Understanding Acceptance Factors for Using e-care Systems and Devices: Insights from a Mixed-Method Intervention Study in Slovenia

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Abstract. An increasing number of scholars have been recently exploring the role of factors that foster the adoption of different types of assistive technologies among older adults. Our study contributes to this field with a mixed-methods intervention study that combines a baseline and follow-up telephone survey with semi-structured interviews to evaluate the user experience and potentially identifies additional acceptance factors of e-care systems and relations among them. Different assistive technologies were tested and evaluated by three groups of participants: (1) older adults testing mobile and wearable devices and (2) informal carers who remotely monitored events recorded by e-care systems installed in the homes of (3) care receivers. The findings indicate heterogeneous needs and expectations these three groups have towards the use of e-care systems. Moreover, the results also unveil the fear of not getting help quickly in case of an emergency, and perception of safety and peace of mind as important predictors of the use of e-care systems among informal carers and care receivers. Indirectly, the results also reveal the importance of intervention and mixed methods design studies as a means of a more comprehensive understanding of acceptance factors of assistive technologies.

Keywords: e-care · Assistive technology · Acceptance factors · Mixed methods design · Intervention study · Older adults · Informal carers

1 Introduction

The new generation of information and communications technology (ICT)-based assistive technologies has the potential to increase quality of living, safety, wellbeing, and interpersonal relationships for older adults and their informal carers [1–3]. However, assistive technologies have rarely been upscaled, so an increasing number of studies has explored the barriers to use as experienced by older adults [4], such as individual (e.g., resistance toward technology) and contextual issues (e.g., socio-economic status, family support), as well as design demands concerning age-related issues with older adults' perceptual, cognitive and movement difficulties [5]. Several conceptual models exist that study user acceptance and behavior among older adults related to assistive systems or technology in general, including the USE–Model [6], the STAM model [7],

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McCreadie and Tinker's model [8], the ecological model [9], the Smart Home Technology Acceptance Model [10], as well as a model of factors influencing the level of technology used by older adults who are aging in place [11]. As such, informal carers are becoming more important, as access to paid assistants and public services is limited [12, 13]. Moreover, informal carers have been shown to play a central role in decision-making processes related to adopting assistive systems for care receivers' homes [12].

The aim of this study is to evaluate user experience and potentially identify additional factors that influence acceptance. The study will further examine the relationships among the acceptance factors for e-care systems and devices aimed at enhancing the security and independence of community-dwelling older adults within their home environments, as well as relieving informal carers' burden and concerns. The study is comprised of three groups of participants: (1) older adults testing mobile and wearable devices, (2) informal carers who remotely monitor events recorded by e-care systems installed in the homes of (3) care receivers[1], typically being family members of informal carers. Mobile and wearable devices included two smartphones with an SOS button and two fall detectors with an SOS button adapted for older adults. The four tested e-care systems encompassed various combinations of sensors and gadgets such as wearable SOS buttons, movement sensors, door sensors, fall detectors linked to the main unit, which enables informal carers (and service providers via a care assistance center) to monitor activities and trends in care receivers' homes via smartphone or web app.

Drawing on an intervention study consisting of two telephone surveys and semi-structured interviews, we first present results of the quantitative evaluation of the e-care systems and mobile and wearable devices among older adults and informal carers, which is based on the American Costumer Satisfaction Index (ACSI) [14] and a block of open-ended survey questions regarding positive and negative experiences with the tested system/device. Afterwards, satisfaction and experiences with the e-care systems are further explored with semi-structured interviews, the results of which demonstrate in-depth insight into the experiences of informal carers and care receivers with the tested e-care systems. This information contributes to further elaboration of the complex and broad array of acceptability factors.

2 Research

2.1 Research Design

In order to gain insight and evaluate e-care systems as well as mobile and wearable devices provided by the largest telecommunications company in Slovenia, an interventional study was designed. The telecommunications provider purposefully selected a number of e-care systems and a convenient sample of participants who volunteered to test the devices/systems from three weeks to two months, depending on the type of device/system. The intervention was carried out by the provider, whose staff members

[1] Hereafter, for the sake of simplicity, we refer to older adults with installed e-care systems in their homes as "care receivers" (given the fact that they receive care in terms of using e-care systems), irrespective of whether they receive any other form of help or care.

installed, monitored, maintained and removed the e-care systems/devices. The evaluation was based on a panel design consisting of a baseline and follow-up telephone survey, lasting approximately 10 min, conducted before and at the end of the e-care system/device testing period. Also, semi-structured interviews with a subsample of participants, lasting 30 to 90 min, were conducted after the end of the testing period (see Fig. 1). While e-care systems have been tested by care receivers and informal carers, only the latter were involved in the baseline and follow-up survey. In the semi-structured interviews, however, both types of users in the dyad of informal carer and care receiver were interviewed. Thus, our approach to collect data on user experiences can be characterised as sequential explanatory mixed methods design [15].

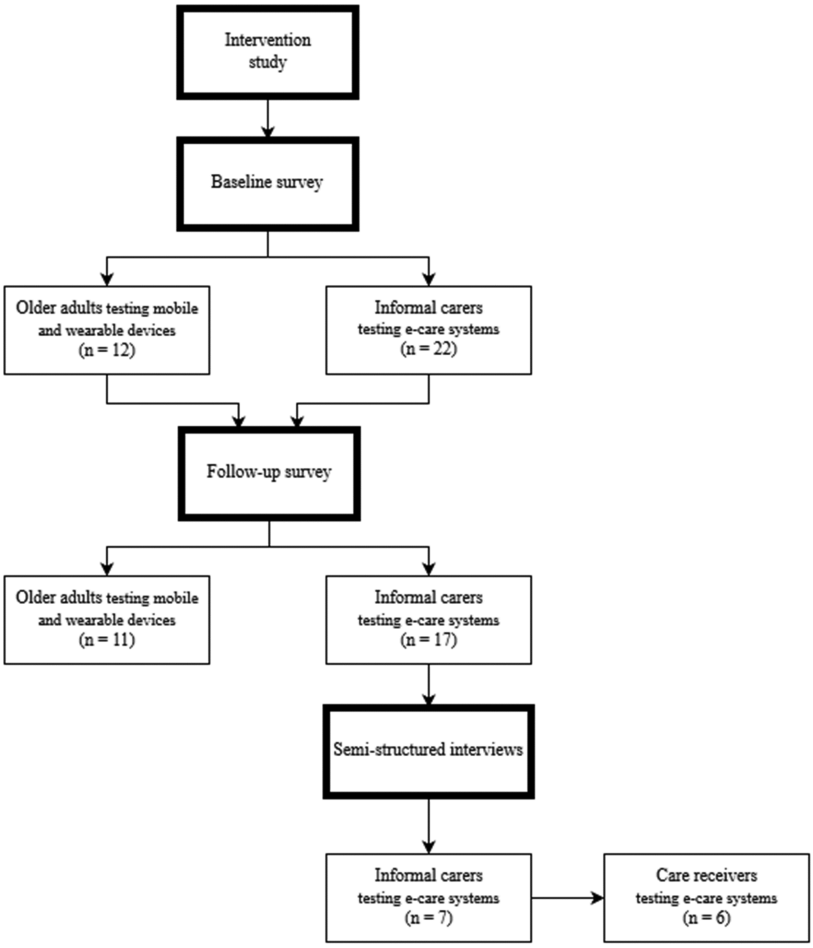

Fig. 1. Sample structure and design of the mixed methods intervention study.

Surveys were conducted among informal carers testing e-care systems (e.g., movement sensors) and older adults testing mobile and wearable devices (two types of age-friendly smartphones with an SOS button and two fall detectors). The baseline survey aimed at gaining insight into participants' expectations regarding the tested systems/devices prior to the testing period. Accordingly, the follow-up survey measured users' satisfaction and experiences with the tested system/device at the end of the testing period. In addition to topics under investigation herein, the baseline survey covered the following topics: use of new technologies; provision (for informal carers)/reception (for older adults) of help regarding (instrumental) activities of daily living; technology acceptance factors; price sensitivity; care receivers' (for informal carers)/older adults' recent need for emergency help; his/her health condition; and socio-demographics.

Further, informal carers were asked about their relationship with care receivers. Likewise, in the follow-up survey, participants were asked about use of the tested system/device, technology acceptance factors, and purchasing decision.

2.2 Apparatus

Participants involved in the intervention study tested four e-care systems and four mobile and wearable devices. The e-care systems consisted of Sensara, Essence, LivOn and CMIP. With e-care systems we refer to remote monitoring systems enabling family members and (informal) carers to check the wellbeing of a care receiver living on their own through the web or mobile app. A set of sensors, linked to the main unit, transmits the data to the cloud and triggers alarms in case of any deviation from the routine. Furthermore, e-care system provider's care assistance center monitors events, provides support and assistance to informal carer and care receiver and deals with critical events. Mobile and wearable devices included two fall detectors (i.e., IN LIFE smartwatch, PERS FD) and two age-friendly smartphones (i.e., Doro 8031, Emporia Smart). All tested devices are described in detail below.

Mobile and Wearable Devices

Doro 8031. Doro is a smartphone built to be as easy to use as possible. Its features are large icons and large buttons, an age-friendly user interface, loud and clear sound, hearing aid compatibility, GPS, a step-by-step tutorial, and an assistance button. Furthermore, the My Doro Manager application enables the user to get remote help from a relative or carer who can read the device and write/make changes to it. Charging the battery is simplified due to the attached charging cradle [16].

EmporiaSMART. EmporiaSMART is the second tested adapted smartphone. Its main difference in comparison to other smartphones is a removable keypad display cover that enables entering numbers, scrolling through the telephone book, or writing and reading messages. Moreover, the included stylus pen that can be attached directly to the device makes using the touchscreen easier. A charging station simplifies battery charging. In addition to the age-friendly user interface, large icons and buttons, loud and clear sound,

compatibility with hearing aids, and the device's emergency call function enable the user to feel safe [17].

IN LIFE Smart Watch. The IN LIFE smartwatch is a device with fall-recognizing algorithms that initiate an automatic call in case of a fall. The watch has built-in GPS and allows the user to trigger the emergency call, whereby location data is transmitted to the call recipient. Further, the watch monitors users' activity and automatically generates daily reports on device and user status. Carers can access the watch and manage it remotely through a user-friendly web interface. The watch has been developed in Slovenia as an output of the Horizon 2020 project IN LIFE [18].

PERS FD. The Personal Emergency Response System Fall Detection (PERS FD) is a wearable fall detector that can be worn as a wrist strap or pendant. An SOS button enables the user to activate an emergency call. When a fall is detected, the alarm with location data is forwarded to predetermined numbers and voice communication is enabled without any user action required. For an example of PERS FD, see [19].

e-care Systems

Sensara. Sensara (see Fig. 2a) is a remote monitoring system.[2] It uses small, unobtrusive sensors to help provide support for care receivers living on their own. Through use of a smartphone app, family members or (informal) carers can stay up to date on the care receivers' wellbeing. The app provides the user with information on the care receiver's current status and detailed long-term information. The system contains one gateway device, two or three door sensors, three or five activity sensors, and all the equipment necessary for installation. The front door and back door sensors monitor activities such as entering and leaving the house. The kitchen sensor keeps track of activity in the kitchen and can be installed on the refrigerator door. Activity sensors are supposed to be installed to the toilet/bathroom, living room, and hallway. All these sensors were included in the test period.

It takes approximately two weeks for Sensara to learn the resident's behavior fully. Over time, the system learns what behavior is normal and what is abnormal. When there is anything suspicious seen in the app, the care receiver can be called through the app's speed-dial button [20].

Essence. Essence (see Fig. 2b) is a system for home-care providers. It indicates hazards and worsening scenarios and triggers alarms automatically. Family member or (informal) carer can monitor care receivers' daily activities by using the monitor app on a smartphone or computer. The control panel supports up to 32 peripherals/sensors such as cameras, door/window sensors, smoke detectors, and more. It also includes an emergency button and two-way audio communication capability for the care service provider to communicate with the user [21].

Sensors used in this study were motion detectors that identified entrance and alerted for extreme temperatures, door/window sensors reporting the status of door and

[2] None of the interviewees tested the Sensara system.

(a) Sensara

(b) Essence

(c) LivOn

(d) CMIP

Fig. 2. Tested e-care systems.

windows to determine whether someone enters or leaves the premises, and a portable emergency button that can be worn as a pendant or wrist strap. Essence can be further extended with a fixed emergency button, flood detector to warn of water leakage, smoke detector, and cameras. These extensions, however, were not tested in this study.

LivOn. LivOn (see Fig. 2c) is a wireless monitoring system that automatically identifies changes in the activities of daily living. Through online and mobile apps, it keeps family members and (informal) carers informed about care receivers' activities and triggers alarms. The system consists of a wireless base unit with a telephone handset and sensors connected with a service platform [22].

The tested system in this study was composed of a base unit, activity sensors, and a help trigger (i.e., emergency button). LivOn can be extended with additional (not tested in this study) telecare sensors (i.e., fall detector, temperature and humidity sensor), safety sensors (i.e., fire detector, gas detector, intrusion detector, flood detector), and healthcare sensors (i.e., glucose meter, pulsimeter, blood pressure gauge, thermometer, weighing scale and pedometer).

CMIP. CareMobile IP (see Fig. 2d) is the fourth monitoring system tested. It operates using GSM communication and does not require a telephone line. During the testing period, the main Carephone unit was supplied with a wrist radio trigger and a fall detector. An alarm on the CMIP can be activated on the main unit or by the wearable radio trigger. The main unit also enables two-way communication. The CMIP system can be extended with additional sensors and services, such as door alarm, smoke

detector, and additional alarm triggers to meet individual needs (additional products and services were not tested in this study) [23].

Table 1 concisely summarizes the main features of the four e-care systems tested.

Table 1. Comparison of the e-care systems' features

	Sensara	Essence	LivOn	CMIP
Sensor system for monitoring changes in the daily routine	✓	✓	✓	✗
Communication network	Fixed (Ethernet)	Mobile (SIM)	Mobile (SIM)	Mobile (SIM)
Base unit with integrated speaker and microphone	✗	✓	✓	✓
Battery backup power supply of the base unit	✗	✓	✓	✓
Smartphone application	✓	✓	✗	✗
Online application	✗	✓	✓	✓
Healthcare sensors (optional)	✗	✓	✓	✗
Direct emergency call activation	✗	✓	✓	✓

2.3 Sample and Methods

Baseline Survey. Baseline survey data collection took place in September 2016. A total of 22 informal carers testing e-care systems[3] and 12 older adults testing mobile and wearable devices participated in the baseline telephone survey. Surveyed informal carers were between 27 and 72 years of age (average age of 45 years) with an almost equal proportion of males and females. A large majority of informal carers were employed; they were experienced ICT users, and had obtained a university or high education diploma. On average, informal carers spent eight hours weekly providing informal care and did not perceive it as a burden.

The average age of surveyed older adults was 77 years, with age ranging between 70 and 83 years. Eight were women, and four were men. All but one were retired, and half had a secondary education. On average, they assessed their health status as good and mostly lived alone or with a partner or spouse in a house or apartment building. Three out of four received some help with (instrumental) activities of daily living in the past 12 months. The majority of them were able to move unassisted (i.e., did not use a wheel chair, rolator or a walking stick).

Follow-Up Survey. Follow-up survey data collection took place in October 2016. Out of 22 informal carers and 12 older adults who completed the baseline survey, 17 informal carers and 11 older adults also completed the follow-up survey (see Fig. 1). Among 17

[3] Only informal carers were involved in the baseline and follow-up surveys (see Sect. 2.1 for details).

informal carers, seven of their care receivers had installed the Essence system in their home, three used Sensara, four tested LivOn, and three were using CMIP. Among 11 older adults, one was using the Doro smartphone, four were using the smartphone emporiaSMART, two tested PERS FD, and four had been wearing the IN LIFE smart watch.

Semi-structured Interviews. To further examine user experiences and acceptance factors, semi-structured interviews were carried out in November 2016 with 13 users of e-care systems. Among them, seven interviews were carried out with informal carers (who participated in the follow-up survey) and six with their respective care receivers. All interviewees gave consent to participate in the qualitative research phase earlier in the survey. In all cases except one[4], we collected data from both members in the dyad (i.e., care receiver and informal carer) who used the same e-care systems during the testing period. Among the interviewees, three dyads were testing the Essence system, two LivOn, and two the CMIP system. None of them tested the Sensara system.

Informal carers who participated in the semi-structured interviews were between 27 and 57 years old, with an average age of 45 years. Interviews were conducted with two women and five men. All the interviewed informal carers were employed. They considered themselves to be experienced ICT users and had obtained a university or high education diploma. During the last 12 months, four of them provided informal care to their care receivers.

The care receivers interviewed were between 61 and 93 years old. Their average age was 80 years. Four of them were males, and two were females. All were retired, and most had a secondary education. Four lived alone in a house or apartment building, and two care receivers lived together with another person. Three care receivers could move unassisted, while three used mechanical transfer aids such as walking stick or rolator. Furthermore, in the last 12 months, four were receiving informal help.

All interviews were audio recorded and fully transcribed.[5] Personal information was anonymized. They were carried out in the setting of interviewees' choosing (their home or office) and lasted 30 to 90 min. A qualitative thematic content analysis was used to analyze the data gathered from the interviews [24, 25]. Standard coding procedures based in grounded theory [26] were used in collaboration between six researchers to develop concepts and themes emerging from the gathered materials. We strictly adhere to the ethical guidelines of the University of Ljubljana.

3 Results

3.1 Quantitative Evaluation of e-care System Use by Informal Carers

The quantitative evaluation of e-care system use (Table 2) – based on data collected in the follow-up survey – showed that the older adults on average rated their satisfaction

[4] One informal carer declined the interview with his care receiver due to her medical condition.

[5] All interviews were carried out in the spoken Slovene language and were transcribed verbatim. Quotations presented later in the paper were then translated into English by a native speaker.

with the tested device (M = 6.5) slightly higher than they did the overall quality of the device (M = 6.4) and the extent to which it met their personal requirements (M = 6.4). Somewhat lower were their average rates of recommending the tested device to friends and/or family (M = 6.1) and of purchase likelihood (M = 5.1). Furthermore, they assessed the occurrence of difficulties in operation as not too often (M = 3.8).

Table 2. Results of quantitative evaluation of e-care systems and mobile and wearable devices

Variables[a]	Informal carers[b]	Older adults[c]
Overall quality of tested e-care system/device	8.1	6.4
How often things with tested system/device went wrong	1.9	3.8
Satisfaction with tested system/device	8.6	6.5
How well tested system/device met personal requirements	8.1	6.4
Probability of recommending tested system/device to friends and/or family	8.1	6.1
Likelihood of purchasing tested system/device in the near future	6.8	5.1

[a]Responses were measured on a scale ranging from 1 to 10, with higher values indicating stronger agreement. [b]N = 14–17. [c]N = 8.

On the other hand, informal carers attributed the highest average scores (both M = 8.6) to satisfaction with the tested system and to probability of recommending it to friends and/or family. Overall quality of the system and personal requirements met were also, on average, rated high (both M = 8.1). Considerably lower average scores were attributed to purchase likelihood (M = 6.8). Likewise, difficulties in operation were also rated low (M = 1.9).

Further, in the follow-up survey, additional information on positive and negative user experiences was also gathered with a set of open-ended questions. The answers were coded and categorized in a way that reflected positive/negative user experiences of participants with the system/device. The results are presented in Tables 3 and 4. On one hand, among the most-frequently-expressed positive aspects were feelings of safety and security, being able to monitor the care receiver remotely, as well as specific functionalities of the tested devices/systems. On the other hand, the most-often-mentioned negative experiences were specific technical or physical characteristics of the devices/systems and, interestingly, their (limited) functionalities. Informed by previously presented findings, the researchers decided to explore these issues in detail in the ensuing qualitative phase.

Table 3. Positive experiences with tested systems/devices

Coded answers	N (%)
Safety and security when using system/device	40
Monitoring care receiver remotely	30
System's/device's functionalities	25
Importance of the assistance center	20
Technical/physical properties of system/device	20
Quality of life when using system/device	20
Usability of system/device	15
Entertainment and relaxedness when using system/device	15
Relationship between informal carer and care receiver	10
User interface of the system/device	5
Other aspects/factors/reasons	5

N = 20.

Table 4. Negative experiences with tested systems/devices

Coded answers	N (%)
Technical/physical characteristics of system/device	39
System's/device's functionalities	22
User interface of the system/device	17
Compatibility of system/device with lifestyle	6
Respondent has not stated any aspect/factor/reason	28

N = 18.

3.2 Qualitative Evaluation of e-care System Use by Informal Carers and Care Receivers

The initial analysis of data collected through semi-structured interviews showed that a frequently mentioned and often-determining factor in considering and deciding to adopt an e-care system is the occurrence of (potential) critical events related to serious health issues and corresponding consequences, such as fall, stroke, and similar. Fear of recurrence of critical and potentially dangerous events, together with the concern of not getting rapid and appropriate assistance, are major sources of worry for care receivers and informal carers. Increasing needs for personal safety and wellbeing stem from age-related health declines that diminish the care reciever's ability to live at home independently. Accordingly, health problems considerably increase the need for care and control (monitoring) of older adults by their carers. An older female, for instance, explained what it means to her to use an e-care system:

Care receiver, 81 years: *I feel more sure, more safe, don't I?*
Interviewer: *Something else maybe?*

Care receiver, 81 years: *Well, I don't know. So that I'm not, how should I put it, always tense everywhere. When I came home from hospital, I said, oh no! Now it will throw me out. Now it will throw me out* [referring to stroke]*, and then what? That fear, right, that you are alone, right*.

Further, the results reveal that use of the e-care system should lead to a feeling of relief among informal carers and care receivers. This "relief" affects both the psychological and behavioral aspects of the relationship between the two groups. On one hand, psychological relief is reflected in reduced anxiety and apprehension, which leads to a greater sense of safety and reassurance. On the other hand, the behavioral aspects of relief refer the actual physical and logistic burdens of informal carers that might be alleviated by the fact that with the e-care system, they can remotely check and monitor the condition of care receivers. For example, an interviewed informal carer explained:

Informal carer, 44 years: *You don't have to ring dad to see if everything is okay with him, because you simply look at the application. /…/ So, that /…/ part of the communication fades away since you simply look at the telephone and see what was happening.*

However, both informal carers and care receivers shared a concern that the remote access provided by the e-care systems would lead to a decrease in the number and quality of in-person visits between them. The possibility of fewer visits is perceived as a potential disadvantage, since the systems provide care receivers with the feelings of safety and emotional reassurance. Also, in-person contacts play a role in socializing, as they allow for opportunities to maintain and strengthen personal support networks. In this sense, the factors presented above regarding e-care system utilization demonstrate a wider impact on users' daily lives. Carers also realize these concerns, and one pointed out:

Informal carer, 56 years: *Now, I remembered just then, when you said before, potentially, what could negatively affect these people, the users of that…would maybe be feeling they are going to lose attention as a result.*

If the care receivers and carers perceive that an e-care system can provide them with a feeling of relief and safety, while, at the same time, decrease the actual burden placed on the informal carers, then it is likely that both groups would be motivated to use e-care in the future. However, other important factors shape interest in using an e-care system in the future. First, the system should be designed to accommodate the everyday needs, customs, and routines of users. Second, the system should not be disruptive; its presence in the home and/or its use should not substantially alter the care receivers' daily lives. Third, the e-care system should be error-free. In other words, users learn to trust the system and never lose confidence about the e-care system's operation and reliability. Fourth, the e-care system should have an age-friendly design and system features in order to be appreciated as useful and easy to use. It is important to note that one interviewee commented on the sensor bracelet's design:

Informal carer, 56 years: *Currently, it's a rugged thing, a little bit, still, isn't it? But okay, with time, this will change, so it will get a nicer shape, as such.*

On one hand, usability is, by and large, related to adapting to the user interface and ergonomically designed devices that are part of an e-care system (e.g., central unit, sensors, wearables). On the other hand, the essential feature of the system for it to be perceived as useful seems to be a physical emergency button or a panic button that should

be available on the central unit. Moreover, care receivers prefer a button that enables two-way communication with a care assistance center. Also, interviewees would prefer a wearable, emergency button that can be used both inside and outside of the home. The wearable, emergency button would allow automatic detection and activation of alarms in case of critical events (e.g., fall, stroke). Likewise, mobile-based e-care systems should enable an automatic alert to carers through a push notification in the mobile app.

The e-care system should be equipped with features that enable timely and responsive provision of assistance to care receivers by allowing remote monitoring of their actions in the home and support voice communication with the care receivers. In this context, a fully operational care assistance center is a key factor, and the most important added value, of an e-care system. In fact, both informal carers and care receivers recognized its central role in providing prompt support and assistance to care receivers. In particular, an e-care system's efficacy is expected in the management of emergencies. Thus, it seems to be vital that the care assistance center is responsive, reliable, provides appropriate feedback to the user, and/or is able to inform informal carers about the care receiver's conditions. However, there are some indications that both groups do not expect that an assistance center support is focused solely on dealing with life-threatening events. Instead, the assistance center should play a supportive role in fulfilling at least the most basic needs of care receivers regarding socializing and emotional exchange, as illustrated below:

> Informal carer, 35 years: *Positively. I am more positively surprised that the service was complete. Primarily, this human factor was very…it just balanced out with a positive opinion like that.*

Whenever possible, the assistance center's role should be aligned with the expectations, needs, and heterogeneous requirements of system users. In addition, users should be thoroughly familiar with the operation of the e-care systems and equipment installed in their homes. An e-care system's most significant technical characteristics, as well as the assistance center's role and the subsequent handling in activating the aid (e.g., What happens in emergency cases regarding access to the apartment?). In this context, the results indicate the critical role of technical staff who monitor and maintain the equipment in the care receiver's home. During installation, users must be informed about the system's features and equipment in a user-friendly manner. Namely, technical staff should be able to explain and show users how the equipment and system work, its features, and how to establish a connection with the assistance center and their (informal) carers (e.g., how to activate an emergency call). Manuals should be adapted to match the cognitive, sensory, and memory-processing abilities of care receivers and highlight the most relevant instructions and illustrations. Preferably during the installation, users should be introduced to the e-care system with assistance from video tutorials and simulations.

In general, the informal carer has a central role in the decision to adopt and use an e-care system. The trial period in this study indicates that such systems come into play (and, due to their features, are most suitable for use) in family situations where a care receiver lives alone and has a solid, close relationship with the informal carer. Emotional attachment and the burden (actual and/or perceived) associated with providing care means that the person who advocated for purchasing the e-care system will most likely

be an informal carer in the care receiver's family. However, this situation of one person taking responsibility for the system does not imply that he or she is the only decision-maker. In fact, due to the complexity and heterogeneity of life situations emerging from the multi-layered relationships in later life between care receivers and their informal carers, both sides can make decisions. Also, significant others outside the care receiver's family, such as general practitioners, neighbors, and/or professional (formal) carers might take part in the decision and purchase process. However, since relatives are expected to provide help in the decision, purchase, and installation processes and will be closely involved with the system, it is crucial that they demonstrate adequate digital skills in order to be able to benefit from the system's features.

Finally, yet importantly, the results indicate that the purchase and maintenance costs of an e-care system are important factors (illustrated in the following excerpt):

> Informal carer, 56 years: *Ah, depends on the price.*
> Interviewer: *Mmm, so, the price…*
> Informal carer, 56 years: *Mainly. The determining factor is the price. A need, an urgent need for that, we don't have at the moment. That could change tomorrow, right? No one knows that. If there was some normal, acceptable price, right, then I would decide. 'Cause it is, after all, quite a big addition.*

The initial purchase price should be set at an affordable level, considering the financial capacities of care receivers and informal carers. Otherwise, both sides might not become actively involved in the purchase process. In this sense, what is critical from the informal carer's and care receiver's point of view is the trade-off between costs and perceived value added through using the e-care system for enhanced safety, security, release of burden, health management, and more. This is particularly true when compared with technologies and services both groups already use for care provision. In this context, the perceptions of (potential) users are meaningfully shaped by their existing experience with assistive technology, as well as expectations for their current and future needs.

4 Discussion and Conclusion

The intervention study enabled us to examine "real life" experiences with tested e-care services and mobile and wearable devices. Quantitative evaluation showed that various aspects of the tested e-care systems were, on average, rated positively by informal carers. However, the likelihood of purchasing the tested system in the near future was not very high. From another perspective, older adults who tested mobile and wearable devices rated them, on average, less favorably, but still quite positive. Although satisfaction with the system/device during the testing period received a higher average score among informal carers and older adults, open-ended questions asked during the second survey revealed important discrepancies. Interestingly, system functionalities were often mentioned among the positive as well as negative aspects of the testing period.

Results from the semi-structured interviews unveiled the full complexity of the phenomenon. The results indicate the heterogeneous needs and expectations users have towards using e-care systems. Moreover, alleviating the fear of not getting help quickly

in an emergency increased the perception of safety and peace of mind; both were assessed as important factors for further use of the service. In order to attain further use, we recognized various design and service features as important factors in the purchasing decision. Some concerns about the e-care system potentially creating less contact between the carer and the care receiver were also raised.

Furthermore, the results of this study underline the importance of intervention research design for researching assistive technology. Accordingly, the results indicate the importance of a more in-depth examination, confirmed by the rich data gathered in semi-structured interviews. While various modifications of the Technology Acceptance Models (TAM) (e.g., [7, 8, 10]) typically include several acceptance factors[6], these factors turned out to be non-exhaustive when studying the intention to use the tested e-care system by both informal carers and care receivers. Our inductive orientation uncovered new and not-yet-reflected issues by quantitative TAM studies of smart technology for independent living of older adults at home. The phenomenon under examination demonstrated a complex mix of interrelated factors (system characteristics and functionalities, service management, [overlap of] informal carers' and care receivers' needs, characteristics, expectations and perceptions), which should all be considered when studying technology acceptance in this field. Technology anxiety, for example, was brought out as a minor inhibiting factor. Furthermore, fear that the e-care system would be substituting for human contact and thus negatively influence the caregiving relationship, was clearly identified in the semi-structured interviews [27, 28]. Hence, further and more detailed analysis of the qualitative data will be carried out in the future. This finding should prove useful also for providers launching e-care products in the rapidly growing and highly competitive market. In addition, mixed methods design enabled us to "tap different domains of knowing" [29], where different (also more sensitive) issues related to experiences with the e-care systems were provided in the semi-structured interviews compared to those raised in the open-ended questions of the follow-up survey.

However, our mixed methods intervention study has some limitations concerning the convenient sample of participants who volunteered to test the devices/systems. During the interviews conducted with care receivers and their informal carers, the researchers noticed that participants' motives for being involved in the intervention study were not only related only to a current need to use the e-care system, but by other motives as well. Most informal carers were technologically skilled employees of the telecommunication provider. This fact might have partially influenced the narrative of the semi-structured interviews. Also, the study is limited by a rather small sample size that prevented us from studying statistically significant differences, for instance, in perceived and actual satisfaction with e-care systems, as reported in the baseline and follow-up surveys. A longer testing and intervention period could also enable care receivers and informal carers to evaluate the systems' and assistance center's function in a more informed way. An extended testing and intervention could also result in more urgent interventions regarding the need for immediate help and assistance. Nevertheless,

[6] Besides perceived ease of use and perceived usefulness, acceptance factors examined in TAM studies are: social influence, compatibility with lifestyle, availability of resources, enjoyment, technology anxiety, and resistance to change.

the rich materials gathered in this intervention study will enable us to analyze the complex relations between acceptance factors in greater detail in the future, particularly difficulties related to the actual e-care systems. Additionally, users' ideas for additional functionalities were identified, providing a sound basis for further exploration of the findings.

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References

1. Chiatti, C., Fry, G., Hanson, E., Magnusson, L., Socci, M., Stückler, A., Széman, Z., Widéhn, N., Barbabella, F., Lamura, G.: Deliverable 4.3. Final report containing case-by case detailed description and analysis of selected 12 good practices. Vienna (2011)
2. Dolničar, V., Müller, S., Santi, M.: Designing technologies for older people: a user-driven research approach for the Soprano Project. In: Colombo, F. (ed.) Broadband Society and Generational Changes, 5th edn., pp. 221–246. P. Lang
3. Kidholm, K., Dinsen, B., Dyrvig, A.K., Schnack, R., Yderstraede, K.B.: Results from the World's Largest Telemedicine Project – The Whole System Demonstrator. Ugeskr Læger, Denmark (2014)
4. Czaja, S.J., Charness, N., Fisk, A.D., Hertzog, C., Nair, S.N., Rogers, W.A., Sharit, J.: Factors predicting the use of technology: findings from the Center for Research and Education on Aging and Technology Enhancement (CREATE). Psychol. Aging **21**, 333–352 (2006). doi: 10.1037/0882-7974.21.2.333
5. Fisk, A.D., Rogers, W.A., Charness, N., Czaja, S.J., Sharit, J.: Designing for Older Adults: Principles and Creative Human Factors Approaches, 2nd edn. CRC Press, Boca Raton (2009)
6. Dewsbury, G., Clarke, K., Rouncefield, M., Sommerville, I., Taylor, B., Edge, M.: Designing acceptable "smart" home technology to support people in the home. Technol. Disabil. **15**, 191–199 (2003)
7. Renaud, K., van Biljon, J.: Predicting technology acceptance and adoption by the elderly: a qualitative study. In: Proceedings of the 2008 Annual Research Conference of the South African Institute of Computer Scientists and Information Technologists on IT Research in Developing Countries: Riding the Wave of Technology, pp. 210–219. ACM, New York (2008)
8. McCreadie, C., Tinker, A.: The acceptability of assistive technology to older people. Ageing Soc. **25**, 91–110 (2005). doi:10.1017/S0144686X0400248X
9. Sixsmith, A.J., Gibson, G., Orpwood, R.D., Torrington, J.M.: Developing a technology "wish-list" to enhance the quality of life of people with dementia. Gerontechnology **6**, 2–19 (2007). doi:10.4017/gt.2007.06.01.002.00
10. Bierhoff, I., Müller, S., Schoenrade-Sproll, S., Delaney, S., Byrne, P., Dolničar, V., Magoutas, B., Verginadis, Y., Avatangelou, E., Huijnen, C.: Ambient assisted living systems in real-life situations: experiences from the SOPRANO project. In: Sixsmith, A., Gutman, G. (eds.) Technologies for Active Aging, pp. 123–153. Springer, US (2013)
11. Peek, S.T.M., Rijnaard, M.D., Nieboer, M.E., Van Der Voort, C.S., Aarts, S., Wouters, E.J.M., Van Hoof, J., Luijkx, K.G., Vrijhoef, H.J.M.: Older adults' reasons for using technology while aging in place. Gerontology **62**, 226–237 (2016). doi:10.1159/000430949

12. Carretero, S., Stewart, J., Centeno, C.: Information and communication technologies for informal carers and paid assistants: benefits from micro-, meso-, and macro-levels. Eur. J. Ageing **12**, 163–173 (2015). doi:10.1007/s10433-015-0333-4
13. Hlebec, V., Srakar, A., Majcen, B.: Care for the elderly in Slovenia: a combination of informal and formal care. Revija za Socijalnu Politiku **23**, 159–179 (2016). doi:10.3935/rsp.v23i2.1317
14. The Regents of University of Michigan: American Customer Satisfaction Index (ACSI): Methodology report. Michigan, United States (2001)
15. Creswell, J.W., Plano Clark, V.L.: Designing and Conducting Mixed Methods Research. Sage, Los Angeles (2011)
16. Doro 8030. https://www.doro.co.uk/doro-8030.html. Accessed 6 Feb 2017
17. telecom emporia emporia telecom - emporiaSMART. http://www.emporia.eu/en/products/overview/emporiasmart. Accessed 6 Feb 2017
18. Bizjak, J., Gjoreski, H.: Gams M Projekt IN LIFE v Sloveniji. In: Bela knjiza EMZ. Institut "Jožef Stefan," Ljubljana, Slovenija, pp. 32–34
19. Personal Emergency Response System - Bay Alarm Medical. https://www.bayalarmmedical.com/medical-alert-system/in-home/. Accessed 6 Feb 2017
20. Sensara|Beter weten, beter zorgen. In: Sensara. https://sensara.eu/. Accessed 6 Feb 2017
21. Smart Care. http://www.essence-grp.com/smart-care. Accessed 6 Feb 2017
22. LivOn. http://www.hidea.kr/hidea/livon/livon.html. Accessed 6 Feb 2017
23. Doro Care|Social security services for elder and disabled. http://care.doro.co.uk/. Accessed 6 Feb 2017
24. Boyatzis, R.E.: Transforming Qualitative Information: Thematic Analysis and Code Development. Sage Publications, Thousand Oaks (2005)
25. Braun, V., Clarke, V.: Using thematic analysis in psychology. Qual. Res. Psychol. **3**, 77–101 (2006). doi:10.1191/1478088706qp063oa
26. Corbin, J.M., Strauss, A.L.: Basics of qualitative research: techniques and procedures for developing grounded theory. Los Angeles, Calif. [u.a.] (2015)
27. Huber, L.L., Shankar, K., Caine, K., Connelly, K., Camp, L.J., Walker, B.A., Borrero, L.: How in-home technologies mediate caregiving relationships in later life. Int. J. Hum. Comput. Interact. **29**, 441–455 (2013). doi:10.1080/10447318.2012.715990
28. Wild, K., Boise, L., Lundell, J., Foucek, A.: Unobtrusive in-home monitoring of cognitive and physical health: reactions and perceptions of older adults. J. Appl. Gerontol. **27**, 181–200 (2008). doi:10.1177/0733464807311435
29. Mathison, S.: Why triangulate? Educ. Res. **17**, 13–17 (1988). doi:10.3102/0013189X017002013