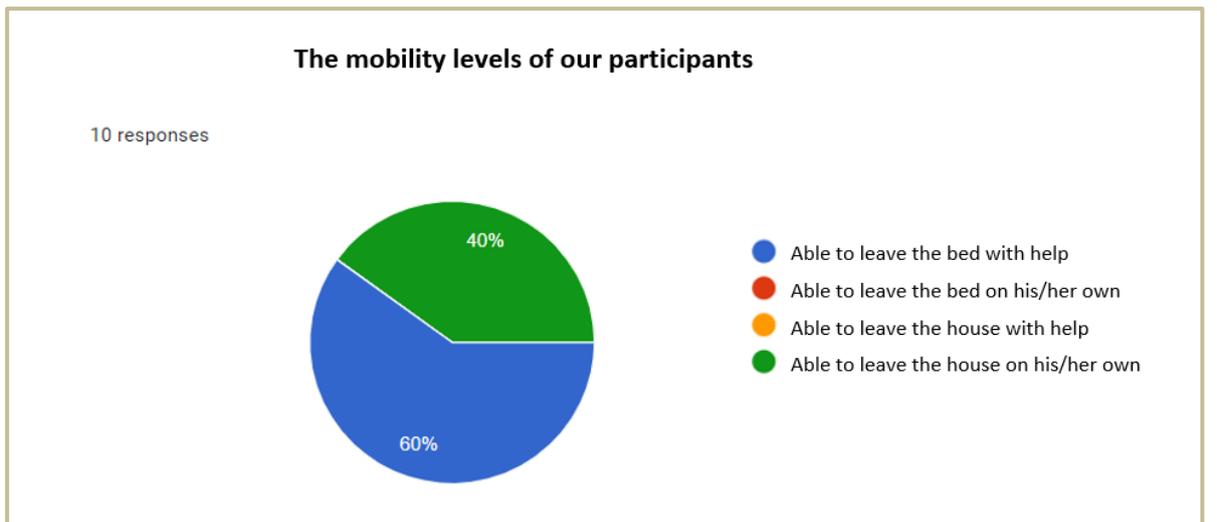
Figure 11 - Mobility levels of the senior participants.

Given this data, we can conclude that 4 of our senior participants are quite independent, having the ability to walk outside without needing or requiring help, while 6 of our senior participants are completely dependent on their informal caregivers, as they cannot get out of bed without requesting exterior help and support.

Concerning independence in everyday activities, the majority of our participants said that they take care of their shopping needs on their own, without exterior help from an informal caregiver. With regard to the planning, serving and eating of adequate meals, only 4 out of 10 participants said that their meals are prepared by them and are healthy. The rest of the participants mentioned that either their diet is not adequate or their meals are not prepared by them. Almost all of the participants said that they participate in householding tasks, some can only do simple ones, such as folding the laundry, while others can even do complex ones.

As for medical treatments, our seniors are mostly autonomous, being the ones responsible for taking the medicine in the right dose and at the right time. Only 2 of the participants admitted that they help in this particular matter, the informal caregivers being the ones responsible for preparing the right dose of medicine and giving them to take it at the right time.

2.2.1.2. Informal caregivers

- **Demographics**

The informal caregivers were mostly old adults, between 40 and 71 years old. The average age was approximately 54 years old. Regarding the gender division, we had only women caregivers, an explanation being that, in our country, mostly women take the role of caregiver. They are relatives of the seniors they take care of, being either spouses, children or grandchildren. All of the informal caregivers lived in the same city as their elderly relative, half of them in the same house as the senior, and half separately. Two of the caregivers were each helping two family members.

- **Caregiving**

The caregivers offered help in a variety of household activities, which cannot be performed by their elderly relatives alone. Our participants mentioned activities which can be divided into 2 categories: for dependent and for mostly independent seniors. For the dependent seniors the following activities were mentioned: helping them get out of bed, helping them reach the bathroom/toilet and preparing food, etc. The independent seniors were helped with: paying their bills, shopping, driving them by car to certain places and keeping them company.

Regarding the number of hours participants usually devote to caring for their elderly during one week, 25% were helping 1-2 hours, 50% were helping 9-20 hours and 25% were helping more than 20 hours.
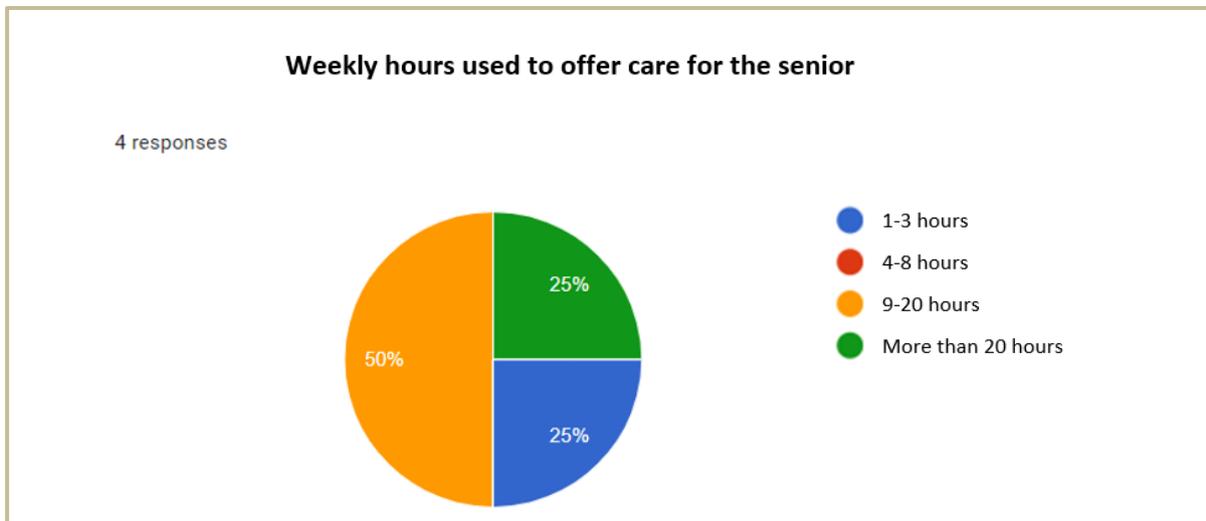

Figure 12 - Weekly hours used to offer care to the senior (caregivers).

The number of hours is mostly high, and, based on the received input, the caregivers feel that they need to spend more time with their elderly so they won't fall victim to accidents or have health crises which they won't be able to solve. In a lot of these cases, it is hard, or even impossible, for seniors to ask for help. What is more, the caregivers had different opinions when it came to the sufficiency of the number of hours devoted to the seniors, some considering that the time they spend with the elderly was enough to satisfy their needs, some not. The areas in which the participants believed the elderly would need more help were: walking outside the house, physical exercises, cleaning and cooking.

Caregivers agreed about the types of activities where seniors can be independent and the types of activities where they need help.
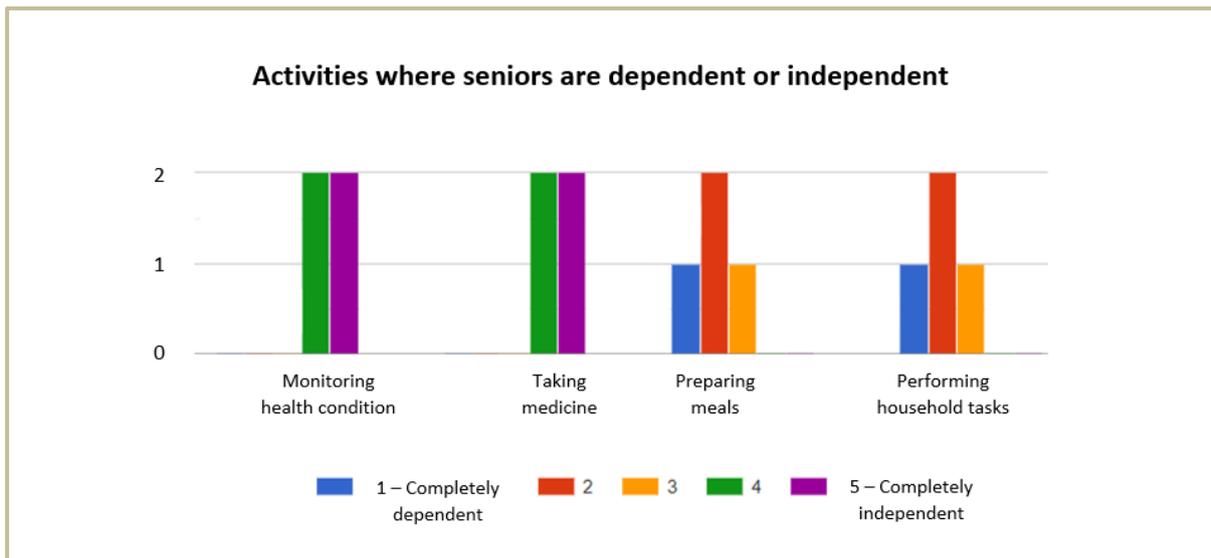

Figure 13 - Level of dependency of seniors in certain activities, according to caregivers.

As we can see, seniors are mostly able to monitor their health and take their medicine, as these are simple tasks, which do not require mobility or extraordinary skill. On the other hand, it seems that this does not apply to activities such as preparing their own meals or executing household tasks, as these activities are more complex and require a higher level of mobility, both in their feet and their hands. Cleaning and cooking were also mentioned earlier, when we asked the caregivers what are the tasks where the elderly would need more help.

● **Satisfaction with life**

Another factor that we have to take into consideration when we think about the INCARE platform is the impact of the caregiving on the caregivers' lives and how we can ease its effects. This being said, our caregivers were asked about different parts of their life and how caregiving is affecting them. Two of them revealed that they are unhappy with how they live as a result of the constant support they need to offer. They mentioned a permanent feeling of exhaustion, the steady need to escape their situation and the feeling that they are not the same person as before the caregiving. They also specified that their quality of life decreased as a consequence of the care they constantly have to give. Concerning the social aspect of their lives, the 2 caregivers said that they feel torn between their environment requirements, such as family, and the senior care requirements, and, likewise, their relationships with their relatives, friends and acquaintances suffer because of the care they give.

2.2.1.3. Robotic platform evaluation

For the robotic platform evaluation, we had 13 users, of which 9 were elderly persons, and 4 were the caregivers of some of the seniors. The elderly participants were between 65 and 78 years old, while the caregivers were between 50 and 58 years old. Six participants (4 seniors and 2 caregivers) evaluated the Tiago and Turtlebot robotic platforms directly, in life demos, while the rest of the participants have evaluated the robotic platforms by using of movies prepared with three robotic platforms (Tiago, Pepper and Turtlebot). While Tiago is a service robot capable of offering support in the daily life activities, Pepper is more of a companion robot, and Turtlebot can offer help with carrying items and hazard detection.

2.2.2. Evaluation of specific components of the INCARE solution (application)

During the testing process we asked our participants which was their opinion regarding certain elements of the INCARE solution. Some components were seen as useful, some not, but, in general, the solution was well perceived.
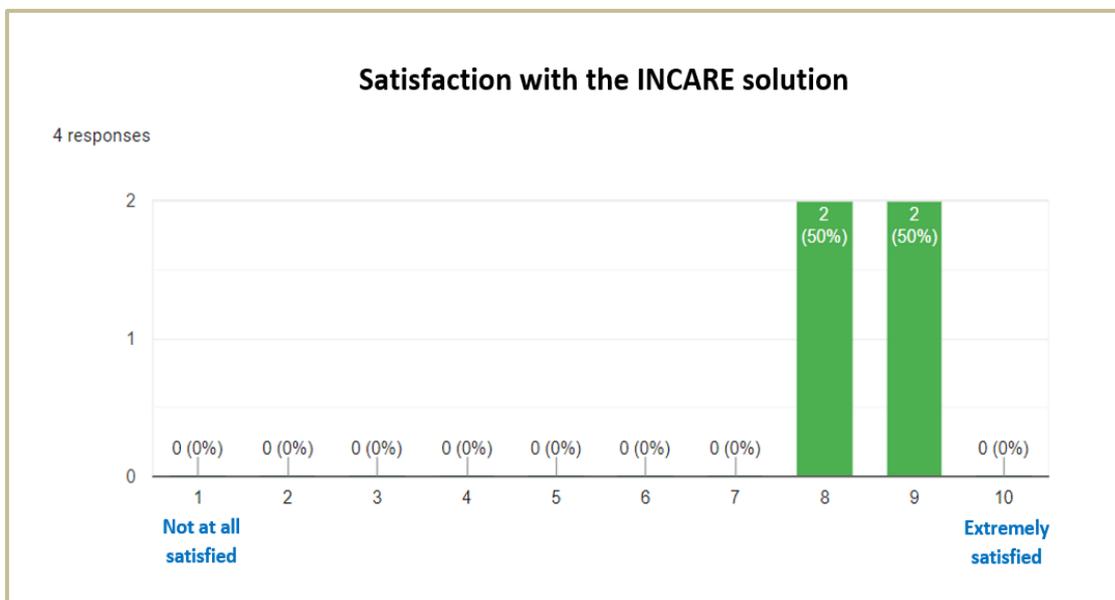
Figure 14 - Level of satisfaction of caregivers with the INCARE solution.

As we can be seen in Figure 14, all caregivers were satisfied with the functionalities of the INCARE solution, considering that it helps with the care they have to give and, also, with their own peace of mind. They don't have to worry that much about their elderly relatives because INCARE allows them to monitor their health, activity and cognitive progress.

2.2.2.1. Health panel

The possibility of recording the health parameters was the most appreciated functionality of the INCARE app, by both seniors and informal caregivers. All the seniors mentioned health monitoring and history of health data, saying that they find it very easy to share this data with their caregivers or their doctors. This is especially true for elderly participants with chronic diseases.

*'I love the glucose monitoring, it is very useful for a diabetic and
I also like that my wife can also check my measurements'*

Senior participant with diabetes

For this participant who suffers from diabetes, the health monitoring functionality was extremely helpful, as it enabled him to have a history of his measurements. Also, the wife was less concerned because she was able to monitor his values.

When asked if he was satisfied with the INCARE solution, another participant mentioned the usefulness of the health history.

'Yes, I am using the health history when going to the doctor'

Senior participant with chronic illness

They also mentioned that the detection of new health problems or the deterioration of the actual health condition would be easier if the seniors' doctors had access to a database which stores all the health measurements taken by their elderly patient. The caregivers felt that it was easier to stay up to date with the health parameters and the overall health condition of the elderly they take care of, being mostly satisfied with the INCARE app.

Despite the ease of use and intuitiveness of the health panel, which were mentioned repeatedly, there were also some parts in which the seniors required help. At the beginning of the pilots, seniors had difficulties in remembering how to use the app, how to take measurements and what buttons to press. Several of them called even couple of times to ask for help. Also, we noticed that the participants tended to view the whole idea of our project as an obligation, something they had to do, more than something that could benefit them personally. This solution was designed to take care of their lives and improve their way of living, yet they treated the whole measurement taking process as something similar to homework.

2.2.2.2. Games

An appreciated component of the INCARE solution were the games. They were a source of entertainment for the seniors, an aspect valued by the informal caregivers. Seniors don't usually have a high level of activity, especially the ones with reduced mobility or serious health problems, and this is why they are often bored and unhappy with their lives. Games were a good way to pass some time and enjoy themselves while doing so.

Some improvements to make in this regard were pointed out by a senior, who requested some more complex games, maybe some strategy games or something more appropriate for their age, like Sudoku. The same participant considered that the available games are interesting, but a little childish. Likewise, a caregiver mentioned their elderly relative's desire for a game loved by the senior generation.

'Cognitive games were a plus but he would have liked Sudoku to be among the games'

Caregiver of elderly participant

Thus, we must take into consideration some important factors when further developing this functionality such as which games elderly like to play. The most frequently mentioned was Sudoku, but other games were also popular: crossword puzzles, Scrabble and computer games.

2.2.2.3. Medical devices

The medical devices were considered useful and relatively easy to use by the majority of the participants. Some of them already used similar devices in order to take their health parameters, thus testing the medical devices was not difficult. They mostly tested the blood pressure meter, the glucometer, the oximeter and the thermometer. In one case, a senior also tested the weighting scale.

The blood pressure meter was the most appreciated device, being the medical device the seniors used most frequently. A good part of our elderly participants had cardiovascular problems or hypertension, conditions which makes them bound to use the blood pressure meter permanently. Regarding this device, the advantages were the ease of use and the fact that the hand band inflates quickly, making the whole process fast and comfortable.

The glucometer was also considered easy and fast to use. The majority of the elderly participants said it was ok, it worked well, but they preferred the glucometer they had at home. This was especially true for one senior with diabetes, who said that he prefers his glucometer, the one he has been using for a lifetime, because he has more trust in it.

The oximeter was the device the elderly participants used the frequently. There are 2 explanations for this: the oximeter was the quickest and easiest device to use and the pandemic situation determined the seniors to be more attentive to their lung health.

The thermometer was definitely not as popular as the rest of the medical devices, seniors finding several reasons why they don't like to use it. It is important to mention that it was a digital thermometer, not an infrared one, so it took a bit more time to take the temperature. This was the main reason why the elderly participants did not like it because otherwise the feedback regarding large display with large print was positive.

2.2.2.4. App functioning

The INCARE app had a high level of approval, being considered mostly easy to use and clear. The app worked well and had a quick response to commands and to health measurements, proving suitable to be used by both informal caregivers and their elderly relatives. However, problems appeared from time to time and users started complaining about connection issues.

'Sometimes I was not able to connect to the interface and sometimes
my parents in law were not able to log in on their tablets, especially at the end
of the usage. There were no problems for several months and then problems started to appear'

Caregiver of elderly participant

Other problems involved the Calendar functionality of the app, which got negative reviews from most of our participants. One issue was the fact that the seniors had to write their own reminders, and this proved really difficult for the majority of them, as the elderly were not used to the touchscreen interface of the tablet. The touchscreen was difficult to use in general, but writing while using the keyboard was considered almost impossible to do. Another problem was the form in which the reminders were shown on the tablet, which most seniors considered useless. They said the whole functionality should be improved in order to be easier to utilize.

The NFC tag proved to be a bit too small, and hard to place in the right spot on the back of the tablet, thus the elderly participants had problems connecting to the app. Also, the elderly had difficulties understanding why they needed to use the tag in order to connect to the app.

However, the problems experienced by the participants were easy to solve, we had the possibility of connecting to their tablets remotely. We implemented a remote assistance solution so we won't have to go to their homes every time something went wrong with the app. This had been a very good idea, as it saved us time. If an issue appeared, we connected to their tablets and showed them how to solve it or, if they were stuck somewhere, we helped them get back where they should be.

2.2.2.5. Usefulness of the INCARE solution

There were different opinions regarding the usefulness of the INCARE solution, but most of them focused on the positive impact it can have on the seniors' lives. Thus, we can say that the first advantage is that the usage of the INCARE app accustoms the seniors with technology and it makes them more open to using it. Most of the people over 65 years old from our country don't know much about technology and they reject it in every aspect of their lives. They lived most of their lives in a world without technology and they don't understand what benefits its employment might bring to their lives. This is why it is very important to push seniors into taking contact with technology. A more technology-friendly elderly generation could make their own lives, and the lives of their caregivers way easier.

The second advantage was that the existence of the INCARE solution in the homes of the seniors made them to pay more attention to their health. The easy way in which the app works and displays health measurements determined the elderly to pay more attention to their general health condition. Furthermore, the possibility of storing health information was reported to be a real advantage when going to the doctor, as it shortens the appointments and points the doctor in the right direction, making it easier for him or her to diagnose complex illnesses and conditions.

The third advantage of the INCARE solution were the effects of the game playing for the seniors. Games are fun at any age, making the elderly spend their time in an entertaining and amusing way. It can make them feel less alone when the caregivers are not available to spend time with them or when they have nothing else to do. On the other side, the games implemented in INCARE have real cognitive benefits for the seniors. They are meant to 'train the brain' and make the seniors less likely to develop cognitive impairments, such as dementia. At the same time, they helped the elderly which already have dementia or other cognitive affections train their memory and thinking.

 The fourth and last advantage stems from the peace of mind the INCARE solution can give to the informal caregivers. Many caregivers reported that, not being in the company of the senior determines anxiety and fear, because they don't know what might happen when they are not there. Seniors are prone to accidents, such as falling and hurting themselves, and to health emergencies due to comorbidities, such as strokes. Moreover, some seniors with cognitive decline tend to have panic attacks, as they forget or don't remember where they are, what they are doing there and so on. When the caregivers are aware of the daily health parameters of the elderly, and their possibility of pressing the panic button if everything is wrong, they can assess their condition better and intervene if there is anything unusual.

2.2.3. Evaluation of the robotic platform

- **Tiago**

Tiago is a relatively large mobile service robot designed to work in indoor environments. It has an extendable torso and its sensor suite allows it to perform a wide range of perception, manipulation, and

navigation tasks. CITST's Tiago also has a manipulator arm to grab tools and objects[4]. He is capable of lifting up to 2 kg with an extended arm. Tiago has also a powerful hardware computing hardware and can run a huge number of applications in real time. The demonstrated ones were: navigation, object recognition and manipulation (including objects dropped on the floor which can pose a hazard to the users), activity recognition (including falls), person identification and tracking, communication with caregivers.

There were 3 short videos of Tiago available mid into the pilots. The first short movie showed the participants the ability of Tiago to detect a person in the room, greet them, say its name and shake their hand. It also showed the functionality of detecting objects that fell on the floor, telling the person that they should be careful with the objects on the floor and taking the objects from the floor and removing them from the person's path. It is especially made to remove any obstacle in the person's path, so there won't be any possibility of tripping and falling.

Figure 15 - Tiago greeting a person and shaking hands.

The second video was of a person falling in their room and Tiago coming from another part of the house when it detected the fall via the wearable sensor. It recognized that the persona was lying on the floor and started a communication asking about the status. Tiago also sent an emergency alarm to the caregiver when it detected the fall and when it received an answer from the victim.

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[4]https://robots.ieee.org/robots/tiago/#:~:text=TIAGo%20is%20a%20mobile%20service,%2C%20manipulation%2C%20and%20navigation%20tasks [Accessed February 4, 2022].

Figure 16 - Tiago reacting to a human fall in a work office.

The third movie showed Tiago helping a person using crutches by bringing a cup of tea from the kitchen to the room. Tiago listens to commands and follows the person to the kitchen, waits for them to prepare the tea, turns around so the person can put the tea on its platform. It then follows the person back to the room and turns around to allow the person to take the tea.

Figure 17 - Tiago helping a person using crutches to transport a cup of tea.

At CITST, we showed the 4 seniors and the 2 caregivers the robot Tiago and its functionalities live, asking them what is their opinion regarding it. The rest of the seniors were watching the videos and asking questions online.

- **Pepper**

Pepper is a social robot able to recognize faces and basic human emotions. Pepper was optimized for human interaction and is able to engage with people through conversation and his touch screen. It is also programmable and can perform certain vocal commands[5]. In addition, Pepper is also compatible with home monitoring apps allowing him to interact with smart home devices such as lights, blinds, etc.

The short movie about Pepper showed the participants the ability of Pepper to detect persons and recognize them, greet them and follow commands such as showing them their health measurements, telling them how the weather will be tomorrow and command the environmental sensors (lowering the window blinds, changing the color of the light in the room). Pepper can also follow a person and stop when it is requested to do so.
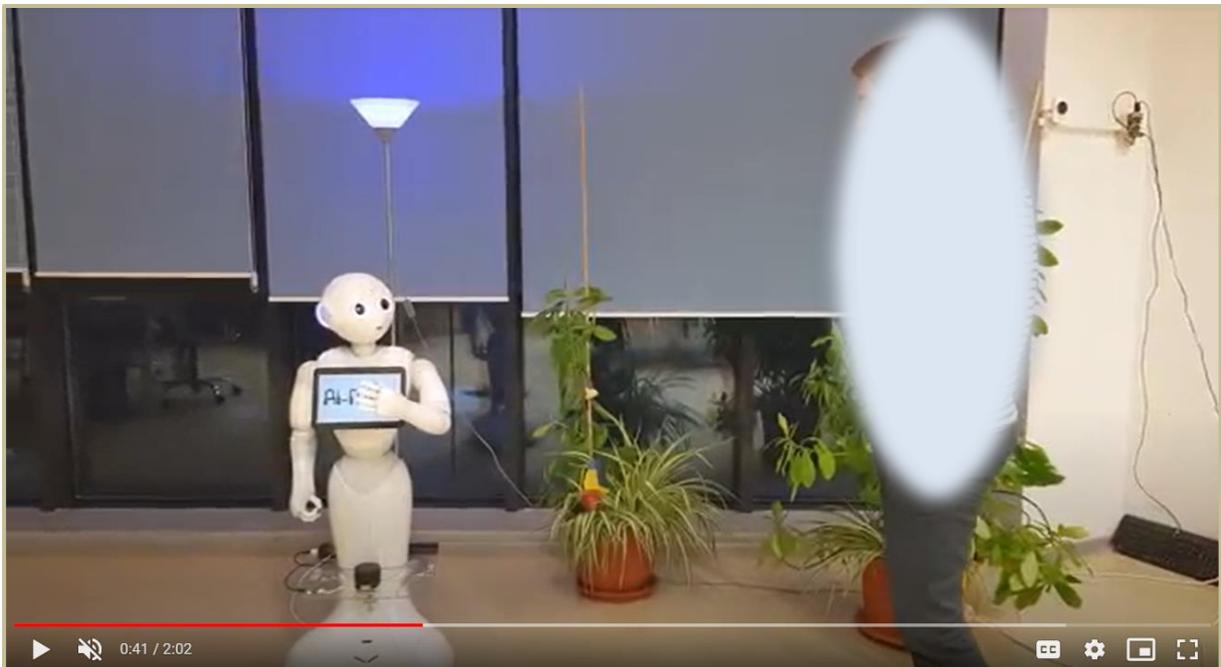
Figure 18 - Pepper talking to a person and responding to their commands.

- **Turtlebot**

Turtlebot is a simple and affordable robotic platform which is capable of autonomous navigation on predefined trajectories making it more predictable. It can carry small objects such as cutlery, medical devices, books, remote, etc. In INCARE it is also compatible with the following apps: navigation, auto-docking, object and activity recognition. A screen was added to the commercial Turtlebot version and a loudspeaker. In this way, Turtlebot can display information for the users via an image or voice.

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[5] https://www.softbankrobotics.com/emea/en/pepper [Accessed February 4, 2022].

Figure 19 - Turtlebot recognizing objects on the floor and interacting with a user.

2.2.3.1.   Acceptance of the robotic platform

As it was expected, seniors were mostly reluctant when it came to the existence of robots in their house and their lives. The majority found the functionalities of the robots interesting when watching the short movies, but the idea of a robot in their proximity was mostly frightening. A part of them motivated their hesitation by saying that they have a small apartment and the level of comfort will dramatically drop if they would also have a robot in there.
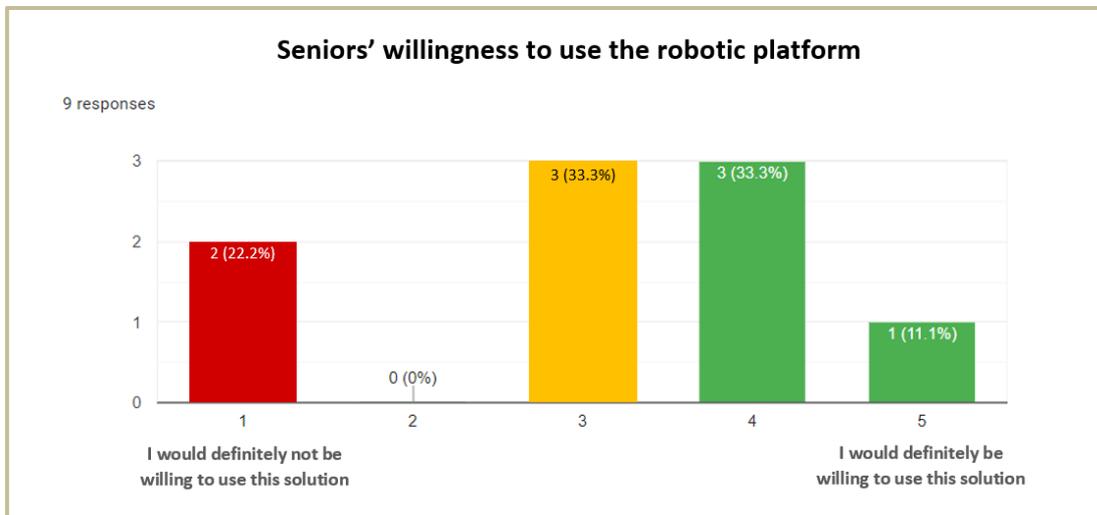
Figure 20 – Level of acceptance of seniors of the robotic platform.

As we can see in this chart, there were different levels of willingness to use the robotic platform. The seniors who did not use technology or were not familiar with it said that they wouldn't like this kind of solution in their homes or they were undecided regarding it. They evoked reasons such as the expensiveness of these robots, being afraid not to break them, or the fact that the movies almost always present them in a negative, frightening way. The seniors who were used to technology or worked with it during their lives were more likely to accept the idea of a robot assistant, especially if they had reduced mobility. They said that such robots could be very useful around the house, as they can be programmed to do a lot of tasks, and they are the future of this world.

- **Tiago**

As appearance goes, Tiago, with its relatively voluminous body, was not preferred by our participants. Some seniors considered that it would be better if Tiago would be smaller. Some said that the arm is a bit scary and can hurt them. One participant would appreciate it if it would look more like a machine, and less like a human, as its appearance is disconcerting. Due to its large size, especially of the arm, some seniors considered that Tiago cannot be trusted

- **Pepper**

Pepper was more popular than Tiago when it came to appearance, mostly due to its smaller size and its human-like voice. To quote from the elderly participants, Pepper is 'cute' and 'more stylish' than Tiago, being easier to accept inside the house.

- **Turtlebot**

Turtlebot was considered to be interesting from cost point of view but less appealing despite its many functionalities.

2.2.3.2. *Evaluation of the usefulness of the presented features of the robot*

- **Tiago**

Regarding usefulness, Tiago got a better review, the seniors considering that it can help with more things and perform more tasks than its partner, Pepper. The arm was considered very helpful, its ability of lifting and carrying objects around the house would be greatly appreciated by our participants. The seniors mentioned the ability to detect falls and sound the alarm as another important feature of Tiago. It was all the more important if the senior spent most of his or her time alone, without the company of family or an informal caregiver.

About what our participants would like to change about Tiago, we can say that most of them want a more fluid interaction with the robot, as they believe its 'voice' sounds unnatural and its movements are not very fast. Its inability to pass over obstacles was, likewise, considered an inconvenience. The shape of the robot was considered 'bulky', a participant mentioning that they would like this robotic companion to look more like a robot vacuum cleaner. Furthermore, an appreciated improvement would be the ability of this companion to actually do household chores, such as cleaning the house, cooking, putting things back to their place or lifting heavy objects.

- **Pepper**

Pepper was considered 'fun, but not very helpful'. Its main advantage was the ability to keep company to the lonely seniors and entertain them. One participant said that their nephew would love it, as it seems a device more suitable for a kid. Other 2 participants recognized that the features of this robot assistant could be better valued in a smart home, as it could do a lot more tasks if it were to be connected to such a place.

Our participants would have considered Pepper more useful if it were to be able to use its hands to help them or to be able to have a more complex conversation. Moreover, a participant asked for built in games, so the entertainment experience could be complete.

All the caregivers agreed that they would like robots as assistants, to help them take care of their elderly relatives. They appreciated the robots' ability to assist in the tasks they have to perform for their families and Tiago's ability to communicate with them in an emergency situation.

- **Turtlebot**

Both seniors and caregivers appreciated the functionalities implemented in Turtlebot. However, seniors perceived it as being less useful mostly because it appeared not to be sturdy enough. They also questioned the capability of the robot to pass over carpets. However, they thought that its price is the most attractive and affordable one. So, there were suggestions to improve its appearance such as to make it more acceptable.

2.2.4.   Recommendations for optimization the INCARE solution:

We mentioned several problems regarding the interface and the app functioning in some of the last chapters, so here we are going to also add the solutions we and the participants found for these issues.

- A new design for the Calendar functionality with alerts accompanied with sound signals or provided via SMS.

- A larger NFC tag or a clear and visible delimitation of the place, on the back of the tablet, where the NFC tag should be placed.

- The fixing of bugs or stability issues of the app and/or of the platform.

- A larger variety of games, which should include Sudoku, and more levels and difficulty settings for the available ones.

- Warning messages for the senior and, also, for the caregiver, if the usual health measurements are outside the normal parameters.

- Larger print on the health history axis, as the dots and their markings are hard to read and comprehend and the majority of the elderly have eye problems and cannot see very good even with glasses.

- More communication means with other users (caregivers), so they can easily get in touch with them if there is any problem. The calendar was not considered a good idea in terms of interaction, this is why some of the participants asked if a video meeting feature or a call feature could be developed within the app.

- A more detailed manual for the use of the app, as some features are hard to discover and comprehend by the seniors. If the seniors don't understand how the app works, they become frustrated and are less likely to use it.

- A button for printing the health history, as some of our participants considered that they are very unlikely to take the tablet with them to the doctor.

2.3.   Hungary

2.3.1.   Sample description

130 elderly users participated in the test. 100 seniors were living in their homes and testing the solution at a day-care facility under the supervision of caregivers. 30 seniors were living in a nursing home where they also tested the solution. A total of 5 professional caregivers participated in the tests. Two informal caregivers have also participated.

2.3.1.1.   Testing

Individual testing was performed in different day-care centers for 100 elderly people, always with the supervision of formal caregivers. This solution was implemented in order to reduce the risks associated with the pandemics. These risks would have increased substantially if the seniors were to be tested in their homes. It would have involved moving the equipment between seniors in order to cover all 100 users.

The 30 seniors testing the solution in a nursing home have used the platform on a regular basis. Three sets were installed in the 3 locations of the same nursing home. These locations were in the same district. The internal health safety and environmental procedures of the institution were in line with the regulations, and the safety and health of the elderly, the caregivers and the end-user organization personnel could be taken care of.

2.3.1.2.   Seniors

After the testing people were interested in continuing the measurements to see the eventual changes in the data. This justifies both the process and the web interface for informal and formal caregivers and for the elderly interested in checking themselves directly on the web. People have the opportunity to do so, however elderly people very rarely log in to the system, while the formal caregivers by definition are interested, able and willing to log in and check data.

- **Demographics**

All seniors taking part in the test are over 51 with the youngest being 51 and oldest being 92. In terms of gender there were 75% women and 25% men.

2.3.1.3.   Caregivers

10 caregivers were involved in the testing, who gained enough experience to provide valuable feedback on using and improving the system.

For example, caregivers in the first testing phase found the following: the Blood Pressure Monitor worked fine and the data was also posted on the Internet interface with all but one that was later corrected. Pulse Oximeter measurements were fine, however the results of the measurement were not visible on the web interface, or the measurement was broken several times on the web interface.

During Balance Scale measurements, data appeared only on the display of the device, neither on the Tablet nor on the web interface. The latter did not even appear as a listable tool.

Tablet NFC scans were fast, but it was difficult to switch from one user to another; the application had to be exited and relaunched and always had to step out and close the program to detect the next subject. Between measurements, idling, the tablet and app went asleep, so the user had to relaunch the app.

Some hardware errors also occurred during testing, which was an enriching experience: how the error was detected, reported, escalated, fixed and operation went back to normal.

After fixing the errors the measurements were carried out correctly and became visible on the web interface. The web interface has also been corrected with the data measured by other devices and is already being uploaded to the interface.

Configuration was tested in 3 different sites, which was a good practical experiment for the professional caregivers, how to pack, unpack, restart the configuration and do successful measurements at another location.

Caregivers welcomed the functionality that all measurements are available through the web interface and they can comment on them.

Commercially available measurement devices run out of power relatively quickly during regular use, which implies using heavy duty professional devices in case the frequency of the measurements goes beyond "home use" level.

2.3.2. Robotic platform evaluation

The aim of the robotic platform evaluation was to assess how elderly people would or would not accept non-human help, and 22 elderly persons aged between 65 and 75 were involved in and 7 caregivers were also involved in the evaluation. All participants listened to a short presentation on the role of robots and then watched educational videos about robots via the INCARE platform.

2.3.3. Evaluation of specific components of the INCARE solution (application)

2.3.3.1. Health panel

Health panel was fed by all data from the measurements. This was not directly used by the elderly, they relied upon the formal caregivers to ask for data eventually. They expected that notifications about extreme data (out of normal range) will be automatic, and proper medical escalation procedure is proposed by the formal caregivers in case of any deviances, which would imply consulting with a medical doctor.

2.3.3.2. Games

Our experience so far has shown that boredom is a serious problem for many older people, which is why the INCARE "Games" module has been a joy for many users. In addition to entertaining elderly users, the mental exercises help to maintain their mental fitness and increase their activity level.

A third of institutional users do mental exercises or games regularly or rarely, 26.7% very rarely and 6.7% never do them. 80% of the users involved in the pilot had tried the games or one of the games.

Respondents' opinions were rather positive, but many of them indicated that they would have preferred a larger screen or had problems navigating, most of them not being able to do so on their own. The

majority of users with more experience found some games too easy, while those with less experience of using IT tools found the games too fast in many cases and therefore they felt tired or discouraged relatively quickly.

All in all, it would be worthwhile to integrate additional games into the system that are more similar in form to the games they are used to (e.g., crosswords), and with the help of these, they would probably be more open to other games and play them more courageously.

2.3.3.3. Medical devices

The following configuration was tested in Hungary:

- Tablet
- Wi-Fi router
- Thermometer
- Blood pressure monitor/ECG
- Pulse Oximeter
- Weighting scale

Blood glucose monitor was not used due to the strict hygiene measures. It served the elderly and the caregivers for feeling safe, and not to be stressed by the risk of possible contamination by any sort of pathogens (virus, bacteria etc.).

2.3.3.4. App functioning

During testing, approximately 80 issues, bugs and feedback improvement suggestions were captured from the users. Most of them were fixed and built in the final application.

2.3.3.5. Usefulness of the INCARE solution

Elderly found the INCARE solution useful, however, they would not consider using it BY THEMSELVES, on a daily basis, unless it is offered by an institution in proximity, and operated by a professional caregiver.

There is a central application in Hungary for capturing the health data of the citizens, captured in the licensed health providers (https://www.eeszt.gov.hu/oldalvalaszto.jsp). This application is run by the government health authorities and is primarily for control, and for avoiding unnecessary redundancies, duplications of tests, and medical procedures. The system offers a well-defined interface for applications like INCARE. Currently, for some functions, digitally literate citizens use the system for checking data, making appointments, etc.

Clearly, there is a missing functionality where INCARE could be a great advantage and can be even connected to the central EESZT database with the permission of the user for the benefit of them, the medical professionals and private and government health institutions. This implies a later additional development and certification effort.

The elderly are less digitally literate, a fact that is going to change, in a few years, thanks to the development of digital education and the use of technology by the younger (future older) generations.

From the feedback, the main benefits for elderly, using the INCARE system regularly are:

- feeling of being taken care of

- providing basic feedback for more health and wellness conscious behaviours
- peace of mind in terms of expected vital signs are measured
- in case of out-of-range data, escalation process is triggered through the professional caregivers
- scheduled measurements at the daycare institution are also connected to a social event, which provides the opportunity of not being alone, having a conversation with like-minded people, learning, playing, exercising, and being more active.

For professional caregivers the main benefits are:

- they can enrich the services they provide to the elderly, meaningfully, expected and welcomed by them
- avoids emergency situations by having regular control over vital signs (e.g., blood pressure, pulse, oxygen saturation, weight, temperature, glucose level etc.)
- provides a good opportunity to talk about health and fitness education, and motivation to stay active and healthy, physically and mentally)
- motivates the elderly to visit the day-care institution and do more about staying fit.

For institutions engaged in elderly care, the main benefits are:

- offloads the system by regular basic measurements
- provides additional care to the one-off medical interventions at health institutions
- provides historical data to capture the evolution of the status of the elderly
- enables focusing on the exceptionally out of range cases
- provides feedback on the efficacy of medical treatment (e.g., stable blood pressure)
- helps motivate users to maintaining good life habits
- optimizes services

2.3.4. Evaluation of the robotic platform

According to statistics from the Hungarian Central Statistical Office, in Hungary, the ratio of women to men in the population over sixty-five is 60%-40%. Unfortunately, the ratio of men is significantly lower among people over sixty who are active and visit senior citizens' clubs. Therefore, our evaluation results are not representative in terms of gender. In our survey, there were nine female and one male respondents, giving a gender ratio of 90%-10% female to male. Data was collected using a questionnaire prepared by the INCARE consortium partners. The questionnaire focused on the knowledge, acceptance and possible use of robots and the acceptance of care assistance. 10 out of 22 elderly users had the opportunity to meet Pepper the robot in person. The rest of the elderly have been watching the prepared videos. After the presentation, the videos and the personal interaction, there was a relative increase in confidence in handling robots, and the initial relative caution was replaced by a confidence that the robots would not go wrong. It was confirmed that the aversion is not deep-rooted but based primarily on a lack of detailed and reliable knowledge. It was shown that after a short introduction and demonstration, a significant part of the prejudices could be reduced and acceptance and confidence could be greatly increased.

2.3.5. Recommendations for optimization the INCARE solution:

There have been 80 suggestions from primary and secondary users, forwarded to the developers which can be grouped into the following categories:

- improving the user experience, (e.g., ease of use, logging in, changing user smoothly)

- enriching functionality (e.g., search and listing features, warning thresholds, process recommendation in case of deviations from normal data, etc.)
- integration (e.g., with devices from other manufacturers, extending battery life)
- connection to the central health database operated by the government health authorities

These suggestions were carefully considered, some of them were reflected within the boundaries of the project, while some longer-term recommendations were considered for later stages of the development, while looking for commercial justification.

3. Conclusions

3.1 Statistics

A number of 155 elderly (15 Poland, 10 Romania, 130 Hungary) and 27 caregivers (15 informal Poland, 4 informal Romania, 5 formal Hungary, 2 informal Hungary) from 3 countries have provided feedback following their participation. The Romanian and Polish seniors were living in their homes while the Hungarian ones were 100 living independently and 30 in a care facility The feedback from all types of users from Poland, Romania and Hungary was collected by a structured individual interview and a semi structured interview conducted by an expert from an end-user organization on every stage of the research (pretest, midterm, post-test). The Slovenian users will provide their feedback in the end of the pilots because of limited resources of the self-funded organization IZRIIS.

3.2 Health

Summarizing everything that was presented previously, we can conclude that the health devices were the most popular components of the INCARE solution. The seniors liked the idea of a health monitoring app which can store their health parameters recorded over an extended period of time. Out of the 4 tested medical devices, the most appreciated one was the blood pressure meter which is not surprising considering the incidence of cardiovascular diseases and hypertension. *According to the health data acquired during the pilots, there were 105 seniors who tested the medical devices and 97% of them used regularly the blood pressure meter*. The overall opinion was that it was easy and fast to use, had a comfortable cuff and a large screen.

The oximeter was also relatively popular, with 66% of the seniors choosing to use it regularly. We believe that its popularity was linked to the necessity of checking the blood oxygen because of the Covid 19 pandemic and the dangerous effects the virus can have on people with multiple morbidities. The thermometer was tested by 48% of the seniors and it had the least positive feedback. Even though it was precise, the amount of time it required to take the measurement made participants use it less. Also, one has to keep in mind that, in general, people don't measure their temperature on a regular basis but rather when they feel sick. The glucometer was only tested by the seniors who had diabetes or pre-diabetes. The Figure below is presenting the usage of the medical devices based on the data recorded from the devices during the pilots. That is, the percentage of seniors who had a certain type of data in the INCARE database.

Medical devices used by seniors (%)
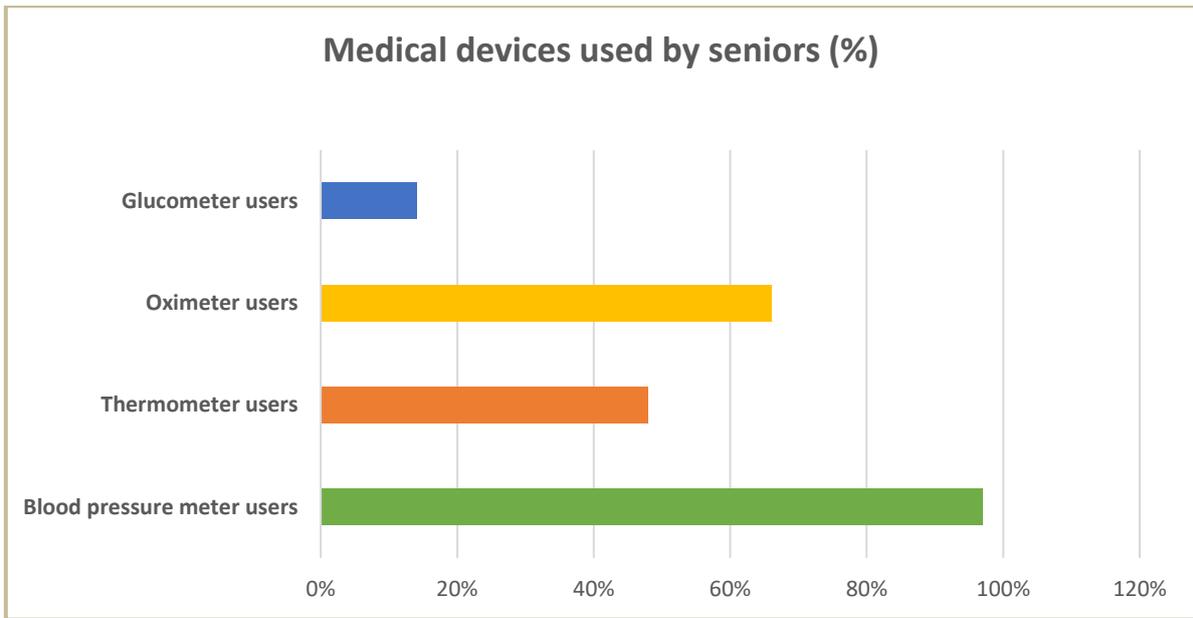
Figure 21 - Medical devices used by the seniors, presented in percentages.

3.3 Games

Games were usually popular during the trials in all 4 countries (Poland, Romania, Slovenia, Hungry), with a lot of seniors and caregivers appreciating the idea of integrating them into the INCARE solution. There was a total of 44 seniors who tried out and reviewed the games. There was little difference in the frequency of playing for the games, the frequency being between 63% and 77%. We computed based on the data recorded in the INCARE database the percentage of seniors who played a certain game.

Games played by seniors (%)
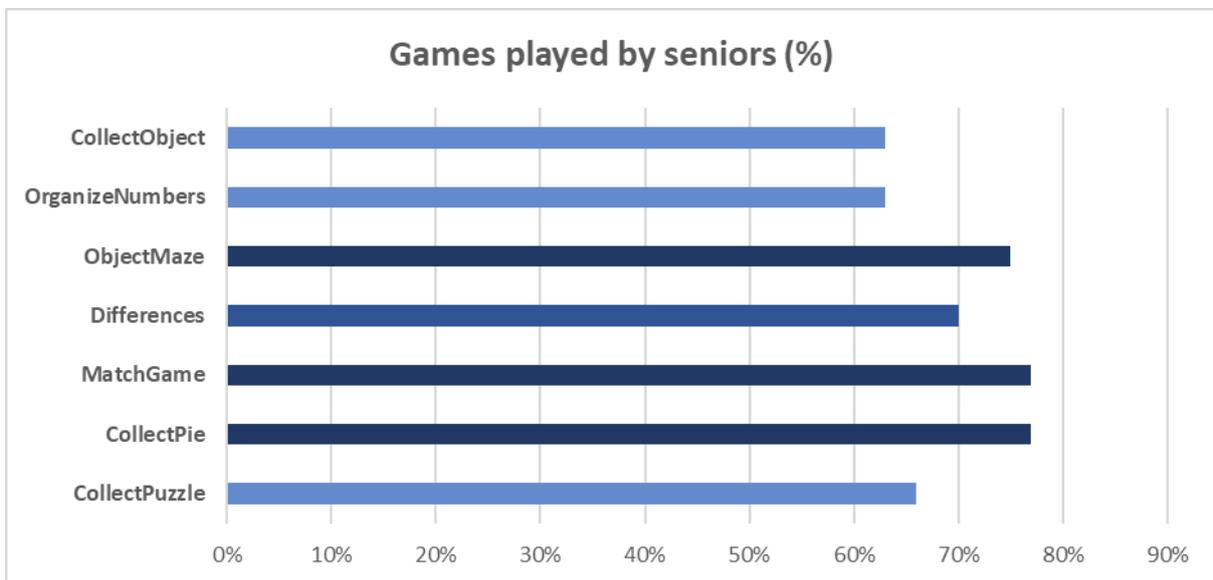
Figure 22 - Games played by the seniors, presented in percentages.

Thus, we can say that the most frequently played games were Object Maze, Match Game and Collect Pie, while the least frequently played were Collect Object, Organize Numbers and Collect Puzzles. We believe the ones which were most frequently played were easier to play and less complex than the other ones, and this is the reason why the seniors preferred them.

3.4 Robots

In Poland, 12 participants took part in a study dedicated to evaluating the INCARE robotic platform – 6 people aged 60-70 and 6 people over 70. Even though the idea of using robots to support people with reduced mobility and physical illnesses was seen as positive, most respondents considered that a robot can offer limited support and it cannot replace a caregiver. This was especially visible when the group of seniors discussed about the video of Tiago offering fall assistance, as they considered that the robot should be able to do a lot more things in order to actually be helpful in a situation like that (e.g., call an ambulance, open the door for the paramedics).

Another problem which was pointed out by the seniors was that a robot is prone to malfunctions and it is too big and dangerous to be used in a home. Stairs, thresholds and carpets are usually a challenge for the robot. Nonetheless, the possibility of a malfunction made seniors afraid of what the robot could do, as they did not trust the robotic platform and it did not meet their needs. In order for the robotic platform to be considered a viable replacement for a caregiver, changes such as a more human-like appearance and a better way of interacting with the seniors and moving inside the apartment should be made. Despite this, a bit more over 70% of the people participating in the study would accept the robotic platform in their daily life.

In Romania, for the robotic platform evaluation, there were 13 users, of which 9 were elderly persons, and 4 were the caregivers of some of the seniors. The elderly participants were between 65 and 78 years old, while the caregivers were between 50 and 58 years old. Six of them interacted live with the robots, the rest watched movies with them. The majority found the functionalities of the robots interesting when watching the short movies, but they were reluctant when it came to having a robot in their proximity.

The most appreciated features when it came to robots were the ability of lifting and carrying objects around the house and to detect falls and alert the caregivers (Tiago), the ability to keep company to the lonely seniors and entertain them (Pepper). The disadvantages pointed out by the seniors were the size and appearance of Tiago, which is too big to be comfortably kept in an apartment, the lack of hands or any ability to help with house chores of Pepper, but also its inability to maintain a more complex conversation, and the lack of apparent sturdiness of Turtlebot. Despite this, the acceptance rate of the robotic platform was mostly high, over 75% of the users being willing to use it on a daily basis. The users who were familiar with technology were more likely to perceive the robots as being an alternative to a caregiver, as they believed the robots are the future.

In Hungary, for the robotic platform evaluation, there were 22 elderly users living at home who watched movies about the robots and 10 out them also had the opportunity to meet Pepper the robot in person. Similarly to Poland and Romania, the seniors were reserved when it came to having a robot in their homes. They believed that Tiago was too voluminous to sit in their room and offer support if they are in need. Despite this, they liked the idea of a robotic assistant, especially if they had reduced mobility. When it came to Pepper, the seniors enjoyed its small size and social skills. They believed that Pepper could be a decent companion if it would be able to hold a longer and more interesting conversation.

3.5 Caregiver interface

In Poland, the possibility of accessing remotely the health parameters of the seniors was highly valued, as the caregivers are usually worried about what might happen with their elderly relative while they are not home with them. An important advantage of this feature was the reliable transferring of the health data to the caregiver web interface.

In Romania, the caregiver web interface was considered a very good idea by the caregivers, who were satisfied that they have constant access to their elderly relatives' measurements. The fact that they can access these parameters from any device, anytime and without having to install a separate application was also highly appreciated, some of the caregivers using their personal smartphone or the work laptop.

In Hungary, caregivers welcomed the functionality that all measurements are available through the web interface and the permanent access to them, but also the fact that they can comment on them.

4. Document history

Date	Changes	Version	Author
M23	ToC initiated	1	STOCZNIA
M25	Polish pilot feedback described	2	STOCZNIA
M27	description of the Romanian pilots	3	CITST
M27	revision by STOCZNIA and implementation of changes by CITST	4	STOCZNIA
M28	description of the Hungarian pilots	5	BZN
M28	revision by STOCZNIA and implementation of changes by BZN	6	STOCZNIA
M29	CITST writing conclusions and abstract, dynamic figure and table captions	7	CITST
M29	revision by STOCZNIA and BZN. Submission	8	STOCZNIA, BZN