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A capability approach model**

Nikou, Shahrokh; Agahari, Wirawan; Keijzer-Broers, Wally; de Reuver, Mark

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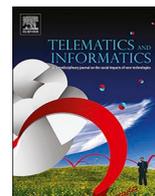
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Digital healthcare technology adoption by elderly people: A capability approach model

Shahrokh Nikou^{a,*}, Wirawan Agahari^b, Wally Keijzer-Broers^c, Mark de Reuver^b

^a Faculty of Social Sciences, Business and Economics, Åbo Akademi University Turku, Finland

^b Faculty Technology Policy and Management, Section Information and Communication Technology, Delft University of Technology Delft, The Netherlands

^c Zo-Dichtbij, Delft, The Netherlands

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ABSTRACT

Digital technologies, such as online healthcare portals, enable elderly people to live independently at home for a longer period of time. Independent living, in this context, refers to the freedom elderly people have to live their lives in ways that they find important. Borrowing from the capability approach (CA) framework from Nobel Prize winner Amartya Sen, the core argument of this paper is that elderly people make decisions on whether to use digital healthcare technologies by considering how these technologies enhance their capabilities to live their lives in ways that are valuable to them. This paper develops a theoretical model of adoption of digital healthcare technologies that support independent living applying the CA framework. We follow a mixed-methods approach with a sequence of qualitative, quantitative, and qualitative methods. We find support for our theoretical model, specifically that the intention to use online healthcare portals depends on whether elderly people expect to enhance their capabilities for living independently by using them. Our study contributes to the information systems literature on adoption of digital healthcare technologies as it is the first that applies the capability approach. For adoption studies on digital technologies in healthcare and beyond, our study poses two major theoretical implications: (1) when considering how outcome expectations affect adoption, scholars should consider how digital technologies allow people to live their lives in ways that are valuable to them, rather than considering how technologies help to execute predefined tasks, jobs, or activities; (2) the availability of digital technologies should be considered as a mediator between outcome expectations and intention to use technologies.

1. Introduction

Digital healthcare technologies are important enablers for elderly people to live independently at home for a longer period of time, next to physical and economic support (Agree, 2014; Kao et al., 2018; Reeder et al., 2013; World Health Organization [WHO], 2007). It has also been argued that because of changing demographics of societies, ageing has increasingly become a major issue for governments and policy makers alike (Chang et al., 2015; Choudrie et al., 2018). Raad and Yang (2008) argue that one major challenge to successful aging is the capability to preserve health or avoiding disease. Independent living refers to the degree to which elderly people have the autonomy to control and lead their own lives, even if they do not do everything by themselves (Brisenden,

* Corresponding author.

E-mail addresses: shahrokh.nikou@abo.fi (S. Nikou), w.agahari@tudelft.nl (W. Agahari), wallykeijzer@zo-dichtbij.nl (W. Keijzer-Broers), G.A.deReuver@tudelft.nl (M. de Reuver).

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1986). While elderly people represent a diverse population, most of them prefer to live independently at their own homes as they age, as various studies have consistently shown (Ball et al., 2004; Carstensen et al., 2010; Gilleard et al., 2007; Vasunilashorn et al., 2012). Yet, adoption of digital healthcare technologies for independent living is low amongst elderly people (Fox and Connolly, 2018; Kapadia et al., 2015; Morris et al., 2013; Nikou, 2015; Thielke et al., 2012).

While most of the information systems (IS) literature on adoption of digital health-related and wellbeing technologies focuses on the physician's perspective (Romanow et al., 2012), there is a growing body of research on adoption by end-users such as elderly people. For example, (Venkatesh, 2008) argues that digitization and in particular digital homes provide ample benefits allowing the elderly people to continue living at home with much improved security and safety mechanisms. Prior studies provide evidence of various antecedents of adoption of health-related digital technologies, such as privacy concerns (Angst and Agarwal, 2009; Fox and Connolly, 2018; Peek et al., 2014; Yusif et al., 2016), costs (Cohen-Mansfield et al., 2005), information quality and credibility (Koo et al., 2014), trust (Coughlin et al., 2007; Fox and Connolly, 2018; Yusif et al., 2016), risk perceptions (Fox and Connolly, 2018), and adherence to human values (Liu et al., 2016). Prior studies indicate that the importance of adoption antecedents depends on the elderly person's characteristics, as moderators include age (Niehaves and Plattfaut, 2014), cultural and socioeconomic factors (Coughlin et al., 2007), and physical disabilities (Liang et al., 2017). Outcome expectations are also found to be relevant antecedents of adoption of digital technologies by elderly people, both for healthcare-related technologies (Kordzadeh and Warren, 2017) and other technologies such as social networking (Maier et al., 2011) and for the use of Internet (Niehaves and Plattfaut, 2014). However, how outcome expectations related to independent living affect adoption decisions has not been studied yet.

IS literature offers several well-established theories on the role of outcome expectations in the acceptance and adoption of digital technologies. In the technology acceptance model (TAM), the major predictor of adoption is perceived usefulness, which is defined as the degree to which a system is expected to increase job performance (Davis, 1989). Similarly, the unified theory of acceptance and use of technology (UTAUT) model focuses on performance expectancy as a major predictor of adoption (Venkatesh et al., 2003). Affordance theory has recently become popular in IS literature to theorize how information technology (IT) devices create the preconditions to conduct activities or actions (Gibson, 1966; Leonardi, 2013; Majchrzak and Markus, 2012). However, independent living does not imply a predefined set of jobs, tasks, or activities that elderly people execute. Instead, independent living implies that elderly people have the freedom to decide on their own lifestyle, depending on what they find valuable in life (cf. Leeson et al., 2004). Rather than relating to the functional aspects of technologies, independent living is related to human values (Liu et al., 2016). Hence, independent living is an objective that transcends specific tasks or activities. Therefore, we argue that a novel theorization is needed on how expected outcomes related to independent living affect the adoption of digital health-related technologies.

Our theorization builds on the capability approach (CA) developed by Nobel Prize winner Amartya Sen (1992). The CA framework explains how resources, such as technologies, give people the freedom to live their lives in ways they find valuable. Within the framework, so-called capabilities refer to the opportunities to make choices on how to lead one's life, which are enabled by resources. We argue that independent living can be conceptualized as a set of capabilities, as it entails the freedom to live at home in the way an elderly person wants to, facilitated by digital technologies. Within information systems, the CA is almost exclusively used within the field of information and communications technology for development (ICT4D), where it has become a powerful lens through which to conceptualize the impact of digital technologies on people's development goals (Sahay et al., 2017). Specifically, ICT4D researchers use the CA to evaluate the impact of digital technologies beyond economic goals (Kleine, 2010) and to emphasize development goals of wellbeing and agency (Zheng, 2009). Application of the CA on digital healthcare technologies for elderly people has been pioneered by other authors, but without making the link to adoption decisions (e.g. Talaei-Khoei et al., 2015b). Talaei-Khoei et al. (2015a,b) and Vichitvanichpong et al. (2017) conceptualize how capabilities play a role in the cognitive process of converting a potentially useful technology into actual usefulness, within a context of independent living. However, they do not conceptualize how understandings of the potential use and expected capabilities in turn affect the intention to use technologies. Similarly, Talaei-Koei and Daniel (2018) conceptualize the perceived transfer of technologies to elderly people's capabilities as a source of perceived usefulness. In an exploratory study, Meijering et al. (2019) elicit various capabilities that contribute to independent living. However, none of these studies explain how capabilities as expected outcomes affect adoption decisions of elderly people.

The goal of this paper is to develop and test a theoretical model that explains the intention to use digital healthcare technologies by elderly people, by considering how these technologies improve their capabilities to live independently. We develop our theoretical model based on the CA framework. To develop and test the theoretical model, we follow a sequential mixed-methods approach with three empirical steps (Venkatesh et al., 2013). In our empirical work, we focus on a specific subclass of digital healthcare technologies: online healthcare portals, that is, websites providing information and communication features related to health and wellbeing. First, we conducted a qualitative study using exploratory and focus group interviews to unearth which features a digital healthcare technology should have in order to facilitate independent living. This first study allowed us to contextualize the constructs in our theory to apply them in the domain of independent living. Second, we conducted a quantitative survey to test the hypotheses on the contextualized constructs and the path relationships in our model. To ensure that respondents were knowledgeable about digital technologies for independent living, the survey used a clickable mock-up healthcare portal as a probe, which we developed based on features elicited by the first qualitative study. In terms of Venkatesh et al. (2013), the first two studies have a development rationale: the qualitative study contextualizes the constructs in our theory, whose related hypotheses are tested in the quantitative study. Third, we conducted a qualitative study based on seven interviews with elderly people. In this third study, elderly people were asked, through open-ended questions, to explain how the features in the clickable mock-up would contribute to their capabilities to live independently. In terms of Venkatesh et al. (2013), the second and third studies have a corroboration rationale: the qualitative interviews provide additional evidence of the interplay of digital healthcare technology features and capabilities for independent living. Fig. 1 illustrates the relation between the three studies.

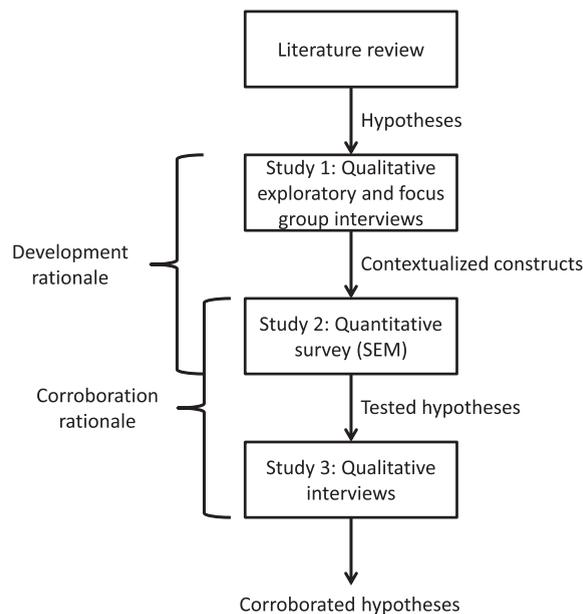


Fig. 1. Interrelation and rationale for three studies.

This paper contributes to understanding the antecedents of elderly people's intentions to adopt digital healthcare technologies that would allow them to live independently for a longer period of time. Our theoretical model is built on the CA framework, which has not yet been used in the literature on independent living, or adoption of digital healthcare or other digital technologies by elderly people. While the scope of this paper is on digital healthcare technologies that facilitate independent living, our theorization may be relevant for other phenomena in which digital technologies contribute to people's quality of life.

The paper is structured as follows: [Section 2](#) provides a theoretical background of the capability approach. Our conceptual model is developed in [Section 3](#). Next, the three empirical studies are presented in [Section 4](#) (qualitative exploratory and focus group interviews), [Section 5](#) (quantitative survey), and [Section 6](#) (qualitative interviews). [Section 7](#) discusses our findings and [Section 8](#) concludes the paper.

2. Theoretical background

This section provides the basic theoretical notions of the CA ([Section 2.1](#)), followed by an overview of how the CA has been applied in prior studies in information systems research ([Section 2.2](#)). We conclude the section by comparing the assumptions of an adoption model based on the CA with existing adoption theories within the IS literature ([Section 2.3](#)).

2.1. Capability approach

The CA is a normative framework developed by [Sen \(1992, 1999a,b, 2001\)](#) as well as [Nussbaum \(2000, 2006\)](#). The framework describes how people use resources in order to improve their daily lives ([Sen, 1992](#)). The CA is used to evaluate people's wellbeing, for instance, related to inequality and poverty ([Robeyns, 2005](#)). Instead of focusing on opulence (i.e., a person's income) or utility (as in traditional welfare economics), the CA focuses on a person's capability to function, which refers to what the person can do or can be ([Mitra, 2006; Sen, 1999a,b](#)). Hence, increased income or wealth are not the ends but the means to improve human wellbeing ([Garai and Shadrach, 2006; Zheng, 2009](#)). Wellbeing can be conceptualized as the substantive opportunities an individual has to pursue and achieve happiness ([Binder, 2014](#)). The CA frames individual wellbeing in terms of people's capability to function in ways they value.

The assumptions of the CA differ from those of utilitarian and economic approaches in important ways. The main premise of the CA is that resources should be evaluated based on how they affect the freedom to live a life in a valuable way ([Sen, 2001](#)). Hence, resources should *not* be evaluated based on their utility or impact on income ([Oosterlaken, 2009](#)). In this way, the CA differs from utilitarianism and resourcism, which predominantly focus on the availability of means to achieve a good life. Instead, within the CA, an individual's capability to live a good life refers to the range of options from which a person can choose and/or are feasible for her to achieve ([Garai and Shadrach, 2006](#)).

In its original form, the CA framework consists of three core constructs:

- **Functionings:** a person's potential states and activities ([Sen, 1992](#)). Functionings can be categorized into what Sen calls "beings" and "doings." Examples of "beings" are being happy, being healthy, being calm, being safe, and having self-respect. Examples of "doings" are travelling, caring for a child, voting, participating in demonstrations, taking drugs, and having loving relationships

with others to which one has real access (Wells, 2012).

- **Capabilities:** the alternative combinations of functionalities that represent the range of options from which a person can choose (Sen, 1992). In other words, capabilities are the functionalities that are, potentially, feasible for a person to achieve. Capabilities thus represent the freedom that people have to choose the functionalities that they find valuable.
- **Resources:** the goods or services available to individuals (Sen, 1992). Resources are of interest to a person because they allow a certain functioning. For instance, a bike is a resource that allows the functioning of mobility—the ability to move from one place to another.

In a further development of the CA, Sen (1992) introduced the idea of conversion factors.

- **Conversion factors:** conditions that affect the extent to which a person can transform a resource into a functioning. Even though a resource is available, not every individual is able to use it in order to achieve a desired functioning. In the example of a bike, conversion factors determine how much mobility a person can get from using the bike.

A large variety of conversion factors can be found in the literature; for example, Robeyns (2005) distinguishes three groups of conversion factors: personal (e.g., gender, literacy, physical condition, reading skills, intelligence), social (e.g., public policies, laws, social norms, power relations, gender roles), and environmental (e.g., climate, geographical characteristics, infrastructure, and location). Thus, the functionalities a person can achieve do not solely depend on whether resources are available, as personal, social, and environmental circumstances should be considered as well (Robeyns, 2005).

Rather than a fully specified theory, the CA is a broad, multidimensional framework that should be adapted to specific contexts (Alkire, 2005). Which capabilities are relevant depends on both, what is possible and what is desirable in a specific context (Oosterlaken, 2012). Although there have been attempts to develop generic capability taxonomies (most notably by Nussbaum, 2003), Sen has always argued that capabilities should be considered context-bound and dependent on people's purposes. As Sen does not suggest how to specify capabilities (Chiappero-Martinetti and Roche, 2009) identifying and operationalizing them for a given context is a major challenge (Oosterlaken, 2012). All in all, the CA is a theoretical perspective rather than a set of guidelines and, as such, it remains an open framework that can be used for a variety of aims (Robeyns, 2005).

2.2. The capability approach in information systems

A search on the term “capability approach” in the basket-of-eight journals of the Association for Information Systems (AIS) confirmed that the CA has, to date, only been applied in ICT4D studies. In ICT4D literature, the CA is used to conceptualize the development impact of digital technologies (Sahay et al., 2017). In this CA conceptualization, the *resources* are the digital technologies that enable an individual to achieve a valuable goal (Hatakka and De, 2011; Heeks and Molla, 2009). *Capabilities* thus represent what people are able to do by utilizing the features of digital technology (Hatakka and De, 2011; Robeyns, 2005). *Functionings* are those “beings” and “doings” that people actually choose, and thus a subset from the capabilities that digital technology enables.

Proponents of the CA argue that ICT4D researchers should use the CA to conceptualize how digital technologies enable people to live the lives they value (Zheng, 2009). Applying the CA allows evaluating the impact of digital technologies on development, which helps researchers to focus on the impact on people's wellbeing and agency rather than on merely maximizing access to technology (Zheng, 2009). Similarly, Kleine (2010) argues that the impact of digital technologies in developing countries should not be evaluated by considering income growth or wealth, but by considering the impact on individual freedom from a holistic perspective.

Several case studies have used the CA to evaluate the impact of digital technologies on development. For instance, Dasuki et al. (2012) used the CA to analyse how a payment solution in Nigeria failed to fulfil its developmental potential. Dasuki et al. (2014) applied the CA to show how digital technologies allow participation in developing countries, which subsequently leads to empowerment. Alampay (2006a,b,c) theorized that people's personal conditions—such as age, income, and education—affect their freedom to choose whether to use ICT, which consequently affects their ICT usage. In a recent study, Andrade and Doolin (2016) applied the CA in a refugee context, finding that ICT leads to capabilities to participate, communicate, and understand society, as well as to being socially connected and expressing one's cultural identity.

The increasing popularity of the CA in ICT4D literature suggests it is a powerful lens through which to evaluate the impact of ICT on people's wellbeing. This lends support to our assertion that the CA may be used to understand how digital health-related technologies enable elderly people to live independently. While the context of elderly people in developed economies is arguably different, capabilities of empowerment, participation in society, and being socially connected may be just as important to elderly people as they are to people in developing countries.

2.3. Capability approach and IT adoption

In this paper, we develop a theoretical model of adoption of digital healthcare technologies for independent living based on the CA framework. The central construct of the CA is capabilities, which are the “beings” and “doings” that resources, such as digital technologies, enable people to achieve. Hence, capabilities are potential outcomes that can be realized by using technologies.

Expected outcomes are core to several well-established adoption theories in IS. For instance, the technology acceptance model (Davis, 1989) explains adoption by considering the expected improvement on job performance (i.e., perceived usefulness).

Importantly, the CA is a nonutilitarian approach,¹ which means that outcomes are not considered to be in the realm of utility, wealth, or income. Rather, outcomes should be conceptualized as the ability of individuals to live their lives in the way they choose to. This basic notion of nonutilitarianism in the CA implies that the expected outcomes in our model are on a different abstraction level than those in most adoption theories in IS. From a CA perspective, expected outcomes should go beyond the direct impact on job performance (as in the technology acceptance model by Davis, 1989), performance more generally (as in the UTAUT model by Venkatesh et al., 2003), or tasks (as in the task–technology fit model by Goodhue and Thompson, 1995).

The CA explicitly assumes that availability of resources, such as digital technologies, does not automatically lead to outcomes on the level of “beings” and “doings.” Instead, the notion of capabilities represents that availability of resources leads to opportunities to achieve “beings” and “doings” and that people have the freedom to choose whether they want to realize these opportunities or not. In this way, an adoption theory based on the CA may appear similar to the affordance theory coined by Gibson (1966), which has been widely used in IS research (e.g., Goldkuhl, 2004; Pozzi et al., 2014; Strong et al., 2014; You and Chen, 2007; Zhang, 2008). Affordance theory posits that the environment of an individual contains so-called affordances, which provide possibilities for actions or activities. For instance, a knife provides the affordance of cutting (Gibson, 1950, 1966). Some scholars combine the CA and affordance theory, for instance, using the construct of affordances to theorize on how individuals explore digital technologies to enhance their capabilities (Hatakka et al., 2016). Others assert that the construct of affordances may be extended to capabilities in the CA framework (Kaaronen, 2017).

We argue here that there are at least two major differences between affordance theory and the CA. First, as Sein et al. (2016) argue, affordance theory and the CA differ in what they try to explain. While the CA conceptualizes the development goals that people may seek to achieve, affordance theory explains what digital technologies are and how they enable actions. Hence, while affordance theory focuses on the direct actions or activities that digital technologies enable, the CA focuses on the higher-level values that people seek to achieve. For instance, in the case of a bike, an affordance is the possibility to cycle, while a capability would be the freedom to move around. Second, the assumptions on what generates a capability versus an affordance are fundamentally different. While capabilities are “beings” and “doings” that individuals consider to be valuable for their quality of life (Sen, 1992), affordances are anything the environment provides or furnishes, “for good or ill” (Scarantino, 2003, p. 950). Hence, in contrast to capabilities in the CA, affordances are not subjectively based on the needs and experiences of the observer but given by the objects in the environment (Gibson, 1979; Oliver, 2005). Therefore, we argue that capabilities in the CA are substantially different from affordances since they are not objectively posed by the environment (or digital technologies) but rather a consequence of the interplay between what people want to achieve and what technologies offer.

3. Theoretical model

We develop a theoretical model of adoption of digital technologies for independent living building on the core notions of the CA framework. The central construct of our theoretical model are the capabilities that are derived from using digital technologies. Specifically, we focus on those capabilities that are related to independent living. Our core theoretical argument, consistent with the CA framework, is that people make decisions on whether to use digital technologies by considering how these technologies provide them with capabilities to achieve desirable “beings” and “doings.” In other words, people do not make decisions on the use of technologies based on the characteristics of technology in and of themselves, or even on the tasks that they can perform with those technologies, but rather on whether those technologies enable them to achieve a goal they have set for themselves.

Our core argument is consistent with existing adoption theories such as TAM (Davis, 1989) and UTAUT (Venkatesh et al., 2003), which posit that outcome expectations affect intention to use. However, as stated in Section 2.3, the outcomes in our CA-based theory are at a fundamentally different level of abstraction, as we focus on capabilities to achieve “beings” and “doings” that people intrinsically value in their lives, rather than on performance improvement in externally defined jobs or tasks. Thus, the first hypothesis in our theoretical model is as follows:

H1: Capabilities for independent living that can be derived from using digital healthcare technologies positively affect people’s intention to use those technologies.

According to the CA framework, the utilization of resources to attain capabilities—such as technologies, goods, and services—takes place through a process of conversion. So-called conversion factors, such as individual, social, and environmental conditions, affect the extent to which a person is able and willing to utilize the available resources to attain capabilities. Hence, the availability of resources is not a sufficient condition for their usage. Similarly, usage is not a sufficient condition for the attainment of capabilities. For this reason, we distinguish the intention to use resources (i.e., a digital technology), which is our dependent variable, from the importance that people attribute to having those resources available, should the need to use them arise in the future.

To illustrate our argument, consider an elderly person who wants to live independently and is not yet facing any challenges in their daily life to do so. Such a person will not use digital technologies that provide capabilities for independent living, simply because they do not need them yet. However, the same person may still find it important to have those digital technologies available should they face physical, social, or cognitive impairments in the future. In line with this, we hypothesize that:

¹ Please note that, consistently with the CA framework, we use the term “nonutilitarian” as the contrary of economic and utilitarian approaches (cf. Zheng 2009) and not as the equivalent for “hedonic” information systems (cf. van der Heijden 2004).

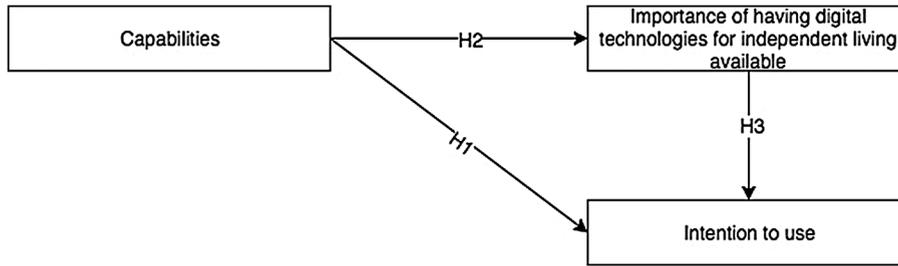


Fig. 2. Theoretical model.

H2: The capabilities for independent living that can be derived from using digital healthcare technologies positively affect the importance that people attach to having them available.

H2a: The importance that people attach to having digital healthcare technologies available mediates the impact of capabilities for independent living on intention to use those digital healthcare technologies.

The impact that capabilities for independent living may have on the importance that people attach to having digital healthcare technologies available will influence people's decision to use digital healthcare technology, thus we hypothesize that:

H3: The importance that people attach to having digital healthcare technologies available positively affects their intention to use those technologies.

The mediation effect hypothesized in H2a depends on conversion factors. Conversion factors in the CA framework are largely context-specific and agreed-upon classifications of them are not available. Broadly, conversion factors can be personal, social, or environmental (Robeyns, 2005). In the context of health and disability, Saleeby (2007) has considered personal (e.g., physical condition, preferences, cultural values) and environmental conversion factors (e.g., location, social forces). Moreover, Talaei-Khoei et al. (2015a,b) and Vichitvanichphong et al. (2014) identified individual characteristics (e.g., human capacities, strength and limitations based on different demographic factors) and individual opinions about goods and services.

For our context of independent living, the most important conversion factors are those related to the challenges that people face when living independently. These challenges will amplify how capabilities affect the importance of having resources available and the intention to use them. In other words, the higher the challenges people face when living independently, the higher the impact of the desire to live independently on the importance of having digital technologies available and on the intention to use those technologies. Hence, in our analyses, we control for the different types of challenges elderly people face when living independently, which we use as moderators in our research model. Fig. 2 summarizes the hypotheses in our theoretical model.

4. Interviews and focus group sessions

Prior to examining the hypotheses, we contextualized the features of digital healthcare technologies for independent living. We identified and prioritized those features that specifically contribute to independent living in order to ensure the content validity of our subsequent quantitative study. We focus on a specific subclass of digital healthcare technologies: online healthcare portals. We elicited and prioritized the main classes of features of digital healthcare technologies for independent living through two qualitative rounds of data collection: exploratory interviews ($N = 59$) and focus group interviews ($N = 12$).

4.1. Qualitative interviews

Semi structured interviews were conducted with various stakeholders, such as elderly people; providers of technologies; services; and products; informal caretakers; local government officials; investors; and experts in healthcare and elderly care. Interviewees were

Table 1
Interview.

| Type of stakeholder | Role | Interviews |
|---|--|------------|
| Providers of technologies, services, products | Technology Providers (i.e. platform developers) | 5 |
| | Service Providers (i.e., suppliers of smart living services) | 6 |
| | Product suppliers (i.e., suppliers of smart living products) | 6 |
| End-users | Citizens age 50 – 75 | 9 |
| | Informal caretakers | 10 |
| Other stakeholders | Local governments | 5 |
| | Investors | 8 |
| | Universities | 5 |
| | Knowledge institutes | 5 |

Table 2
Functions and categories.

| Providers of technologies, services, products | End-users | Other stakeholders |
|---|--|---|
| Portal (one stop shop) for communication about independent living (7) | Community (i.e., contact, solutions, social wellbeing, marketplace) (10) | Information exchange about independent living between (service) providers and end-users (i.e., matchmaking) (9) |
| Information exchange about independent living between (service) providers and end-users (i.e., matchmaking) (7) | Portal (one stop shop) for communication about independent living (4) | Cross-industry knowledge exchange about independent living (7) |
| (Health) Intervention instrument to support citizens with independent living services (6) | Support citizens finding independent living services (3) | (health) Intervention instrument to get in contact with citizens about independent living needs (5) |
| Cross-industry knowledge exchange about independent living (3) | | Online community (4) |
| Online community (2) | | Portal (one stop shop) for communication about independent living (3) |

selected from the principal author's professional network based on the criterion that they were either affected by healthcare problems or could contribute to creating a digital platform to solve that kind of problems. We conducted 59 interviews, 17 with providers of technologies, services, and products; 19 with elderly people and informal caretakers; and 23 with other stakeholders (see Table 1). All interviewees were from the Netherlands and interviews were held in Dutch. All conversations were summarized and compiled in a logbook. Interviews were open and informal. During the interviews, open questions were raised on whether online healthcare portals would help to accelerate independent living, and what such portals should look like.

Answers were categorized into generic functions of online healthcare portals (see Table 2). A frequently mentioned function was *information exchange* between providers and end-users. In addition to exchanging information about services and products, interviewees pointed out that matching end users' needs with online services automatically would certainly add value to a portal. Providers were mainly interested in communicating their offerings to potential user groups (i.e., business to consumer [B2C]) rather than communicating about smart living at a provider level (i.e., business to business [B2B]). The main benefit of these features would be that elderly people could more easily find products and services they need to live at home independently.

An online *community for social interaction* was often mentioned by end-users. Such a community would not only help end-users to find and recommend applications to each other, but also to check on each other's social wellbeing. The main rationale behind this function is the need for social cohesion (i.e., staying in touch with other elderly people and the outside world). A *portal for communication about solutions* was often mentioned as well by all three types of stakeholders. Such a portal would be a marketplace for solutions and a "one-stop shop" to access products and services. Another feature, although less frequently mentioned, was an *intervention instrument* for the municipality to contact citizens about needs for services and questions on healthcare legislation. Such intervention instrument would be especially relevant as elderly care has been shifted as of 2016 to municipalities as result of regulation changes.

4.2. Focus groups

We used two focus groups to validate and refine the three more frequently mentioned features (i.e., information exchange, community for social interaction, and a tool for communication about solutions). A focus group is "a carefully planned discussion, designed to obtain perceptions on a defined area of interest in a permissive, non-threatening environment" (Krueger, 1994, p. 6). Thus, focus groups are informal group discussions among a small group of individuals in which different views and experiences are explored through group interaction (Litosseliti, 2003). In essence, they are group interviews, the purpose of which is to collect qualitative data. However, focus groups rely on the "explicit" use of group interaction to produce data and insights that would be harder to access without such interaction (McGraw and Seale, 1988). A group session is useful for dealing with complex, unstructured problems in which the actors have incompatible interests, diverging areas of knowledge, and multiple backgrounds. As such, focus groups are expected to be more productive than single interviews (van Herik and Vreede, 2000).

For the first focus group, participants were carefully selected to mirror the diversity of viewpoints from the interviews with providers, end-users (i.e., informal carers and elderly people), and other stakeholders from the Netherlands. By doing so, we ensured that findings would be comparable between the interviews and the focus group. In a second focus group, we aimed to get more of an outsiders' perspective on the features elicited in the interviews. To do so, we invited academic experts from another country to participate (i.e., the UK; see Table 3).

In general, participants argued that collaboration between end-users, service providers, and government agencies is required to help people stay at home as long as possible; they also argued that an online healthcare portal would be a viable tool to help the stakeholders to interact with each other. According to the 12 participants in the two focus group meetings, all combinations of platform features (information exchange platform, online community, communication tool, intervention instrument) are possible because the suggested features are more or less related. The feature that gained the most support was a communication tool. Seven participants (2, 7, 8, 9, 10, 11, and 12) suggested that a platform should combine the information exchange and communication tool features as both support interaction between providers and end-users. As an additional suggestion, three participants (5, 6, and 7) came up with a specific intervention feature for district nurses working in a community centre for elderly people. Two participants (1

Table 3
Focus group 1 and 2 participants.

| Focus group 1 | | |
|---------------|---|---|
| Identifier | Organization | Job description |
| #1 | Arts en Zorg Provides pharmacy, general practitioner and physiotherapy in larger region | Administrator |
| #2 | Stichting Welzijn Midden Delfland Provides information and services to support informal carers and elderly in a municipal region | Director |
| #3 | Tympaan Association for informal care providers | Project leader informal caretakers/volunteers |
| #4 | KPN Largest Dutch telecom operator | Strategist/advisor (smart homes) |
| #5 | Dutch government | Consultant and advisor |
| #6 | General practitioner | General practitioner |
| #7 | N/A | Retiree/elderly person |
| Focus group 2 | | |
| #8 | Age-UK: Charity for elderly people | Senior manager |
| #9 | Health Design and Technology Institute | Director |
| #10 | Coventry University | Senior Manager |
| #11 | Coventry University | Lecturer |
| #12 | Utrecht University of Applied Sciences | PhD Researcher |

and 6) suggested a follow-up emergency response system for elderly people. Again, an intervention instrument was seen as the least important feature according to participants 2, 8, 9, and 11; other participants had diverse opinions. Most participants agreed that a web platform would help municipalities stay in direct contact with their local citizens. The rationale behind this assumption is the new Dutch healthcare legislation implemented in 2015 and the consequent new healthcare-related tasks facing the municipalities. The UK participants explained that differences in care health systems did not allow them to reflect on the utility of the proposed intervention feature. Hence, we conclude from the interviews and focus group that the main features to be included are information exchange about health and wellbeing products and services; online community portal for staying in contact locally; and communication tool between care providers, elderly people, and informal caretakers.

4.3. Design of a clickable mock-up

Based on the aforementioned three main features, a clickable mock-up of an online healthcare portal was developed. A navigation plan was outlined for a portal containing the three core features. The navigation plan included (a) a marketplace for health and wellbeing products and services, including reviews; (b) a social community environment listing local activities and contacts; and (c) a personal profile to enable communication between elderly people and caretakers. To visualize the personal profile for communication, it was decided to create an online “care plan,” similar to that already in use in the Dutch healthcare system. The care plan contained an agenda with tasks that can be edited by the elderly person, informal caretakers, and care providers, and a diary with recorded events and observations.

Before designing the clickable mock-up portal, a paper version was created based on the navigation plan with the aid of a user experience engineer. The paper mock-up was tested with four users in a face-to-face setting in which it was verified that the goals and functions were clear and as intended. The clickable mock-up was developed next. Usability of the clickable mock-up was tested with six participants: two elderly people, two informal caretakers, and two professional caretakers. The test took 1.5 h per person and participants indicated that they were able to use the portal. Minor revisions were made after the usability test. Table 4 summarizes how the three main features were visualized on the clickable mock-up. A screenshot of the clickable mock-up is shown in Fig. 3.

The elicited features were used to build the survey measures for the quantitative study. The clickable mock-up was used as a probe in the survey, both to ensure knowledgeability and to increase reliability across respondents.

Table 4
Main features visualization into the Clickable Mockup.

| Feature derived from interviews and focus group | Implementation in clickable mockup |
|--|--|
| Information exchange on services/products between providers and end-users, including reviews | Searchable care products/services Reviews on care products/services |
| Social community portal for staying in touch in local environment | Searchable list of local activities Agenda with local activities |
| Online communication tool between elderly people, informal caretakers and care providers | Care plan comprising diary, agenda and personal profile |

The screenshot shows the homepage of the Zo-dichtbij platform. At the top, there is a navigation bar with 'Zorgplan' and 'Hulp chat' buttons, and a user profile section with 'Berichten 3', 'Help', 'Uw Profiel', and 'Uitloggen' options. The main content area is divided into three sections:

- Planbord:** A table with columns 'Taakbeschrijving', 'Datum', and 'Voltooid'. It lists two tasks:

| Taakbeschrijving | Datum | Voltooid |
|---------------------------------------|-------------|--------------------------|
| ** Anton ** fysio therapeut uitzoeken | 11 mei 2016 | <input type="checkbox"/> |
| ** Ria ** hoog/laag bed regelen | 14 mei 2016 | <input type="checkbox"/> |
- Activiteiten:** A table with columns 'Activiteiten beschrijving', 'Datum', and 'Voltooid'. It lists one activity:

| Activiteiten beschrijving | Datum | Voltooid |
|--------------------------------|-------------|--------------------------|
| 14:30 - Bingo in het buurthuis | 21 mei 2016 | <input type="checkbox"/> |
- Dagboek berichten:** A list of journal entries. The first entry is by Ria, dated 21 mei 2016, describing a visit to Bingo. The second entry is by Anton, dated 21 mei 2016, asking about Bep's hospital discharge.

On the left side, there is a navigation menu with buttons for HOME, PLANBORD, ACTIVITEITEN, DAGBOEK, GEZONDHEID, CONTACTEN, PRODUCTEN & DIENSTEN, HELP, and UITLOGGEN. The profile section on the left identifies the user as Bep van Leeuwen, born 12 april 1936, with a 'Ga naar profiel' link.

Fig. 3. Homepage of Zo-dichtbij.

5. Quantitative study

5.1. Sample

The sample for the survey consisted of elderly people that live independently in the Netherlands. An electronic survey was sent out to an existing (representative) panel of 401 elderly people, which belongs to a care foundation. We assured respondents that data were anonymously collected and that we would use the results only for research purposes. Within 2 weeks, 150 people responded (38% response rate). Of the respondents, 82 were female (~55%) and 68 were male (~45%). The average age of the respondents was 71 years, with a standard deviation of 8.78 years; 75% of the respondents were above 66 years old. One out of four respondents provide informal care to family members or spouses. To increase the sample size, the survey was sent to a broader convenience sample consisting of the personal contacts of one of the authors. The survey was sent to 1,100 people, of which 474 responded within 2 weeks (43% response rate). Multi-group analysis on the structural model (see Section 5.3) showed that both measurement model and regression weights were not significantly different for both subsamples, judging by the results of a chi-square difference test. Hence, the two samples were combined for further analyses.

The survey was self-administered through an online tool. At the start of the questionnaire, respondents were asked to click on a hyperlink to our clickable mock-up portal. Respondents were asked to examine the clickable mock-up and the different menus in it. After confirming that they had examined the clickable mock-up, respondents entered into the actual survey.

Since the CA has not been applied in adoption studies yet, scales are not available. In line with the premise of the CA that capabilities and resources are context-specific, we used findings from existing literature and from our qualitative interviews and focus group meetings to develop the measurement items.

The scales on importance of resources and intention to use were developed based on the findings from the focus group and exploratory interviews (see Section 4). The items for these two constructs list the most important features that were found in Section 4. Independent living capabilities are measured through items on being able to stay comfortably within one's current home. All items were measured using a 7-point Likert scale (see Table 5). Validation of the scales is presented in Section 5.2. Several questions were asked regarding personal and social difficulties, which were used as control variables. Regarding personal difficulties, respondents were asked whether they face challenges related to cooking, enjoying food, gardening, doing housework, memory, safety, and washing. In terms of social difficulties, challenges in going outside, leisure, mobility, social life, and travelling were probed. Moreover, gender and age were used as control variables.

Table 5
Survey items.

| Constructs | Items | Item wording |
|--|--|--|
| Importance of having digital technologies for independent living available | Which elements would be important on the platform? (1) Not important at all – (7) Very important | |
| | PIM-1 | Diary (to share with relatives and caretakers) |
| | PIM-2 | Finding local activities |
| | PIM-3 | Personal profile |
| | PIM-4 | Review possibilities products and services |
| Independent living capabilities | I assume the platform will help me (or the one I take care of) to ... (1) Not at all – (7) Very much | |
| | CA-1 | Age in place |
| | CA-2 | Avoid moving to another place |
| | CA-3 | Add extra comfort at home |
| | CA-4 | Stay independent |
| Intention to use | Which functionalities would you like to use (now or in the future)? (1) Not at all – (7) For sure | |
| | IN-1 | Agenda with local activities |
| | IN-2 | Care plan, agenda and diary (share with relatives) |
| | IN-3 | Care products |

5.2. Measurement results

We used partial least square (PLS) for testing the hypotheses and determine the statistical significance of the path coefficients (Ringle et al., 2005). Both, the measurement model and the structural model can simultaneously be assessed using PLS (Hair et al., 2011). As Gefen et al. (2011) have shown, PLS provides similar parameter estimations as covariance-based structural equation modelling (CB-SEM). In comparison to CB-SEM, PLS has higher explanatory power (Hair et al., 2011), which fits our purpose of explaining the intention to use digital health technology by elderly people. Another difference between PLS-SEM and CB-SEM is the model fit assessment. As the basis of the PLS is nonparametric test, it is inappropriate to compute the fit measures such as CFI, NFI and RMSEA which are commonly used in CB-SEM. Instead, Standardized Root Mean Square Residual (SRMR) which could be considered similar as a goodness of fit measure for PLS-SEM (Hair et al., 2016; Henseler et al., 2014) and Normed Fit Index (NFI) can be used to assess the model fit (Bentler and Bonett, 1980). For SRMR value, Hu and Bentler (1999) recommended a value of less than 0.10, or for more conservative approach the value of 0.08 (Hooper et al., 2008, p. 55) for a consideration a good fit. For NFI, Lohmöller (1989) recommended a value of above 0.9. The PLS-SEM results show that the structural model has satisfactory levels of fit index; SRMR value is 0.074 and NFI is 0.91.

An exploratory factor analysis (EFA) was conducted to purify the items and to identify the factor structures. The final output resulted in a three-factor solution and 11 items. Before testing hypotheses, the validity of the constructs and measurement model was assessed through reliability, convergent and discriminant validity. To ensure that all constructs were accurately represented and measured, factor loadings of the measurement items were examined. It is recommended that the average loading for each item in the model be equal to or above 0.70 (Bagozzi and Edwards, 1998; Hair et al., 2014). Next, internal reliability was assessed through composite reliability and Cronbach's alpha, which both should exceed 0.70. Hair et al., (2014) argue that composite reliability provides a better assessment of internal consistency, as Cronbach's alpha tends to underestimate internal consistency reliability (see Table 6). Convergent validity was assessed via average variance extracted (AVE). Convergent validity indicates to which extent a construct converges in its measurement items (by measuring variance) and it is obtained by the AVE for all measurement items. As

Table 6
Descriptive statistics, convergent validity, internal consistency, and reliability.

| Construct | Items | Factor Loadings | Mean | Std. dev | t-statistics | α | CR ^a | AVE ^b |
|--|-------|-----------------|-------|----------|--------------|----------|-----------------|------------------|
| Capabilities | CA-1 | 0.87 | 4.988 | 1.65 | 37.04 | 0.93 | 0.93 | 0.83 |
| | CA-2 | 0.83 | 5.03 | 1.55 | 30.51 | | | |
| | CA-3 | 0.92 | 5.26 | 1.63 | 26.11 | | | |
| | CA-4 | 0.89 | 5.58 | 1.51 | 34.34 | | | |
| Intention to use | IN-1 | 0.79 | 4.83 | 1.67 | 14.11 | 0.84 | 0.79 | 0.58 |
| | IN-2 | 0.70 | 5.02 | 1.51 | 12.80 | | | |
| | IN-3 | 0.77 | 5.24 | 1.62 | 13.40 | | | |
| Importance of having digital technologies for independent living available | PIM-1 | 0.78 | 5.60 | 1.45 | 13.44 | 0.71 | 0.82 | 0.53 |
| | PIM-2 | 0.70 | 4.93 | 1.73 | 14.86 | | | |
| | PIM-3 | 0.77 | 4.72 | 1.67 | 16.47 | | | |
| | PIM-4 | 0.70 | 5.35 | 1.44 | 10.88 | | | |

a: Scale composite reliability.

b: Average variance extracted.

Table 7

Discriminant validity: correlation among constructs and the Square Root of the AVE.

| | Capabilities | Intention to use | Perceived importance |
|--|--------------|------------------|----------------------|
| Capabilities | 0.677 | | |
| Intention to use | 0.547 | 0.752 | |
| Importance of having digital technologies for independent living available | 0.502 | 0.641 | 0.728 |

Note: Diagonals represent the square root of the average variance extracted and other values represent the correlations.

Fornell and Larcker (1981) argue, convergent validity is established when the AVE of each construct exceeds 0.50 and exceeds the variance due to measurement error for that construct. In other words, AVE measures the amount of variance that a latent construct captures from its indicators (items) relative to the amount due to measurement error (see Table 6).

Next, we examined discriminant validity of the constructs in the model using Fornell and Larcker's criterion. Discriminant validity measures the extent to which items within a construct are distinct from other items of other constructs in the conceptual model (Bagozzi and Edwards, 1998; Campbell and Fiske, 1959). The square root of AVE should exceed the value of all inter-construct correlation coefficients (Fornell and Larcker, 1981). As Table 7 shows, discriminant validity was established.

Furthermore, as the conceptual model entails multiple independent variables, multicollinearity tests were conducted. Variance inflation factor (VIF) values of all variables were lower (highest value = 2.19) than the recommended threshold of 10, indicating multicollinearity was not a significant threat (Hair et al., 1998, 2014). As we measured all the constructs with respondents' self-reports, common method bias was examined using two different approaches (Podsakoff et al., 2003). First, Harman's one-factor test (Podsakoff and Organ, 1986) showed that no factor accounted for more than 50% of the variance, while several factors had an eigenvalue greater than 1. Second, common latent factor technique was used to determine whether the shared variance across all the items significantly differed from zero (MacKenzie and Podsakoff, 2012). The test did not show any paths affected by common method bias (chi-square = 76.3, degree of freedom = 90, $p = .848$).

5.3. Structural results and hypothesis testing

Fig. 4 shows the results of the structural model analysis. Explained variance for intention to use equalled 51% and for the importance of having digital technologies for independent living, 40%. All main effects were significant. We found support for our core hypothesis H1 that expected capabilities for independent living positively affect intention to use digital healthcare technology ($\beta = 0.50$, $t = 7.286$, $p < .001$). We also found that the capabilities for independent living that can be derived from using digital healthcare technology positively affect the importance of having digital technologies for independent living ($\beta = 0.63$, $t = 16.611$, $p < .001$), which supports H2 in our model.

Examining whether the importance of having digital technologies for independent living mediates the relationship between expected capabilities for independent living and intention to use, the following results were obtained. As we had established a positive direct relationship between expected capabilities and intention to use ($\beta = 0.50$, $t = 7.286$, $p < .001$), we found partial mediation of importance of having digital technologies for independent living ($\beta = 0.52$, $t = 6.09$, $p < .001$), thus H2a is supported in the model. Finally, we also found a positive relationship between the importance of having digital technologies for independent living and intention to use ($\beta = 0.29$, $t = 4.973$, $p < .001$), thus H3 is also supported in the model.

Next, we examined the moderating effects for all path relationships in the conceptual model by performing a multigroup analysis (MGA). The purpose was to check whether there were any differences in path coefficients among subgroups in the data. In other words, we assessed whether the conversion factors we controlled for (i.e., age, gender, difficulties at the personal and social levels) impose any significant differences in path relationships. The moderation test provided interesting insights. For instance, in the path

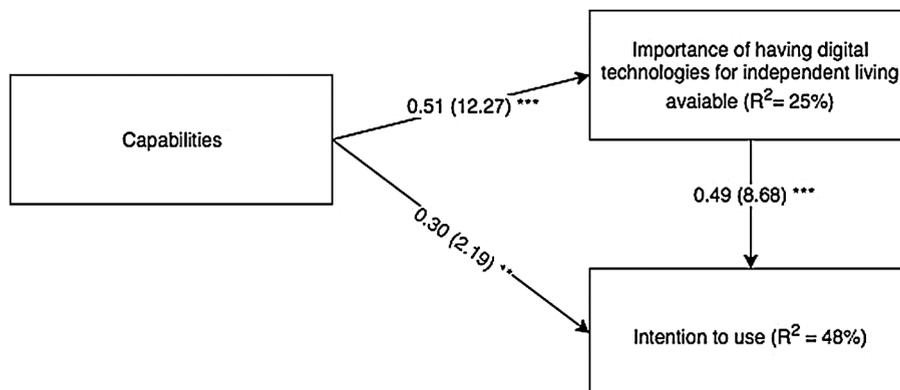


Fig. 4. PLS results of structural model. Notes: *** p -value < 0.001; ** p -value < 0.005; * p -value < 0.01.

between expected capabilities to intention to use (H1), males (H_{1_males} , $\beta = 0.38$, $t = 2.99$, $p < .003$) showed a significantly higher path coefficient than females ($H_{1_females}$, $\beta = 0.18$, $t = 0.48$, *ns*). Gender did not impact any path relationship. Regarding age, a significant difference was found in the path relationship between expected capabilities and the importance of having digital technologies for independent living (H2). Participants under 50 years old demonstrated a significantly higher path coefficient than those over 50 years old ($H_{2_under\ 50}$, $\beta = 0.53$, $t = 10.92$, $p < .001$), ($H_{2_over\ 50}$, $\beta = 0.44$, $t = 6.18$, $p < .001$). Age of respondents did not moderate any other path relationship in the model.

In order to assess whether difficulties and challenges at the personal and social levels moderate the path relationships and SEM results, we performed moderation analyses on these two variables. As explained in Section 5.1, questions in relation to personal challenges were on cooking, enjoying food, gardening, housework, memory, safety, and washing; and for social challenges, questions were on going outside, leisure, mobility, social life, and travelling. As these questions were measured using a 7-point Likert scale, the aggregate metric was constructed based on the results obtained from the explanatory factor analysis (EFA). Next, we calculated the average for each challenge and divided them into two binary groups—having low difficulties and having high difficulties.

For personal difficulties, we found a difference in the path between expected capabilities and intention to use (H1). Those who indicated having low personal difficulties demonstrated a higher path coefficient than those who indicated having high difficulties ($H_{1_P_difficulties(low)}$, $\beta = 0.31$, $t = 1.96$, $p < .005$). However, on the path between importance of having digital technologies for independent living and intention to use (H3), we found different results. Those who indicated that they were facing high personal difficulties ($H_{3_P_difficulties(high)}$, $\beta = 0.51$, $t = 6.34$, $p < .00$) demonstrated a higher path coefficient than those who indicated low difficulties ($H_{3_P_difficulties(low)}$, $\beta = 0.47$, $t = 5.73$, $p < .00$). Regarding social difficulties, the only path affected by this issue was the path between expected capabilities and importance of having digital technologies for independent living (H2), as those who indicated they were facing higher social difficulties ($H_{2_S_difficulties(high)}$, $\beta = 0.53$, $t = 11.01$, $p < .001$) demonstrated a higher path coefficient than those who mentioned having low social difficulties ($H_{2_S_difficulties(low)}$, $\beta = 0.45$, $t = 5.58$, $p < .001$). See Table 8 for more information.

6. Qualitative follow-up interviews

The quantitative survey study (see Section 5) supported the three hypotheses in our proposed theoretical model. The next step was thus to build a fine-grained understanding of the causal mechanisms in our theory. To do so, we conducted follow-up interviews with seven elderly people.

6.1. Method

Interviews were conducted with seven elderly people (average age was 59 years old, ranging between 51 and 70 years old). Similarly, as for the quantitative study, interviewees were asked to use our mock-up portal prior to the interview. Interviews were semi-structured, focused on the three constructs in our theoretical model and their interrelation. Questions were asked about the importance of the online healthcare portal's features in general and the reason why these are important. We also posed questions on the desirability of independent living per se. Next, to evaluate the causal mechanisms in our theoretical model, interviewees were asked about whether, why, and how the portal's features would help them to live independently for a longer period of time. When needed, specific questions were posed regarding whether, why, and how the portal could help them to stay connected with others and manage daily activities.

Interviews were then transcribed and sent back to interviewees for validation, after which, they were analysed using Atlas.ti 7.0 software. Transcripts were printed and examined thoroughly by the authors. Next, a coding list was compiled based on the three concepts in our theoretical model (see Section 3). The transcripts were coded in Atlas.ti using the produced coding list while keeping an open mind about other concepts that might be important as well. Generic codes were further specified in keeping with our aim to enrich the understanding of how capabilities affect the importance and intention to use digital technologies. From the analysis, we derived four sub-capabilities, which contribute to the general capability of independent living. After coding the interviews, an overall network of the themes found was constructed to interrelate the codes as a basis for interpretation. Quotes were selected to illustrate the qualitative findings and are presented in the remainder of the section.

Table 8
Multi-Group analysis results.

| Moderator | Capability → Intention (H1) | Capability → Importance (H2) | Importance → Intention (H3) |
|--------------------------|--|---|--|
| Age (< 50) | | $\beta = 0.53$, $t = 10.92$, $p < .001$ | |
| Age (> 50) | | $\beta = 0.44$, $t = 6.18$, $p < .001$ | |
| Gender (female) | NS | | |
| Gender (male) | $\beta = 0.38$, $t = 2.99$, $p < .003$ | | |
| Low personal challenges | $\beta = 0.31$, $t = 1.95$, $p < .005$ | | $\beta = 0.47$, $t = 5.73$, $p < .001$ |
| High personal challenges | NS | | $\beta = 0.51$, $t = 6.34$, $p < .001$ |
| Low social challenges | | $\beta = 0.45$, $t = 5.58$, $p < .001$ | |
| High social challenges | | $\beta = 0.53$, $t = 11.01$, $p < .001$ | |

Note: Empty cells indicate no differences were found in the multi-group analysis.

6.2. Results

We first assessed whether and why people find capabilities for independent living desirable. Most interviewees were positive about independent living. They were against the idea of living in an elderly care setting because they did not like the way elderly people are treated in such places or they found living at home safer, as one interviewee put forward,

I think that is better for older people to stay in the village they always lived. They know people and the neighbours, so I think it is important. If you like your own home, and you know the neighbours, who is living around you, it is a safe feeling.

Some interviewees argued that living at home independently is not always the best choice for elderly people. They pointed out that the desire of elderly people to live in their own home may burden others, for instance family members. Others argued that living alone would lead to social exclusion as interaction with others is reduced. As one interviewee mentioned,

For me, it is important to live longer at home independently. But when you get older, you do not see a lot of people anymore, and sometimes it is not good for you. Sometimes it is better to live together with other people.

Contextual factors play a role in the desirability of living independently. For instance, physical or mental disabilities might prevent elderly people from living at home independently. The characteristics of the house play a role too, for instance, whether there are stairs in the house. Elderly people's existing social network and support from family members or neighbours also play an important role. Overall, all interviewees found independent living desirable although, they pointed out, it might depend on circumstances. Interviewees also expressed that the desirability of independent living is not static and may change over time. For instance, one interviewee said,

For me now [independent living] is very important, but I think when you are old and you cannot get out, it is nice to live with other people in your neighbourhood.

In the remainder of the analysis, we discuss four identified sub-capabilities that explain why capabilities for independent living affect the importance and intention to use digital health technologies.

6.2.1. Capability to find activities, products, and services

Interviewees expressed that they currently face difficulties in finding the right digital healthcare products and services as well as other activities to support their living independently. They argued that an online healthcare portal could provide suggestions about products, services, and activities suitable for them, which in turn would help them to achieve independent living.

My neighbour wanted to play cards, so I could use the portal to search which community centre is available around me and have these facilities. Then we can call them or go there and have a look. Otherwise it takes too much time to find out where you can play cards in the neighbourhood.

Now, I was searching for everything that can help me to stay at home through the Internet. But I must do it by myself. I was searching and searching. So, when there is a platform that can advise me how to find the best healthcare products and services, that would be great.

A tool to find products, services, and activities is thus an important portal feature related to this capability. Interviewees suggested that a help chat feature would also support them in finding products, services, or nearby activities.

6.2.2. Capability to manage daily activities

Interviewees also mentioned the ability to manage daily activities as an important capability for independent living. This includes making lists of activities, organizing help from caregivers or family members, and sharing details of activities with caregivers. Interviewees mentioned features such as to-do lists and plan boards for organizing activities with family members or caregivers. Also, a diary feature could provide updates for family members or caregivers about which daily activities have been done. A contact feature would enable elderly people to communicate directly with family members or caregivers in case they need immediate help to do daily activities or other tasks. As one interviewee stated,

An online portal would be useful to manage daily activities, maybe arranging who should do groceries and so on.

6.2.3. Capability to stay connected with others

Interviewees argued that staying connected with neighbours is important, especially for those who live independently. Communication is also important for family members and caregivers to reduce their burden of taking care of elderly people. For instance, one interviewee mentioned,

For those who are living at home alone, especially elderly people, an online portal would be useful to stay connected with neighbours and find [the care-related] specialties they need.

Other portal features that would contribute to this capability are a contact feature for emergencies or even for daily interaction as well as a diary feature to exchange information. Specifically, regarding the diary feature, participants expressed positive impressions because it could help to provide the same information to everyone who is connected through the portal.

Table 9

Sub-capabilities that contribute to the importance of online healthcare portal features.

| | Help chat | Products and services | Activities overview | Contacts list | Diary | Plan board |
|--|-----------|-----------------------|---------------------|---------------|-------|------------|
| Find activities, products and services | X | X | X | | | |
| Manage daily activities | | | X | | | |
| Stay connected | | | | X | X | |
| Monitor conditions | | | | | X | X |

6.2.4. Capability to monitor conditions

Besides the capabilities focused on the perspective of elderly people, during the interviews we also found that capabilities for caregivers and family members are also important. Most interviewees mentioned that it is important for caregivers and family members to monitor the condition of the elderly person in order to provide the appropriate level of care. Several online portal features such as a plan board, a diary and a contact tool would play a role in enabling this capability. For instance, one interviewee put forward that,

I also think it is very important to know about the health condition of the person, so the closest people who care for him/her will know if something is going wrong or if they have to stay in the hospital for a longer time.

Interviewees argued that capabilities can reinforce each other. For instance, the capability to stay connected contributes to the capability to monitor conditions. Further, monitoring conditions enables the capability to find products and services since one can search for more specific products or services based on the actual needs and condition of the elderly person.

Table 9 summarizes how each of the four sub-capabilities contributes to the importance of the digital technology features mentioned in the interviews.

6.3. Integration with survey results

We found support for our three hypotheses in the survey. Furthermore, in the qualitative follow-up interviews, we found further support for the causal mechanisms at play. We found that people explain their intention to use and the importance of having digital technologies available based on how they would help them to live independently. Hence, from the interviews, we obtained corroborating evidence that capabilities (Venkatesh et al., 2013) affect the decision to use digital technologies. The follow-up interviews refined our theoretical model by unearthing sub-capabilities that contribute to independent living. Further, we examined in more detail how those sub-capabilities affect the opinions of elderly people about specific features in digital technologies and their perceived importance.

7. Discussion

This paper applied the capability approach framework (Sen, 1992) to build a theoretical model of adoption of digital healthcare technologies that facilitate independent living. Specifically, we built our theory on the central tenet of the CA, which is that resources, such as technologies, provide freedom to people to live their lives in ways they find valuable. The central construct in our proposed theoretical model is the capabilities that individuals can derive from using digital healthcare technologies. At the more theoretical level, we argue that individuals' decision on whether to use digital healthcare technologies depends on the extent to which these technologies provide them with capabilities for living independently at home. In other words, people do not make decisions on the use of technologies based on the technologies' characteristics per se or the tasks that these technologies allow them to do, but rather on whether the technologies enable them to achieve a goal they have set for themselves in their lives. In the following sections, we first outline and explain our theoretical findings and contributions based on the CA. We then discuss our study's implications for practice, limitations, and suggestions for future research.

7.1. Theoretical contributions

Our study has important implications for understanding the adoption of digital technologies, both within the context of independent living and beyond. Our study is a first to apply the CA for building a theoretical model of adoption of digital healthcare technologies. Both our quantitative and qualitative studies lent empirical support to our theoretical model. We thus go beyond prior work that argues for applying CA to ICT4D (Kleine, 2010; Zheng, 2009) and for using CA to understand how technologies become useful for elderly (Talalei-Khoei et al., 2015) and their independent living (Meijering et al., 2019).

Broadly, our study has two important implications for adoption studies in IS. First, our approach calls for new conceptualizations of how expected outcomes affect decisions to adopt technologies. Mainstream adoption models such as TAM, UTAUT and affordance theory consider outcome expectations in terms of whether technologies enable concrete jobs, tasks or activities to be performed. In contrast, our model considers outcome expectations in terms of whether technologies enable people to lead their lives in ways they find valuable. Within our specific context of independent living, such nonutilitarian conceptualization of outcome expectations is appropriate, since independent living relates to the freedom to lead one's life in a self-chosen way, rather than to carrying out specific, predefined tasks or jobs.

We argue that nonutilitarian outcome expectations are important in other areas too. As digital technologies not just enable our working life, but influence our daily lives in profound ways, it becomes increasingly important to think beyond concrete utilitarian tasks and jobs that technologies enable. Extensible and editable digital technologies can be used in ways that cannot be foreseen during their design (Kallinikos et al., 2013), which makes it difficult to define relevant utilitarian outcomes. The growing complexity of the use contexts and re-combinatorial usage of digital technologies implies that use contexts in which technologies become useful are increasingly difficult to predict up-front. Our CA framework, being flexible and reflective, allows exploring a wide variety of relevant capabilities and subsequently considering these capabilities as antecedents for technology adoption. Doing so requires a more open but also reflexive approach to understanding what capabilities are enabled by a technology, in often unforeseen ways.

A major challenge is to identify and define the relevant capabilities for a specific technology and context (see Robeyns, 2005). For adoption studies to follow our approach, it is therefore almost inevitable to carry out exploratory, qualitative research prior to operationalizing relevant capabilities. Within such qualitative pre-study, adoption scholars should consider the (hidden) normative assumptions behind what are considered relevant capabilities (see Robeyns 2006). For instance, in our setting, independent living of elderly people may sound non-controversial at first, but may in fact be harmful since living independently can induce loneliness. Which capabilities are thus relevant is a normative choice, which requires ethical explorations and ethical tools which may fall outside the skillset of most IS researchers. Applied ethics and ethics and IT likely become relevant disciplines to inform adoption studies in IS, providing reflective tools such as value-sensitive design.

A second implication is that our CA framework decouples the ownership and usage of digital technologies (Robeyns, 2005). Such decoupling contrasts with the conceptualizations in adoption models such as TAM and UTAUT, which equate the adoption of a technology with the actual usage (or the intention to use it in the future). In contrast, the CA assumes that technologies, by simply being available, already offer valuable capabilities (e.g. ability to live independently), regardless of whether people use them to achieve relevant functionings (e.g. independent living). We found empirical support for our hypothesis that having digital technologies for independent living mediates the relationship between expected capabilities and intention to use. In other words, elderly people might not yet need to use a specific digital healthcare technology but still desire to have it available, should the need arise in the future.

In one way, our study echoes critique on mainstream adoption models that consider adoption as a one-off choice, rather than an extended process from trying out towards routinizing the use of technologies. There are also similarities between our approach and ideas in domestication theory, which separates phases of buying a technology, using it, routinizing it, and displaying it to the outside world (Silverstone and Haddon, 1996); a theory that has also been applied in explaining adoption decisions (De Reuver et al., 2016). An important implication for adoption studies is that the outcomes of having a technology available may not be readily observable. People may value just having the technology available, to be converted into relevant functionings only when the need arises. Hence, adoption models should consider the perceived importance of having a technology available as a mediator between outcome expectations and intentions to use.

7.2. Implications for practice

With regard to implications for practice, this study provides several important guidelines for developing and offering digital healthcare technologies to enable independent living for elderly people. First, the study shows that designers of digital healthcare technologies should look beyond the direct activities or tasks that their offerings support. Especially in the context of independent living, elderly people are mainly concerned with whether technologies enable them to live independently at home for a longer period of time, regardless of the specific tasks or activities that are needed to achieve that. While such capabilities are arguably on a higher abstraction level than outcome expectations on the level of tasks and activities, and thus possibly more difficult to evaluate, we call upon designers to do so. Second, by including several stakeholders, our study shows that collaboration between end-users, healthcare professionals, service providers, and governmental agencies is important in every stage of the development process of digital service platforms. This is important because a service platform is a viable tool to help stakeholders to interact with each other, exchange information, and communicate with third parties. Third, in our qualitative study, we found three main features important for online healthcare platforms: information exchange, communication tool, and social interaction. We found that each of these features contributes to specific subareas of independent living.

7.3. Limitations and future research

This study is not without limitations; one of them is that we did not include all possible personal characteristics as conversion factors. Elderly people face age-related challenges that may affect their ability to use ICT in their daily lives (Kapadia et al., 2015). This means that elderly people need to (a) have a good physical condition, (b) be cognitively competent (Czaja et al., 2006), and (c) be literate enough to use ICT (Talaie-Khoei et al., 2015a,b). Furthermore, ICT literacy highly depends on people's former occupation, which means that former professionals are expected to be more familiar with ICT (Alampay, 2003, 2006a,b,c). Moreover, elderly people with a higher technological proficiency tend to use ICT more, compared to people considered to be technophobic (Kapadia et al., 2015). Follow-up studies could explore these personal characteristics as conversion factors in our theoretical model.

Some limitations are inherent to the CA, as explained by Robeyns (2005). Selecting the relevant capabilities is non-trivial and often involves normative assumptions. Our choice of capabilities affording independent living is no exception, as in fact independent living may be undesirable for some, as found in our qualitative follow-up study. Further, we could have focused on functionings rather than capabilities, which may lead to different results as some elderly people may choose not to convert their capabilities to

actually independent living. And finally, while our capability set is relatively focused on those that contribute to independent living, a wider capability set may have been considered, including those related to activities of daily life (see e.g. Meijering et al., 2019), which may lead to the issue of “how to trade-off and aggregate capabilities that conflict”.

Furthermore, this theoretical model was specifically constructed for the domain of independent living, hence, its generalizability and explanatory power for other settings is yet to be explored. Another limitation is that we did not compare the explanatory power of our model to that of existing adoption models such as TAM or affordance theory. However, on a theoretical level, we argue that our conceptualization of expected outcomes on the level of capabilities for independent living rather than concrete tasks or jobs is more appropriate for the setting of independent living.

8. Conclusion

In this paper, we developed and tested a theoretical model of adoption of digital healthcare technologies for independent living by applying the CA framework (Sen, 1992) and following a sequential mixed-methods approach (Venkatesh et al., 2013). A qualitative study was conducted to unearth which features a digital healthcare service should have in order to facilitate independent living. This part of the study enabled us to contextualize the constructs for the conceptual model. Furthermore, we collected data through a quantitative survey to test the postulated hypotheses. To familiarize participants with digital healthcare technologies for independent living, we developed a clickable mock-up portal based on the features derived from the first qualitative study. Moreover, through open-ended questions, we conducted a qualitative study based on seven interviews with elderly people to probe how the features in the clickable mock-up portal would contribute to their capabilities to live independently. This study shows that elderly people make decisions on whether to use an online healthcare portal based on how much they expect these portals to enhance their capabilities to live independently at home for a longer period of time. When zooming in on specific features of online healthcare portals, we find that different subareas of capabilities for independent living are being considered in adoption decisions. Finally, our paper contributes to the understanding of intentions to use digital healthcare technologies by first applying the CA framework for theorizing on expected outcomes on the level of improved quality of life rather than facilitation of specific tasks or activities.

Declaration of Competing Interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

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