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Article

Personalizing Digital Health: Adapting health technology systems to meet the needs of different older populations

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Abstract: The ageing of the population is growing significantly and will challenge healthcare systems. Chronic diseases in the older population require a change in service delivery, and new technologies can be a key element in ensuring the viability and sustainability of these systems. However, the generation gap and the physical and cognitive decline commonly associated with the older generation are barriers to the transition to these models of care. Despite this, there has been a trend towards digital healthcare, which has many potential benefits for the older population. Numerous studies have assessed the acceptability of new technologies for older people in health care. These studies highlight the importance of perceived usefulness, compatibility, ease of use and personalisation of the technology. Personalisation is necessary to ensure that the system is useful for users, and different characteristics such as country of origin, gender, age or comfort with the technology should be taken into account. A person-centred approach in the development of new health technology systems is essential to ensure that applications can be better tailored to the needs of different ageing populations. Many organisations have dedicated time and resources to ensure a person-centred approach in the development of new health technology systems, and putting the individual first is the best way forward in digital health. This article presents the work carried out in this regard in the framework of the European TeNDER project together with an analysis of the results obtained in terms of satisfaction, usefulness and usability by end users.

Keywords: aging population; healthcare systems; healthcare system evaluation; chronic illness; digital healthcare; personalization; healthcare usability; healthcare satisfaction

1. Introduction

Population studies predict that the european population of older people (defined as those aged 65 and over) will increase significantly, from 90.5 million at the beginning of 2019 to 129.8 million in 2050. Their relative share of the total population will also gradually increase and is projected to reach 29.4 % in 2050. During this period, the number of people aged 75-84 in the EU-27 is projected to increase by 60.5%, while the number of people aged 65-74 will increase by 17.6% [1].

Given these figures, it is easy to predict the major impact that these demographic changes will have on the health and care needs of the Member States. A population with a higher percentage of older people will mean a greater number of chronically ill people to be cared for by European healthcare systems, making it necessary to change the provision of services, and in this area new technologies can be a key element in guaranteeing the viability and sustainability of these systems.

It is important to underline that despite the potential of new technologies to support the care of the chronically ill, the generation gap is a major obstacle to the transition to these models of care, which is why actions are needed to help reduce it and facilitate the acceptance and usability of the systems. Elderly individuals struggle more with technology than do younger people because they have far less technological experience, and the physical and cognitive deterioration commonly associated with the older

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generation only exacerbates this issue. However, there has also been a trend towards digital healthcare, which has many expected potential benefits for the elderly population specifically. Reliance on health technology systems would enable them to avoid travelling to a healthcare provider, should this be a challenge, or prolong the amount of time they can live at home rather than a nursing home [2].

There are numerous studies on the acceptability of new technologies for older people in the field of health. [3] conducted a study in 2019 assessing the factors that facilitate the use and acceptance of wearable sensors in older people to monitor their health. It concludes that perceived usefulness, compatibility, ease of use and the possibility of user feedback in the form of a health status score are vital. [4], [5] compiled studies using exergaming for people over 65, focusing on summarising how researchers come to know the acceptability of the technology. It concludes that the following aspects are important: acceptability, efficiency/effectiveness/benefits, satisfaction, relevance (appropriateness), fun/enjoyment, challenges, feasibility, safety, interaction, usability, usefulness and ease of use.

Also worth mentioning is the work by [6] assessing the importance of the family environment in the implementation of technological measures for older people. The results show that involving all family members in helping the person with the technological tool is significantly satisfying for them.

In [7] it was conducted a cross-sectional study looking at the perspectives of people with Parkinson's (n=109) on the use of technology to improve their health. The findings of their work can be summarised as follows:

- 28% report having unmet needs in relation to the disease.
- Those >65 years tend to think that technology will help them solve a health problem or better understand their care.
- Those >75 years are less likely to use electronic methods. These patients are less likely to use technology.

Progress has been made to adapt the system to meet the needs of people diagnosed with different diseases, which is a good first step in personalisation. However, we must take into consideration the different ways of interacting with technology depending on other characteristics, such as country of origin, gender, age, or comfortability with technology. Research by [8] found that while 78.3% of the 65-85 year olds they sampled in Cyprus used cell phones, there was a stark gap between genders. About 93.3% of men relied on mobile phones compared to only 59.4% of women. Therefore, it is possible that older women have different needs in their digital health applications than older men. Additionally, older individuals with higher income and levels of education have demonstrated a more substantial ability to adapt to and use new technologies [9]. Thus, further customisation is necessary to ensure the system is as helpful as possible to its users.

Considering these studies, it is clear that for older people to truly benefit from digital health, it is imperative that developers of digital health systems ensure a person-centred approach so that applications can be better tailored to the needs of different older populations. An example was developed in a trial study [10], where patients achieved an 88% of independency in managing medications thanks to personalised recommendations.

In recent years, different organisations have dedicated time and resources to ensure a person-centred approach in the development of new health technology systems. In 2020, the WHO published a proposal regarding digital technologies and global health, which highlights its commitment to support human-centred rather than disease-centred technologies [11]. Additionally, many countries have undergone projects in Digital Health Strategies with the common goal of personalising health technology systems [12]–[17]. The Smart Health Systems International comparison of digital strategies of 17 countries (Australia, Belgium, Denmark, Estonia, France, Germany, Israel, Italy, Canada, the United Kingdom, the Netherlands, Austria, Poland, Portugal, Sweden, Switzerland, and Spain) produced some key findings [18]. This research demonstrated that a) prioritising the individual is the best way to progress digital health, b) it is vital that health technology systems adapt to the varying needs of each end-user, and c) hesitancy and resistance to changes resulting from the digitisation can be expected.

The TeNDER system is a tool for people affected by diseases such as Alzheimer's Disease (AD), Parkinson's Disease (PD), and cardiovascular diseases (CVD). These chronic diseases all require prolonged care and continuous medical attention. It is essential for individuals with these diseases to maintain healthy habits in their daily lives. The TeNDER system aims to assist in this endeavour by empowering patients to stay knowledgeable about their health, adhere to treatment, and preserve their autonomy and quality of life by using a sensorial ecosystem. It was explored in another work in [19], but it was missing potential acceptance/adoption issues, which TeNDER directly addresses. This tool facilitates interaction between patients, caregivers, and professionals while keeping all parties aware and up to date on the patients' health status. It is therefore imperative that the TeNDER system develops and employs technology that a) is personalised to each unique individual, b) more closely meets the needs of patients and clinicians, and c) is as accessible as possible to those who typically face barriers to incorporating technology systems into their lives. In order to effectively personalise the interactions between end-users and assistance systems, it is essential to ensure the personalisation is based upon high-quality data. If the TeNDER system increases the degree of personalisation in its interactions, then its users will feel more secure in their usage of the system and benefit more from their participation in the project.

2. Materials and Methods

The TeNDER system is an integrated care system for people with chronic diseases such as AD, PD and CVD developed in the framework of an H2020 project. It consists of a web app (for professionals), mobile app (for patients and caregivers) and a series of sensors and devices (wristband, binary sensors, depth cameras, among others) thanks to which different symptoms are monitored.

Thanks to the TeNDER system, patients and their carers can on the one hand monitor their state of health and receive feedback on the rehabilitation exercises carried out at the therapy centre. The system also has a recommendation system, which, thanks to the information obtained from the sensors and the interaction with other functionalities of the mobile app, sends users advice, warnings, and recommendations for areas of their daily life such as physical activity, social aspects, nutrition or sleep. Likewise, professionals obtain objective data on the state of health of patients that they can visualise thanks to the web app, enabling closer monitoring. Professionals can contact patients and caregivers through the communication tools of the TeNDER system, for example by including appointments or reminders in the calendar of the patient/caregiver app.

2.1. Codesign process

To ensure the acceptability and usability of the TeNDER system from the beginning of its development, a careful co-design process has been carried out to ensure a person-centred approach. Process has been present in all phases of system development and has involved a constant evolution of gathering direct feedback from end-users and implementing their needs through user needs and requirements.

The co-design process started in M1 of the project and, as a first step, a careful literature search was conducted to define the state of the art, experts in the care and treatment of chronic pathology sufferers (PD, AD and CVD) were consulted and a discussion was held among consortium members representing end-users, including hospitals, regional health systems and patient associations. The main conclusions were:

First, it is imperative to personalise the TeNDER system according to the three types of users – patients, caregivers, and professionals – all of whom have different needs in their reliance on the system. One important aspect of this digital health system for patients is its ability to empower them in their knowledge and management of their own health. The application provides assistance in adhering to therapies and treatment as well as information that aids in the decision-making processes related to the patients' health.

Caregivers, on the other hand, benefit from the system in that they are better able to understand the health status of their loved ones, interact with professionals, and receive warning notifications when patients are in concerning or dangerous situations. These different purposes should be considered in the personalisation of the system, as should the varying technological preferences of end-users. Patients and caregivers have reported that a mobile or tablet application is more accessible. Meanwhile, professionals would prefer not to rely on a mobile application, as the smaller screens make it more difficult to easily see large quantities of patient lists and data at once. Consequently, a web version of the TeNDER system was developed specifically for professionals. Another important factor in customising the system to each user is specific characteristics that would influence the user experience. These include age, gender, educational level, technological affinity, country of origin, main disease (if a patient), and associated comorbidities. It is also important to consider aspects like marital status, lifestyle habits such as smoking, alcohol consumption, physical activity, quality of sleep, rural or urban living environment, and whether living alone or with others.

The co-design process continued with a survey in 4 countries (Spain, Italy, Slovenia, and Germany) for each of the end-user types (patients, carers and professionals) with the participation of 100 patients, 100 carers and 50 health and social care professionals. In addition, 15 face-to-face interviews were conducted with patients, 15 with carers and 15 with professionals.

With the information gathered in the first phases of the co-design process, the first version of the TeNDER System was developed. This was followed by two waves of testing, in which data was collected on the perceptions of all users in terms of usability, usefulness, acceptability, ease of use, as well as all kinds of qualitative comments with proposals for improvement and modification of the system.

The first wave of testing took place between November 2020 and April 2021 and involved 124 patients, 73 carers and 53 professionals. The second wave of testing took place between November 2021 and June 2022 and involved 195 patients, 104 carers and 38 professionals. The co-design process at this stage has been a cyclical procedure of collecting feedback and improving the system leading to a final version of the system.

2.2. *User needs and requirements*

To better understand the needs of end-users, various scenarios involving the implementation of the TeNDER system, the wearables used, and the type of data collected, were drafted, and shown to patients, caregivers, and professionals. These groups of end-users provided evaluations of the usefulness of the various devices and their functionalities in each scenario. Based on this feedback, WP2 (Work Package 2) determined the main functional requirements of the system in several different settings, including the private home, hospital, day-care, and rehabilitation room. These functional requirements include medical examination schedule, adherence to drug treatment, health state, emotional state detection, nocturnal activities, global localization, room-level localization, and safety and wellbeing. Additionally, a table of recommendations from end-users in the first phase of co-design was compiled to guide further improvements to the system. Most patients with AD, PD, and CVD are of the older generations, and only 18% of TeNDER patients are familiar with technology. Therefore, it is imperative that the system is simple and easy to use. This simplicity can be achieved through easier-to-read fonts and screen layouts with minimal components.

Another frequent recommendation from end-users was customisation. Different functionalities can be more helpful to different users, and so it is imperative that, at the very least, the system has distinct offerings for patients, caregivers, and professionals respectively. For example, it is necessary for professionals to have access to patient lists and data, while caregivers and patients themselves should not have this feature available on their screens. In addition, the system should be able to adapt alongside the progression of the disease, due to the possibility that patients' needs will change as this occurs.

Another aspect of the system for which customisation was recommended was the frequency of reports. Both patients and caregivers agreed that the structure of alerts and reminders should be altered. Caregivers felt they should be given priority notification on urgent alerts and receive feedback if a patient has not completed an activity they were reminded to complete. Patients also expressed the desire for more vital reminders to be distinguished from less urgent ones. Finally, all three user groups recommended that the system feature real time activity tracking, more accurate functions to enable better understanding of the reports, and a multimodal tool for the alerts that would make the system more accessible. Ultimately, the two main goals devised from this feedback is a) customisation and b) ease of use.

The main findings of the co-design process are set out in the following Table 1.

Table 1. Co-design interventions for system personalization.

Recommendation	Why?	Target user
Simplicity of interfaces/functionality	The system has to be easy to be used by patients that are not digitally active	All, especially "patients". Only 18% are familiar with technology
Interface fonts	Patients might have problems to read/find a functionality	Patients, carers
Interface functions	Simple screens, with few components per layout	Patients, carers
Customisation	Not all the functionalities are useful to all the users	Patients, carers, some professionals
Data Access	Not all the roles want/can access patients' data	Professionals
Frequency of reports	Customisation might be enabled	All users
Structure of the alerts	Carers shall have priority view/notification on urgent alerts	Carers
Structure of the reminders	To distinguish more important/vital reminders from others	Patients
Feedbacks from the reminders	Carers shall have feedback if the action has (not) been taken by a patient	Patients, carers
Performance to be shown	To encourage and increase motivation	Patients
Real time activity tracking	Enabling the proper performance with exercises, assuring safety and security	All
Accuracy of the functions	To avoid wrong impression and misinterpretation of the reports	All
Multimodal tool for the alerts (voice, text message, e-mail)	To allow broader usage according to the need and technology acceptance	All
Modularity of the system	The progression of the diseases may cause different needs	Patients, carers
Affordability	The system shall be designed in a way the community can afford and benefit from it	All

2.3. *TeNDER integrated components*

To meet the needs and requirements gathered throughout the co-design process, the TeNDER system has articulated 5 technical components that are the basis for all interactions with the system:

An **Electronic Health Record** (EHR**)** as TeNDER system backend, that was developed using HL7 standards. HL7 is a widely used communication protocol technology that allows for the exchange of clinical data, allowing internal researchers to manage data from patients, and observations from the sensorial devices. It helped providing easy access to patient information for healthcare providers, while also reducing errors and improving patient safety.

The **Multimodal Fusion** (MMF) module helps to provide a more complete view of patient data, enabling the system to provide more individualised recommendations to patients and helping both professionals and caregivers to better understand the patient's health status. In addition, the MMF module tracks the emotional state and irregular behaviour of patients, sending important notifications and recommendations to both caregivers and patients.

The **virtual assistant** module consists of two sub-modules: the reminder sub-module and the chat sub-module with the aim of facilitating patient interaction with the system. It incorporates voice commands for the components installed in users' homes so that interaction with the system is done via voice command. Examples of events detected through Speech Analytics include the client asking what day or time it is or requesting that a notification be sent to their caregiver.

User profiling is based on a combination of data fusion of sensory ecosystem data and patient information to discover connections between the patient's health status and patterns of daily behaviour. User profiling aims to group patients according to common characteristics, which helps to personalise recommendations for each patient group. To perform user profiling, this component uses personal information such as gender, age, country and language, diagnoses among the three main TeNDER diseases, comorbidities and multimodal fusion data.

Finally, the **Recommendation System** (RS) receives the results of the user profile and the information received through the personalised patient questionnaires. The system uses this input information to detect triggering situations that require recommendations to improve patients' daily lives. Observations from the devices worn by patients are converted into static data, which in turn triggers the messages of the recommendation tool.

Thanks to these 5 components, users of the TeNDER system can better understand their condition and health data monitored daily, receive alerts, notifications and personalised recommendations based on the parameters recorded in daily measurements and interactions with the mobile app, and interact in a simple way and with a personalised system. They can also contact their caregivers and professionals through the app and send them alerts in case they need help. All this will help users to improve their quality of life, maintain their autonomy and have accurate information to make their own health decisions, increasing their empowerment.

2.4. Evaluation methods

To assess the usability, user experience and acceptability of the TeNDER system, a pilot test was conducted. The test involved end-users of three types of profiles (190 patients, 167 carers and 95 professionals) from 4 countries (Spain, Germany, Italy and Slovenia). During a period ranging from 2 to 8 weeks, users were able to experiment with the system in four different scenarios (rehabilitation ward, hospital, day care centre and their own homes). After the experience they were given a post-intervention interview incorporating the following questions:

1. **SUS (System Usability Scale)** [20]**:** The user evaluates on a Likert-type scale with 5 response options whether he/she agrees or disagrees with the following statements.
    - **SUS1:** I think that I would like to use this system frequently.
    - **SUS2:** I found the system unnecessarily complex.
    - **SUS3:** I thought the system was easy to use.

- **SUS4:** I think that I would need the support of a technical
- **SUS5:** I found the various functions in this system were well integrated.
- **SUS6:** I thought there was too much inconsistency in this system.
- **SUS7:** I would imagine that most people would learn to use this system very quickly.
- **SUS8:** I found the system very cumbersome to use.
- **SUS9:** I felt very confident using the system.
- **SUS10:** I needed to learn a lot of things before I could get going with this system.

2. **Rate of satisfaction (RS):** The user evaluates on a Likert-type scale with 5 response options whether he/she agrees or disagrees with the following statements. In the case of professionals, only the first two satisfaction questions were included.
   - **RS1:** How satisfied are you with Tender system?
   - **RS2:** Rate your experience with Tender system.
   - **RS3:** How satisfied are you with reports about your activities and progress?
   - **RS4:** How satisfied are you with the overview of your health status and events from TeNDER?

3. **Open questions to collect direct feedback:** The user responds in their own words describing their experience.
   - **OQ1:** How do you feel with TeNDER system?
   - **OQ2:** What do you like less about TeNDER system?
   - **OQ3:** What do you like more about TeNDER system?
   - **OQ4:** What would you change in order to make the TeNDER System more useful and applicable for you?

3. Results

The results section of this study presents the findings obtained through the evaluation of the TeNDER system. The System Usability Scale (SUS) and the Rate of Satisfaction (RS) were the two primary instruments used to measure the usability and satisfaction with the system. All the results presented in this section include the data from the surveys completed by the patients, caregivers, and professionals.

Initially, Table 2 and Table 3 display the results on the System Usability Scale (SUS) scores of 167 patients who completed all the surveys.

Table 2. System Usability Scale results table for patients.

Questionnaire	Strongly disagree	Disagree	Nor agree or disagree	Agree	Strongly agree
SUS1	20 (10,18)	20 (11,98)	20 (11,98)	56 (33,53)	54 (32,34)
SUS2	47 (28,14)	60 (35,93)	34 (20,36)	17 (10,18)	9 (5,39)
SUS3	8 (4,79)	20 (11,98)	29 (17,37)	62 (37,13)	48 (4,79)
SUS4	15 (8,98)	1 (0,60)	21 (12,57)	42 (25,15)	59 (35,33)
SUS5	9 (5,39)	11 (6,59)	65 (38,92)	48 (28,74)	34 (20,36)
SUS6	23 (13,77)	49 (29,34)	78 (46,71)	7 (4,19)	10 (5,99)
SUS7	5 (2,99)	24 (14,37)	40 (23,95)	50 (29,94)	48 (28,74)
SUS8	40 (23,95)	64 (38,32)	28 (16,77)	24 (14,37)	11 (6,59)
SUS9	11 (6,59)	19 (11,38)	26 (15,57)	38 (22,75)	73 (43,71)
SUS10	40 (23,95)	32 (19,16)	30 (17,96)	40 (23,95)	25 (14,97)

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It is worth noting that over 65% of patients participating in the pilot said they would use the system frequently and over 41% said the system was easy to use based on the information extracted on Table 1.

Table 3. Rate of Satisfaction results table for patients.

Questionnaire	Very unsatisfied	Unsatisfied	Neutral	Satisfied	Very satisfied
RS1	11 (6,59)	6 (3,59)	32 (19,16)	87 (52,10)	31 (18,56)
RS2	3 (1,80)	1 (0,60)	59 (35,33)	3 (1,80)	101 (60,48)
RS3	16 (9,58)	17 (10,18)	59 (35,33)	75 (44,91)	0 (0)
RS4	1 (0,60)	16 (9,58)	45 (26,95)	73 (43,71)	32 (19,16)

More than 70% of the patients participating in the pilot reported being satisfied or very satisfied with the system and almost 41% of them said they were satisfied with the reports the system provides them (Table 3). Out of the total 167 caregivers, 129 of them were caregivers providing valuable information who completed all the surveys. Results for caregivers are presented in Table 4 and Table 5.

Table 4. System Usability Scale results table for caregivers.

Questionnaire	Strongly disagree	Disagree	Nor agree or disagree	Agree	Strongly agree
SUS1	3 (2,33)	12 (9,30)	21 (16,28)	53 (41,09)	40 (31,01)
SUS2	25 (19,38)	58 (44,96)	31 (24,03)	13 (10,08)	2 (1,55)
SUS3	1 (0,78)	16 (12,40)	19 (14,73)	68 (52,71)	25 (19,38)
SUS4	14 (10,85)	28 (21,71)	26 (20,16)	44 (34,11)	17 (13,18)
SUS5	4 (3,10)	6 (4,65)	49 (37,98)	62 (48,06)	8 (6,20)
SUS6	23 (17,83)	48 (37,21)	51 (39,53)	6 (4,65)	1 (0,78)
SUS7	3 (2,33)	20 (15,50)	36 (27,91)	46 (35,66)	24 (18,60)
SUS8	31 (24,03)	55 (42,64)	20 (15,50)	18 (13,95)	5 (3,88)
SUS9	1 (0,78)	11 (8,53)	27 (20,93)	52 (40,31)	38 (29,46)
SUS10	31 (24,03)	45 (34,88)	26 (20,16)	23 (17,83)	4 (3,10)

It is noteworthy that almost 70% of caregivers felt confident using the system as extracted from the System Usability Scale on Table 4.

Table 5. Rate of Satisfaction results table for caregivers.

Questionnaire	Very unsatisfied	Unsatisfied	Neutral	Satisfied	Very satisfied
RS1	3 (2,33)	10 (7,75)	31 (24,03)	68 (52,71)	17 (13,18)
RS2	3 (2,33)	5 (3,88)	52 (40,31)	0 (0)	69 (53,48)
RS3	1 (0,78)	44 (34,11)	49 (37,98)	44 (34,11)	22 (17,05)
RS4	1 (0,78)	11 (8,53)	47 (36,43)	50 (38,76)	20 (15,50)

It is interesting to note that more than 65% of carers are satisfied with the system (Table 5). Finally, the results from the surveys for the professionals are presented in Table 6 and Table 7. In this case, 77 participants filled all the surveys from the total number (95).

Table 6. System Usability Scale results table for professionals.

Questionnaire	Strongly disagree	Disagree	Nor agree or disagree	Agree	Strongly agree
SUS1	0 (0)	0 (0)	16 (20,78)	42 (54,55)	19 (24,68)
SUS2	24 (31,17)	24 (31,17)	24 (31,17)	4 (1,30)	1 (1,30)
SUS3	1 (1,30)	3 (3,90)	17 (22,08)	39 (50,65)	17 (22,08)
SUS4	34 (44,16)	24 (31,17)	6 (7,79)	13 (16,88)	0 (0)
SUS5	0 (0)	1 (1,30)	16 (20,78)	51 (66,23)	9 (11,69)
SUS6	22 (28,57)	28 (36,36)	25 (32,47)	2 (2,60)	0 (0)
SUS7	0 (0)	4 (5,19)	21 (27,27)	36 (46,75)	16 (20,78)
SUS8	25 (32,47)	38 (49,35)	11 (14,29)	3 (3,90)	0 (0)
SUS9	0 (0)	1 (1,30)	29 (37,66)	33 (42,86)	14 (18,18)
SUS10	25 (32,47)	29 (37,66)	13 (16,88)	9 (11,69)	1 (1,30)

More than 75% of practitioners reported that the various components of the system were well integrated.

Table 7. Rate of Satisfaction results table for professionals.

Questionnaire	Very unsatisfied	Unsatisfied	Neutral	Satisfied	Very satisfied
RS1	0 (0)	3 (3,90)	28 (36,36)	44 (57,14)	2 (2,60)
RS2	0 (0)	3 (3,90)	40 (51,95)	1 (1,30)	33 (42,86)

The percentage of professionals who say they are satisfied with the system is around 60%.

4. Discussion

The TeNDER System was created with the aim of creating a space where patients, carers and professionals can have access to objective information in real time on the state of patients. The system also offers notifications, warnings and recommendations based on the information collected by sensors, devices and interaction with the app, aiming to have a positive impact on perceived quality of life and autonomy, as well as on informed health decision-making.

Thanks to the results tables reported in the previous section, we can see that all end-users, patients, carers and professionals, have mostly positive opinions about the usability and usefulness of the system. It also highlights a high percentage of acceptability taking as a reference the first question of the SUS questionnaire where it is stated that they were willing to use the system frequently.

Looking at the answers to the open-ended questions, we found that the vast majority of patients participating in the pilot reported positive feelings about using the system, such as feeling safe, reassured, motivated, satisfied or relaxed. Some reported feeling in control all the time and others reported feeling insecure or nervous due to their lack of technological knowledge. Similar responses appear in the case of the caregivers who in a large majority report feeling good and more confident thanks to the use of the application. Some carers said that they had not made much use of the app and a few said that they had found it difficult to use the app due to their lack of knowledge, similar to what happened in the case of patients.

Two main conclusions can be drawn from the professionals' responses: the vast majority of the professionals involved say that the purpose of the system is useful and can support them in their daily work; however, they state that there is room for improvement and that it would be good to include more detailed reports.

Among the aspects that were least liked were the short battery life of the bracelets, as well as some connectivity failures and the fact that the system is limited to specific pathologies. As a highlight, it is worth mentioning the perceived usefulness of the data collected and displayed by the system and the motivation that this monitoring provides for many of the participants.

Finally, participants were asked what aspects they would improve to make the system more useful and attractive. Firstly, the resolution of errors or possible technical problems that have arisen in some cases. Terms such as simplicity, intuitiveness, accessibility were also mentioned in numerous responses.

On the other hand, the incorporation of new functionalities, the extension of the recommendations, the inclusion of more questionnaires that provide additional information, are responses that are repeated.

5. Conclusions

The inclusion of technological systems in the field of health is an area of great interest at the present time. It allows for a more efficient approach and reduce the economic burden on health systems. The population pyramid with a growing number of elderly individuals poses a great challenge for the sustainability of welfare systems in European countries and the inclusion of new technologies and care models such as the one proposed by the TeNDER system appear to be really attractive based on results.

However, we must bear in mind the limitations of access, usability, and acceptability that these systems may have in the elderly population, even more so in people with chronic pathologies. It has been shown that those systems built under a person-centred approach, involving the end users in the design of the solutions from the very beginning, are more accepted and more useful than those in which this approach is not developed.

The TeNDER System has carried out a careful co-design process that has resulted, among other actions, in a greater customisation of interfaces, user interactions with the system and the system's recommendations and suggestions. All this has helped to increase the degree of user satisfaction with the system. Even so, there is still a long way to go, and actions must continue to be taken to bring technical developers closer to the real and particular needs of end users.

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Informed Consent Statement: Informed consent was obtained from all participants involved in the study. No camera recording or any other identification was made. They were included with an anonymous identifier in the data collection logbook.
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