Delft University of Technology

# Developing a Service Platform for Health and Wellbeing in a Living Lab Setting
## An Action Design Research Approach

Keijzer-Broers, Wally

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Developing a
# Service Platform for Health and Wellbeing
in a Living Lab Setting

*An Action Design Research Approach*

**Wally Keijzer-Broers**

# Developing a Service Platform for Health and Wellbeing in a Living Lab Setting

*An Action Design Research Approach*

**Proefschrift**

ter verkrijging van de graad van doctor
aan de Technische Universiteit Delft,
op gezag van de Rector Magnificus prof. ir. K.C.A.M. Luyben
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Door

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*To Joop and our magnificent quartet:*
*Kevin, Doreth, Julian and Beaudine*

*Twenty years from now you will be more disappointed by the things that you didn't do than by the ones you did do. So throw off the bowlines. Sail away from the safe harbor. Catch the trade winds in your sail. Explore. Dream. Discover. – Mark Twain*

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Now, haven said this, fasten your seatbelts and I hope you will enjoy the read as much as I enjoyed my magnificent PhD journey at the ICT section from Delft University of Technology.

Wally Keijzer

Delft, October 1, 2016

*Disclaimer: The author initiated, designed and executed the study reported in this dissertation. Under the supervision of the author, several research assistants contributed to data collection in specific parts of the study. These specific contributions are related to the first prototypes (Chapter 8, Florez 2015); end-user survey (Chapter 9, Agahari 2016), architecture development (Chapter 9, Greve 2016), business model (Chapter 10, Hidalgo 2016), and experimental evaluation (Chapter 11, Van den Houdt 2016). All responsibility remains with the author.*

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# 1. Introduction

## 1.1 Research background

The Western world's population is aging rapidly, due to improved public health facilities and a declining fertility rate (OECD, 2015), two trends that are expected to continue in the coming decades. According to the United Nations (UN, 2013), life expectancy at birth will increase globally by ten years, reaching an average of 76 years by 2050. In the same time span, the average global fertility rate will drop to the replacement level. In addition, the UN predict that, within thirty years, older adults will even outnumber children under the age of 15, and the number of people older than 60 will increase from 610 million today, to approximately 2 billion by the year 2050. At the same time, the proportion of people over 80 (i.e., so-called double aging) is expected to triple. An aging population has serious socio-economic consequences and is a major concern for policy-makers, due to the increase in healthcare-related costs, the sustainability of retirement plans and a decelerating effect on potential economic growth due to the increase of social burden (Liddle & Lerais, 2007).

Although there is no such thing as **the** average senior (or elderly) person (Zeeuw, 2006), today's seniors differ substantially from previous generations (Freedman, 2001; Verté & De Witte, 2006). Shortly after World War II, aging meant dependency, and physical and intellectual decay. This so-called Deficit model (Verté & De Witte, 2006), where healthcare issues are taken from the hands of the elderly, is considered outdated and is replaced with more active participation. Nowadays the so-called Competence model, which emphasizes the competences and skills of the elderly without being pessimistic or unrealistic optimistic, is more popular (Ven, 2007).

Although there is no common definition of when an individual should be considered an elderly person, we follow Neugarten (1978), who distinguishes two different groups: 1) the young-old (i.e., young elderly), people between 55 and 75, and, 2) the old-old, people above 75. The term young elderly is in line with Lyons (1991), who refers to people above 55 as Yeepies (i.e., Youthful, Energetic Elderly Population Involved in Everything), in other words, people who want to be involved in society and want to stay in control over their own lives as long as possible.

Globally, 40% of people over 60 live independently, which means completely alone or with a spouse (OECD, 2014, 2015; UN, 2013). As countries develop and their populations continue to age, the percentage of people who live independently will increase. Research consistently indicates that elderly people prefer to live independently in their own home, in what is known as aging-in-place (Ball et al., 2004; Gilleard, Hyde, & Higgs, 2007; Vasunilashorn, Steinman, Liebig, & Pynoos, 2012). In other words aging-in-place allows people to age in a secure manner in a familiar environment, rather than in elderly or nursing homes. To support the aging population to age-in-place, policy-makers are looking for solutions, ranging from physical and economical support for individuals to smart homes supported by ICT solutions (Agree, 2014; Reeder et al., 2013; WHO, 2007).

### 1.1.1 Dutch situation

Like other Western societies, the Dutch society is also challenged by: 1) an aging population, 2) changing patterns in healthcare demand, and 3) continued growth in healthcare expenditures (Eurostat, 2012; OECD, 2014, 2015). Moreover, the number of people with multiple chronic conditions is also steadily increasing (Fortin, Soubhi, Hudon, Bayliss, & Van den Akker, 2007).

From 1968 onwards, long-time care in the Netherlands has been financed by a national compulsory insurance (i.e., AWBZ = Algemene Wet Bijzondere Ziektekosten), which covers the ‘exceptional health risks’ of 1) elderly people who are in need of nursing and care, 2) people with mental health problems, and 3) people with disabilities. Until the beginning of the 1970’s, services covered by the AWBZ were mainly residential, while over the years the proportion of institutionalized elderly has grown considerably. Although the AWBZ was initially created to fund care in nursing homes, over the years it was expanded progressively to cover expenses of residential care and homecare services of elderly people, as well as psychiatric care, aids and appliances.

Until the healthcare reform in 2006 the healthcare system in the Netherlands was structured in three compartments 1) the AWBZ provided coverage of long-time care-related costs, 2) public and private health insurances for those who were excluded from the public fund, providing coverage for acute healthcare-related costs, and 3) supplementary care insurances (Van Ewijk & Kelder, 1999). From 2005 onwards the Dutch government stimulates projects and experiments aimed at extra-muralization (i.e., the replacement of institutional settings with community-based settings).

In the last decade (2006 – 2016), the debate on the Dutch welfare system has been dominated by the tension between ensuring universal, good quality healthcare services on the one hand, and keeping costs under control on the other (Da Roit, 2013). For instance, in 2007, the Dutch care system underwent a transformation from a mainly supply-driven system toward a demand-driven system (Verhoeven & Tonkens, 2013), with to the implementation of the new Social Support Act (i.e., WMO - Wet Maatschappelijke Ondersteuning). Services that traditionally had been covered by the AWBZ, including domestic help (i.e., house hold support), were transferred to local governments (i.e., municipalities). As of 2015, municipalities carry the administrative and financial responsibility for these tasks, even though their budget has been cut by approximately 25% by the central government. In addition, the responsibility for and the provision of healthcare facilities for citizens have also been shifted towards the municipalities. As a consequence local governments are 1) responsible for supporting citizens so that they can participate; 2) free to decide for themselves how they meet their targets, and 3) accountable at a local level for their performance. Local governments receive non-earmarked budgets, which gives them a strong incentive to minimize costs and improve cost-efficiency (Schut, Sorbe, & Høj, 2013). The tension between keeping health care a universal good, while harnessing costs has been the main reason for the paradigm shift in the Netherlands (Colombo, Llena-Nozal, Mercier, & Tjadens, 2011; Da Roit, 2013; Schut & Van Den Berg, 2010).

An aging population and the associated increase of health-related costs, was already a ‘wicked’ problem before the economic crisis (2008 – 2010), and it is even more problematic in view of the sustainability of public finances. Wicked problems are societal problems that cannot be solved in a linear manner by following checklists, but require sophisticated in-depth knowledge of the complex matter, as well as problem-solving skills on the part of the people involved. And, growing social needs, in combination with budgetary constraints, certainly call for innovative solutions. Within the context of limited resources, in particular social innovations, defined as creating new legitimated social practices aimed at social change (Cajaiba-Santana, 2014), offer opportunities to provide solutions to pressing social demands while making better use of available resources. By encouraging social innovation, policymakers in the healthcare domain strive to pursue a triple win 1) providing products and services that are beneficial, of high quality and affordable to citizens and add value to their daily lives, 2) providing services that are sustainable in the long term, and 3) creating new business opportunities for (social) entrepreneurs (Hubert, 2010).

While the Dutch national government emphasizes the shift from a welfare society towards a participatory society, in the long term, this shift could have a huge effect on society and the social inclusiveness of elderly people, in particular, because participatory societies build on people's own responsibilities for their health and wellbeing and making people help each other (Lamb, 2014; Rudman, 2015), which requires a different mindset on the part of citizens. One policy measure aimed at reducing healthcare expenditures is to encourage people to age-in-place (Carstensen et al., 2010). The concept of aging-in-place, which was first used by Pastalan (1990), promotes independence and 'livability' of all types of houses (Lawlor & Thomas, 2008). Moreover, aging-in-place refers to the ability of individuals to stay in their home or neighborhood as long as possible, regardless of their age or level of abilities (Nasar & Evans-Cowley, 2007).

According to the Dutch government, an economic argument in favor of aging-in-place is cost reduction, because there are fewer relocation issues and less expensive (intramural) healthcare. However, as yet, there is no evidence to support this assumption. Although most people prefer to stay at home as long as possible and deinstitutionalization is based on the assumption that homecare services are less costly than institutional services (Müller and Sixsmith, 2008), they also represent a major challenge, because increased support for homecare has to be provided somehow (Jacobzone, Cambois, & Robine, 1999). Typical hurdles for people to age-in-place that are identified in literature are related to, the decline in cognitive and functional abilities of the elderly (Njegovan et al., 2001; Wahl, Iwarsson & Oswald, 2012); social exclusion and loneliness (Shankar et al. 2013; Coyle & Dugan, 2012); the digital divide (Satariano, Scharlach & Lindeman, 2014; Cotten, Anderson & McCullough, 2013), as well as the burden and related time pressure for family caregivers (Rashidi and Mihailidis, 2013). In addition to these general difficulties, people are not aware of which products and services are available to meet their needs and help them to age-in-place (Wiles et al., 2011; Sixsmith, 2013).

To summarize, an aging population is a concern for policy-makers and, to reduce the involvement of the state, the Dutch government has implemented new policies related to deinstitutionalization. To encourage people to age-in-place, the cognitive and functional abilities of the elderly, social inclusion to avoid loneliness and the digital divide all have to be taken into account, as well as support for their informal caretakers. To improve the response to the government's push for people to age-in-place, the paradigm shift in the healthcare domain requires not only a changed attitude and an active involvement on the part of citizens, but from public and private parties as well, which requires a more holistic approach to the problem by all the stakeholders involved. Although this study focuses on aging-in-place and therefore independent living for as long as possible, we are aware that this is not always the best, or indeed the only solution, for the elderly (Golant, 2015). Nevertheless, we consider an important change concerning the attitude of today's elderly, who want to 1) stay active and involved in society, and 2) plan and organize their life independently (Hofäcker, 2015; Verté & De Witte, 2006).

## 1.2 The Problem statement

Aging-in-place can be seen as a wake-up call (Lawlor & Thomas, 2008) to those who understand how to integrate the needs of people (i.e., wellbeing, convenience, security and care) into today's design. To help people age-in-place, supportive products and services, day-to-day activities and social interaction need to be taken into account (Wahl & Weisman, 2003). As people age and become less mobile, meeting other people becomes more and more complicated. Social interaction is especially important because social relationships are widely acknowledged to be a crucial factor to people's wellbeing as they age (Adams, 1995; Fiori, Antonucci, & Cortina, 2006). Consequently, it is important to ensure that elderly citizens stay connected to their neighborhood and to the community (Lui, Everingham, Warburton, Cuthill, & Bartlett, 2009; Peace, Kellaher, & Holland, 2005; Tonkens, 2011).

Smart ICT-enabled solutions designed to support elderly people in their daily routine can help them organize their daily activities in a smarter way and maintain a independent and safe lifestyle for as long as possible (AAL Association, 2016). Although, in this study, we do not focus on smart homes as such (i.e., with advanced automated appliances), the term aging-in-place reflects how to integrate smart solutions in our daily lives, which is related to the concept of smart living, defined as a bundle of ICT-enabled products and services that are offered to households to facilitate a comfortable way of living (Nikayin, 2014). In addition, smart living is related to people's quality of life (Giffinger et al., 2007), because it involves connecting our daily activities when we are at home, on the road, or elsewhere, supported by integrated ICT (Baken, 2010). Although numerous smart living products and services are available to support people living comfortably at home (Nikayin and De Reuver, 2013), they have not been widely adopted yet (Peine, 2009; Solaimani, Bouwman, & Baken, 2011; Wichert, Furfari, Kung, & Tazari, 2012). The reason for that, one would expect are 1) the complexity of the technology (Brush et al. 2011, Sanders et al., 2012; Sponselee, 2013), 2) a low level of acceptance of supportive technologies (Heart and Kalderon, 2013; Ehrenhard, Kijl & Nieuwenhuis, 2014; Peek et al., 2014), and 3) a lack of awareness with regard to smart living solutions (EC, 2014).

In our study, we do not focus on the complexity and acceptance of smart living technology as such, but do look at people's awareness regarding smart living solutions for health and wellbeing. Creating awareness of existing solutions to support age-in-place is challenging, with end-users being unable to find them in today's fragmented marketplace, with its overload on information, which can be seen as a mismatch between supply and demand. Although there is no standard definition of the term awareness, we follow Dourish & Bellotti (1992), who describe awareness as *'an understanding of the activities of others, which provides a context for your own activities'*. We would suggest that awareness regarding smart living products and services that support people to age-in-place may be increased, by offering a digital service platform that 1) provides information on relevant products and services within the smart living domain (Sassen, Benz, & Österle, 2010; Schenkel, Osl, & Österle, 2013) and, 2) helps people to be socially involved. Although most solutions designed to support aging-in-place have an ICT component, this is not always the case. Products that support aging-in-place can range from home modifications to the provision of assistive technologies. Modifications can be defined as adaptations to the environment, ranging from the elimination of slip and trip hazards (i.e., throw rugs, grab bars and railings) to sensor technology accommodating daily living. The same applies to services, which can range from personal care to monitoring and surveillance services. As a result, in our study, we also take non-ICT products and services into account.

To unravel the mismatch between supply and demand in the smart living domain and to increase awareness of existing products and services related to aging-in-place, we approached the problem from three different perspectives: end-user, service provider and governmental).

***An end-users perspective***

The end-users of smart living services related to aging-in-place are elderly people, on the one hand, and informal caretakers who look after ill, frail or disabled individuals on the other. Generally speaking, end-users are not aware of which smart living services are available and how these services could meet their needs. Especially elderly people typically go through various stages of physical and mental impairment, and they are often unaware as to what products and services they could use at what point in time. In addition, there are a number of barriers that make it difficult for the elderly to use ICT (Fischer et al., 2014), and they are not always convinced that ICT is needed to help them in their daily lives (Kapadia et al., 2015; Peek et al., 2015). In addition, the highly fragmented market provides many products and services, but not always integrated systems, which makes it difficult for end-users (i.e., elderly people and/or informal caretakers) to find suitable (bundles of) products and services. As a result, end-users are looking for communication channels that help them to find supportive products and services to age-in-place, as well as to find day-to-day activities to help them stay socially involved.

***The service provider's perspective***

Service providers who offer smart living solutions ranging from health and wellbeing products to home automation (i.e., domotics) can help people to age-in-place (Gann, Barlow, & Venables, 1999; Harper, 2003; Lawlor & Thomas, 2008). To promote and sell their products, service providers need promotion channels to reach their customers.

***The governmental perspective***

As explained in section 1.1, local governments focus on social interventions designed to support the health and wellbeing of their citizens, while keeping the costs under control. Social intervention can be defined as an action that involves the government or an organization in social affairs. In addition, the more citizens are able to handle health and wellbeing related questions them selves, the less they will use the WMO desk for 'unnecessary' time consuming requests. Less people visiting or calling the WMO desk will be beneficial for the local governments, related to saving time and money.
Since the new healthcare regulations in 2015, local governments have to 1) interact with their citizens with regard to health and wellbeing, 2) facilitate the need for supportive neighborhoods that accommodate elderly people's needs, and 3) promote social cohesion. Consequently, local governments are looking for intervention channels to help them meet these three responsibilities.

***The need for a digital service platform***

To address the issues facing the three stakeholder groups mentioned above, we propose the development of a digital service platform in the context of health and wellbeing as a social innovation to support aging-in-place, which serves both citizens (i.e., elderly and informal caretakers), service providers (i.e., in the health and wellbeing domain) and local governments. How to design, implement and rollout such platforms is unclear, because existing literature on digital service platforms includes only ex-post studies of 'successful' platforms (Nikayin, 2014).

At the moment, no service platform exists that involves more than one group of stakeholders in the smart living domain (i.e., health and wellbeing) and that supports the process of matching service and product offers with service and product requests.

| Table 1. Brief overview of existing Health and Wellbeing platforms worldwide | | | | |
|---|---|---|---|---|
| **Platform** | **Description** | **Key concepts** | **Core setting** | **Stakeholders** |
| **Zorgdienstenonline.nl (b2c)**<br><br>The Netherlands | Contact platform Health and Wellbeing | Job seekers (profit), help seekers; | Local Marketplace | Caregivers and end-users |
| Mijnzorgnet.nl<br><br>(b2c)<br><br>The Netherlands | Connects patients and caregivers through digital networks and personal care clinics and practices. | Digital poly; open and closed groups; eHealth interventions | Social network; community (national level) | Caregivers and their patients |
| **Quli.nl (c2c)**<br><br>The Netherlands | Information, support and contact options in healthcare. With advice on healthy and independent living. | Sharing information with caregivers; app store (b2c) | Social network; community (national level) | Caregivers and end-users |
| **Hallozorg (b2c)**<br><br>The Netherlands | Matching care and enabling home care; cooperation between patients, caretakers and home care. | Collaboration and awareness; shared calendar/tasks/ information; on-demand professional care; e-mail notification | Marketplace<br><br>Social network | Caregivers (profit) and end-users |
| **Zorgvoorelkaar (c2c)**<br><br>The Netherlands | Matching care (volunteers and professionals) with elderly | Supply and demand | Local Marketplace | Caregivers (non profit/ profit) and end-users |
| **ElderCare (b2c)**<br><br>USA/Canada | Matchmaking platform that can easily find elder care (for elderly) as well as caregiver jobs (for caregiver) | Job seekers and care seekers | Local Marketplace | Caregivers and end-users (elderly and families) |
| Family Portal by Senior Care Society<br><br>Worldwide<br>**(b2c)** | Portal to manage and share the information about the elderly with other caregivers (personal care plan) | Collaboration and awareness; information management and sharing; task management | Social Network | Caregivers and end-users (elderly and families) |
| **Beautiful Years (b2c)**<br><br>India | Portal discussing elderly-related issues as well as finding relevant care services and products | Product and service finder; information sharing | Social Network, Community, Marketplace | Caregivers, Product providers, and end-users |

| | | | | |
|---|---|---|---|---|
| **Care Worldwide (b2c)** | Online marketplace for finding and managing family care | Job seekers and care seekers; matchmaking between supply and demand | Local Marketplace | Caregivers and end-users (elderly and families) |
| **Tending (c2c)** Worldwide | Eldercare management solution for coordination and communication between family and caregivers | Collaboration and awareness; information management and sharing; task management | Social Network | Caregivers and end-users (elderly and families) |
| **HomeHero (c2c)** USA | Matching the home caregivers with the elderly according to their specific needs | Job seekers and care seekers; matchmaking between supply and demand | Local Marketplace | Caregivers and end-users (elderly and families) |
| **Senior Care Manager (c2c)** Worldwide | Application for organizing elderly-related information, coordinate the care needs, and ask for help from friends and families | Collaboration and awareness; information management and sharing; task management | Social Network | Caregivers and end-users (elderly and families) |
| **CareLinx (b2c)** USA | Matchmaking between caregivers and elderly with specific needs | Job seekers and care seekers; matchmaking between supply and demand; task and information management | Local Marketplace | Caregivers and end-users (elderly and families) |
| **CareMerge** USA **(c2c)** | Care coordination platform for caregivers, relatives and elderly to keep them informed | Collaboration and awareness; information management and sharing; task management | Social Network | Caregivers and end-users (elderly and families) |

Note: b2c (i.e., business to consumer), c2c (i.e., consumer to consumer).

According to Trastour et al. (2001) *'matchmaking is the process by which parties that are interested in having exchange of economic value are put in contact with potential counterparts'*. As such, the matchmaking process is enabled by matchmaking features, required by one party and provided by another. In other words: a matchmaking platform can be seen as an intermediary between providers and requesters of services (i.e., information, goods or expertise) and enables buyers to choose sellers and products (Klusch and Sycara, 2001). Although serving three different stakeholder groups (i.e., end-users, service providers and government) through the same platform, while taking the interests of the various stakeholders into account, is a challenge, we focused on the development of a viable platform solution, realized within the allotted research time.

To make sure that such a platform did not already exist, we visited several healthcare platforms within and outside of the Netherlands, while excluding illness specific platforms. In table 1, we present a brief overview of the available healthcare related service platforms that were closest to our platform idea. One of the sources we used to find related platforms worldwide (between 2013 – 2016) was the AngelList (www.angel.co). Although we reviewed a limited number of platforms (fourteen in all), this overview gives an impression of the status quo of available matchmaking service platforms for health and wellbeing that are similar to our initial platform idea.

One thing that stands out from this overview is that most of platforms connect (professional) caregivers and elderly people (i.e., b2c), like Zorgvoorelkaar, ElderCare, Care, HomeHero and CareLinx. Other platforms position themselves as platforms for a personal care plan or elderly management solution that can be used to manage health information and share health information with families and caregivers (i.e., c2c). Examples of this type of platforms are Hallozorg, Family Portal, Tending, Senior Care Management, and CareMerge. However, there is one platform called Beautiful Years from India that not only serves as a matchmaking platform between elderly people and caregivers, but that also serves as a marketplace for relevant products or services to assist independent living. In addition, this platform has a community feature, where end-users can ask questions and discuss their issues with other users in an online forum setting. Although this platform is most similar to our platform idea, we can conclude that there is no platform yet, that matches smart living products and services, while at the same time encouraging social interaction. Given the fact that all the stakeholders in Beautiful Years come from the healthcare sector, it is clear that there are no platforms that involve multiple stakeholders from different sectors in the smart living domain related to health and wellbeing.

Therefore, there is an opportunity for a digital service platform with a focus on filling the gap in relation to the involvement of multiple stakeholders (end-users, service providers and government) and realizing a competitive advantage by offering these comprehensive features via a single platform: a matchmaking platform that helps people find smart living solutions that support the aging-in-place process and that may increase the awareness of smart living services, with a focus on health and wellbeing. The service platform has to provide access to products and services that enable citizens to live comfortable and independently in their home environment by providing empowering solutions.

To summarize, we argue that a service platform is needed that 1) helps citizens look for smart living products and services to age-in-place, 2) helps service providers promote their products and services, and 3) contributes to the specific tasks of local governments to support social intervention in relation to citizens within the context of health and wellbeing, while keeping the costs under control. In addition, we propose that developing, implement and evaluating such a platform, could provide a possible solution that helps people age-in-place. The aim of the digital service platform we propose is to reach citizens and encourage them to change their circumstances or behavior, and improve their quality of life.

## 1.3 Theoretical background

This study builds upon concepts from several kernel theories, which can be related to the design of service platforms. Kernel theories are drawn from natural or social sciences directing design activities and are used in our design approach. These theories frequently originate outside the Information System (IS) discipline and suggest novel techniques or approaches to IS design problems (Walls, Widmeyer, & El Sawy, 1992; Walls, Widmeyer, & El Sawy, 2004). A kernel theory enables the formulation of testable predictions of a class of solutions and their behaviors, which are relevant to the associated design process. Therefore, kernel theories can be viewed as scientific knowledge that supports the design of an artifact, and when focusing on requirements, meet the implementation, adoption and use and effect of the artifact-to be.

Below we present a brief description of the kernel theories that are relevant to the proposed service platform. The theories provide input to the design process with regard to the application of existing knowledge and address IT artifact-specific issues. We will use Platform Theory as an applicable kernel theory relevant to dealing with a stakeholder perspective (i.e., service providers and government), while we use insights from the Capability Approach to deal with the end-user perspective (i.e., elderly people and informal caretakers). Subsequently, we describe Social Innovation as the context of our study.

### 1.3.1 Platform Theory

Platform Theory is relevant to our study because it provides concepts and questions on which we can build, like 1) how to develop a platform, 2) how to identify potential and patterns for collaboration, and 3) how to organize different groups of users and create a foundation for their interactions. In short, Platform Theory helps us to understand what has to be done when developing a platform. The term platform can have different meanings and most platform definitions focus on the reuse or sharing of common elements. From a technical perspective a platform can be seen as *'a hardware configuration, an operating system, a software framework or any other common entity on which a number of associated components or services run. Economically, platforms and their providers mediate and coordinate between various stakeholder constituency'* (Ballon, 2009, p. 4). Evans and Schmalensee (2007) propose that a business is an economic catalyst if it creates value by bringing different groups together and getting them to interact. As stated by Gawer and Cusumano (2008, p. 29), a platform could add value to the overall system: *'it should be easy to connect to or to build upon to expand the system of use as well as to allow new and even unintended end-uses.'* What is common in all platform definitions is that they all have modular architectures, which (re)uses modules and therefore mediates multi-sided networks.

In economics literature, the term multi-sided platform is used to describe a system, product or service (or even an organization) that mediates interaction between two or more groups of agents (Ballon, 2009; Evans et al., 2006; Rochet & Tirole, 2003), while complementary products and services are offered on top of the platform (Hagiu, 2006). Due to an exponential growth of platforms in almost every industry, platform theory has also found its way into Information Systems (IS) research (Tiwana, Konsynski, & Bush, 2010; Yoo, Henfridsson, & Lyytinen, 2010). Although concepts can be borrowed from innovation management and economics literature, digital service platforms are notably different (Yoo et al., 2010) in that they appear to change the entire IS landscape, fueled by digitized products. Furthermore, rapid technological developments transform digital service platforms into complex research objects (Evans & Basole, 2016).

A service platform can be regarded as an IT artifact that enables, shapes and supports the business processes needed to deliver products and services and improve the value proposition of those who use the platform (Evans, Hagiu, & Schmalensee, 2006). We use the term service platform to refer to a software architecture, which consists a set of core modules (i.e., building blocks) to offer Internet-enabled services to end-users. The aim of a multi-sided service platform (e.g., for health and wellbeing) is to facilitate transactions between different sides of the market, in what can be regarded as a matchmaking process. Platforms typically bring together multiple user groups and a multi-sided platform can serve as a connection between users and service providers (Tiwana, 2014). Multi-sided markets are similar to industry platforms, for instance in the existence of indirect network effects (Armstrong, 2006; Rochet & Tirole, 2003, 2006). However, many multi-sided markets are pure exchange or trading platforms that connect different groups of stakeholders (i.e., buyers or sellers) who transact with each other through the intermediary of a double-sided market, without offering other functionalities. We argue that platform theories are mainly analytical in nature and that there are no platform design theories that include 1) how to start a service platform, and 2) what the critical design issues are when developing a service platform.

In our study, critical design issues can be defined as decisions involving the design characteristics that have a significant impact on the viability and feasibility of the artifact-to be. We refer to Bouwman et al. (2008) who used Critical Design Issues (CDIs) as design variables to achieve viable Business Models (section 4.1.2). To start a multi-sided service platform from scratch, as stated in the problem statement (section 1.2), implies that we have to deal with those critical design issues, as well as come up with design principles ex-post to support the design process.

### *1.3.2 Capability Approach*

Since Platform Theory takes the perspective of stakeholders into account, the second focus in our study is on the end-users. Although there are clear benefits using smart living technologies, adoption levels of the technology are still limited (see section 1.2). A service platform can be beneficial in promoting smart living technologies as well as empowering citizens to improve their quality of life. Little is known about the potential ability of service platforms to expand the capabilities of elderly people achieve independent living (Yeung & Breheny, 2016; Oosterlaken, 2009). However, the fact that a service platform exists is no guarantee that it will actually benefit end-users (Hatakka & De, 2011). End-users always have a choice whether or not they want to use the service platform.

A kernel theory that takes the freedom of choice into account is the Capability Approach (Robeyns, 2005), which brings together the main conceptual and theoretical aspects developed by Sen (1985) and Nussbaum (1992). Robeyns (2005) defines the Capability Approach (CA) as a broad normative framework for the assessment of 1) individual wellbeing, 2) social arrangements, 3) the design of policies, and 4) proposals about social change in society. CA has thus far merely been applied in development studies, welfare economics, social policy and political philosophy. It has been used to evaluate certain social aspects of people, such as inequality, poverty, individual wellbeing or the average wellbeing of a certain group. It is an instrument that can be used to evaluate these phenomena, but is not a theory that can explain why they occur. Robeyns (2005) argues that the end of wellbeing should be conceptualized in terms of people's capabilities to function; in other words to realize desired actions and activities and to be who they want to be.

According to the CA, the focus of evaluation is not income, resource, primary goods, utility, or preference satisfaction (Oosterlaken, 2009). Instead, the focus should be on human capabilities, which is the freedom or effective opportunities people have to live lives that they deem valuable (Sen, 2001), because the relationship between the amount of goods and effective opportunities is different for each individual, which means it makes sense to focus on people's capabilities rather than the available resources (Sen, 1993). In short, the conceptualization and evaluation in the CA should focus on how policies, intervention, or any kind of development contribute on people's capabilities to function (Robeyns, 2005). The main concept of the CA lies in the notion of 'functionings' and 'capabilities'. Functionings refer to the 'beings and doings' of individuals, while capabilities refer to what people are effectively able to do and to be (Robeyns, 2005). Sen (1992) has pointed out that the combination of a person's functionings is the part of their capability set, or can be referred to as functionings they are able to do. Sen also underlined that the conversion from capabilities to functionings depends on three types of conversion factors: personal (e.g., gender, literacy and physical condition) social (e.g., social norms, public policies and laws) and environmental (e.g., geographical access and social forces). Another important term is what Sen (1999) calls an agent, which is defined as someone who acts and brings about change, whose achievement can be evaluated in terms of their own values and goals. Agency is important because people have the ability and the freedom to choose the functionings they prefer. This notion makes CA suitable for exploring the social context of a service platform because of the 'people-centered' nature of the approach (Sen, 1992). In addition, CA is especially suitable for our research domain, because retaining functionings and capabilities are core for elderly people to age-in-place.

Although the CA is not a fully specified theory and can be better described as a philosophical framework to improve people's quality of life, and has mostly been used in ICT4D (i.e., Information and Communication Technologies For Development) from the perspective of human development for the poor (Hamel, 2010), we discuss the limits and possibilities of the approach to provide opportunities to people in general to realize the desired capabilities. Secondly, we use the CA to assess the consequences of the artifact in an experimental setting. CA is appropriate because it affects the functionings of people and, in our particular case, the functionings of elderly people.

### *1.3.3 Social Innovation context*

For the context of our research we focused on Social Innovation. Although there is still a debate about the exact definition of social innovation (OECD, 2010) Nobel Prize winner Joseph Stiglitz describes social innovation as '*new responses to pressing social demands, which affect the process of social interaction. It is aimed at improving human wellbeing*' (Hubert, 2010, p. 33). In general social innovation incorporates new ideas like products, services and models that meet social needs, and create new forms of collaborations and a better use of assets and resources (Caulier-Grice, Davies, Patrick, & Norman, 2012). A well-defined social innovation should not only tackle social issues, and thus be 'good' for society, but it has to enhance society's capacity to act accordingly. As such, it is connected to solidarity, reciprocity, social capital and change (Richez-Battesti & Vallade, 2009). Furthermore, social innovation is related to social entrepreneurship, which can be defined as an entrepreneurial activity with a social purpose (Austin, Stevenson, & Wei-Skillern, 2006). Although social entrepreneurs usually start out with a small initiative and target local problems, they can end up being relevant on a more global scale. Despite scepticism concerning the ability of social entrepreneurs to solve large-scale societal problems (Sud, VanSandt, & Baugous, 2009), this can be seen as a context for studying the broader phenomena of entrepreneurship (Dacin, Dacin, & Matear, 2010; Mair & Marti, 2006; Zahra, Gedajlovic, Neubaum, & Shulman, 2009). Therefore, there is not only a growing interest in social entrepreneurship (Dacin, Dacin, & Tracey, 2011) from a business perspective, but also from an academic perspective.

Social innovation is a risky proposition because is requires 1) a social entrepreneurial mindset, 2) persistence to develop a creative idea within a complex domain, and 3) the skills to bring like-minded people together to mainstream the innovation. How to design for social innovation is also challenging. Although social innovation is part of a broader 'movement' it cannot be seen as a general solution to society's problems. We explore whether an innovation that addresses a social demand (i.e., aging-in-place and taking care of elderly) contributes to addressing a societal challenge (i.e., aging society), and whether, through its process dimension (i.e., active engagement of the elderly and healthy aging) it helps reshape our society from a welfare state into a participatory state. In addition, we explore which role the social entrepreneur plays in the entire process.

The initial impulse for designing an IT artifact for Health and Wellbeing comes from a desire to solve an every day social problem how to support people age-in-place? This idea is used to clarify what the IT artifact should achieve and on the other hand serves as an early presentation of relevance. Although Social Innovation is not the focus of our study as such, by describing all stages of the design cycle, while designing, prototyping and evaluating a social innovation within a real-life setting, it designates the context of a societal problem that 'matters'. In addition, we look what the role is of the researcher in developing a social innovation in the form of an IT artifact to help people age-in-place.

## 1.4 Research objective

In the previous section, we explained that, although kernel theories for designing a service platform exist, they either do not focus on design (i.e., Platform Theory), are not specifically suitable for platforms as IT artifacts within a social context (i.e., Social Innovation) or are used to explore a generic end-user perspective (i.e., Capability Approach).

Based on the theories and the gaps in literature outlined earlier, our research objective can be described as follows:

**The aim of this study is to design, prototype, implement and evaluate a service platform for Health and Wellbeing in a real-life setting that 1) enhances the capabilities of citizen to age-in-place, 2) unburdens informal caretakers, 3) helps service providers promote their products and services and 4) contributes to the specific tasks of local governments to support social intervention for citizens in the context of Health and Wellbeing, while managing the costs.**

Based on the research objective, the overall question of our research can be framed as follows:

***How can a digital service platform for Health and Wellbeing be designed, prototyped, implemented and evaluated within a real-life setting, which subsequently supports three different stakeholder groups (i.e., end-users, service providers and local governments)?***

To realize the research objective, four sub-questions have been defined:

***SQ 1. What do Platform Theory and the Capability Approach prescribe on how to design a service platform for matchmaking in a social context, which supports different stakeholder groups?***

The first sub-question (SQ1) explores how the Platform Theory and the Capability Approach are used to design a service platform for Health and Wellbeing based on a literature review approach.

***SQ 2. What are the main design requirements for a service platform for Health and Wellbeing that supports three different stakeholder groups (i.e., end-users, service providers and local governments) in related to aging-in-place?***

The second sub-question (SQ2) identifies functional and non-functional requirements for the platform, which can be used as design input to support the different stakeholders involved. Requirements can be defined as detailed descriptions of '*what is wanted from the design by the client and by potential end-users*' (Dym, Little, Orwin, & Spjut, 2004). Functional requirements describe the specific functionality of a system (i.e., what it should do), while non-functional requirements describe how the system should behave or work (Stellman & Greene, 2005) within a given context.

***SQ 3. How to design and prototype a service platform for Health and Wellbeing to support three different stakeholder groups (i.e., end-users, service providers and local governments) related to aging-in-place within a real-life setting?***

The third sub-question (SQ3) results in an overview of the challenges (i.e., from a service-oriented, technological, organizational and financial perspective) involved in designing a Health and Wellbeing platform in a real-life setting (Bouwman et al. 2008). To be able to evaluate the Health and Wellbeing platform, several low-fidelity prototypes are developed in order to end up with a Minimal Viable Product and to include the implementation of the prototypes in several different settings. To determine the potential value of the developed service platform, we set up an experiment that focused on two aspects: 1) whether all the requirements that were identified in SQ2 were met and 2) whether the service platform could support people to age-in-place.

***SQ 4. What can we learn from the design process of a service platform for Health and Wellbeing related to aging-in-place within a real-life setting?***

The focus of the fourth sub-question (SQ4) is on the formalization of learning (Sein et al. 2011) and how to develop the project further into general solution concepts for a class of field projects? To that end, we extensively evaluated the used Design Science Research process, to support our design principles, which are developed ex-post.

### 1.4.1 Contributions and relevance

Our study, which involves designing, prototyping, implementing and evaluating a service platform, aims to bridge the gap between the theoretical analysis of service platform development and the actual design process. As such, it builds upon earlier research on Platform Theory and the Capability Approach and aims to advance theory development in this field. Our research has both an IT and a governmental component, and is related to a real-world problem. In addition, the project has both a technical character (i.e., the design of an IT-enabled service platform) and a societal character (i.e., impact on daily life of elderly people as well as business and government interests in aging-in-place). By adopting a design approach, we will create a practically relevant IT artifact.
At the same time, the project contributes to our scientific understanding of how to design platforms in a multi-actor setting. Based on the outcomes of our research, we can add to design science by providing ex-post principles for designing platforms and for guiding the design process (see Chapter 2).

Service platforms are becoming increasingly important in the field of IS, as modular architectures are transforming legacy information systems into flexible service platforms. To place platforms at the center of research in IS helps us understand how digital service platforms emerge, evolve and are governed over time, which in turn contributes to the emerging scientific debate in the IS community on the development of digital service platforms.

While digital platform literature is often concerned with evaluating profitability for platform providers or the generative potential for app developers, our study looks at how platform functionalities affect the capabilities of elderly people. As such, we use design theory to provide prescriptive statements on how to design and implement a multi-sided service platform to improve those capabilities. Given the problems outlined earlier, we examine whether a service platform can support end-users, providers and local government in relation to aging-in-place.

The scientific relevance is to theorize the development of a digital service platform for Health and Wellbeing, and to contribute to the knowledge and the design process of service platforms. We contribute in terms of 1) how a service platform can help people achieve independent living, and 2) how the core concept of the Capability Approach in the context of a Health and Wellbeing platform for elderly people can be operationalized. In addition, our study bridges the gap between the current information exchange with regard to smart living and the ideal situation, where interaction and information exchange between different stakeholders groups (i.e., service providers and local government) and end-users (i.e., elderly people and informal caretakers) in this field are common practice.

In practical terms we contribute to a social demand regarding aging societies by proposing a digital service platform for Health and Wellbeing to help people to age-in-place.

### *1.4.2 Outline of this dissertation*

In this chapter, we introduced the problem statement from a theoretical and from a practical perspective. The research method is discussed in chapter 2, with a focus on Action Design Research and a refined research framework. Chapter 3 reviews the research domain, which encompasses smart living. The theoretical framework is explained in greater detail in chapter 4, which is divided into four phases. In chapter 5 Research phase I: Problem Formulation, is described, followed by phase II: Design Requirements in chapter 6. Phase III: Building, Intervention and Evaluation (chapter 7) is divided into four design iterations: Planning (chapter 8), Concept Design (chapter 9), Prototype Design (chapter 10), and Innovation Design (chapter 11). This chapter is followed by the description of research phase IV: Formalization of Learning (chapter 12). Chapter 13 presents the conclusion and reflection of the design process involving a digital service platform for Health and Wellbeing to help people age-in-place, including the theoretical and practical contribution and limitations of this study, as well as proposing avenues for future research.

# 2. Research approach

Our study adopts a socio-technical perspective, rather than a technical or engineering perspective. The term socio-technical refers to the interrelatedness of the social and technical aspects of the IT artifact and focuses on social as well as technical design features (Silver & Markus, 2013). The initial impulse for designing a socio-technical IT artifact for Health and Wellbeing comes from an idea to solve a social problem, which is identified in daily life, i.e. how to support people age-in-place? According to Gibbs (2005) there are two types of epistemological research strategies that dominate social science literature 1) positivism and 2) interpretivism. Both research strategies are part of a paradigm debate and although both streams (i.e., positivism and interpretivism) have their pros and cons we used the interpretive research philosophy for our study, mainly because we wanted to understand how aging-in-place can be enhanced by a service platform.

To understand the social world under study as well as find a convincing explanation, this study is conducted in a Living Lab setting, which we define as an open research and innovation ecosystem where users are involved in an early stage of the development process. Not only as observed subjects but rather as a participative force to achieve co-creation and co-design of an innovation together with researchers and other stakeholders (Ballon & Schuurman, 2015; Eriksson, Niitamo, & Kulkki, 2005; Pallot et al., 2010). In our study we established a Living Lab setting with four large and two small-medium enterprises, the university, a public organization (i.e., municipality) and end-users (i.e., elderly people and informal caretakers). The main objective of the Living Lab was to 1) explore the platform idea, 2) experiment the IT artefact, and 3) evaluate breakthrough scenarios that could turn the platform idea into a successful innovation. In Chapter 7, the background of the Living Lab setting is described in detail.

## 2.1 Motivation of the research

Our research goal is to design and evaluate a socio-technical IT artifact (i.e., a service platform) that provides a potential solution (i.e., social innovation) for a class of real-world problems (i.e., aging-in-place). Simon (1996) refers to an IT artifact as something that is artificial or constructed by humans as opposed to the natural, while Orlikowski and Iacono (2001, p. 121) define an IT artifact as *'those bundles of cultural properties packaged in some socially recognizable form such as hardware and software'*. Although there is no common manifestation of the IT artifact (Offermann, Blom, Schönherr, & Bub, 2010), Design Science Research artifacts can include models, methods, constructs, instantiations and theories (Gregor, 2002; March & Smith, 1995) as well as social innovations, implementation processes and methods (Levy & Ellis, 2011). To deal with the interpretive research criticism we apply the criteria from Lincoln and Guba (1985) with regard to the internal and external validity and reliability of the research (see table 2).

**Table 2. Application of evaluative criteria for interpretive research as suggested by Lincoln and Guba (1985)**

| Evaluative criteria | Main question | Applications in our study |
|---|---|---|
| **Credibility** | How to get confidence in the 'truth' of the findings? | Prolonged engagement: long-term relationship with trust and understanding of the setting (i.e., Living Lab)<br>Persistent observation: focus on details and ensure research depth within the Living Lab and related to the different stakeholder groups<br>Triangulation: ensure the research is rich, robust, comprehensive and well-developed by using qualitative and quantitative data collection (i.e., mixed method)<br>Validate the research within existing literature |
| **Transferability** | Are the findings applicable in other contexts? | Thick description of the documented research (i.e., transcripts, protocols, audio and video, logbook) with sufficient detail to allow researchers to replicate the study and enable generalization |
| **Dependability** | Are the findings consistent and could be repeated? | Audit inquiry: to examine whether findings, interpretations, conclusions and process are supported by the data to include research assistants and an Expert Team outside of the Living Lab |
| **Conformability** | What is the degree of neutrality of the research findings? | Reflexivity: use of a reflexive journal (i.e., logbook) to ensure transparency and to track the research flow |

As described in table 2 we adopt different perspectives to ensure the reliability of our study with regard to credibility, transferability, dependability and conformability. Although there are many ways to do so, we use different applications, including prolonged engagement within a Living Lab setting (from 2015 onwards), triangulation using a mixed method approach as described by Creswell & Clark (2007) (i.e., qualitative and quantitative data collection) and reflection (i.e., use of a logbook with over 1.100 memos), to address the criticism of interpretive research methods.

## 2.2 Design Science Research

According to Gregor (2006), there are five interrelated types of theories that are relevant to the Information System domain: 1) theory of analysis, 2) theory of explanation, 3) theory of prediction, 4) theory of explanation, and 5) theory of design and action.

*The theory of design and action* is the most suitable for our research, as it describes how an IT artifact can be created, including methods, techniques and principles for the development of the artifact. Our study strives to contribute to *the theory of design and action* by providing appropriate design knowledge through the development of a digital service platform that helps people age-in-place. Based on the outcomes of our research we can add to *the theory of design and action* by providing ex-post principles for designing IT artifacts and guiding the design process.

Since researchers have a natural desire to improve things, Design Science Researchers want to study and understand certain phenomenon, but also learn how they can improve them. Design science was first used by Fuller (1967), who defined design science as a systematic form of designing. Design Science Research (DSR) attempts to solve a specific problem and to generate and empirically test a design theory that can be reused in solving a class of related problems. Our research is positioned within the design sciences paradigm (Iivari, 2007; Van Aken, 2004) and can be seen as a fundamental problem-solving paradigm that has its roots in engineering and the sciences of the artificial (Simon, 1996), as well as in social sciences.

In the 1990's the IS field recognized the importance of Design Science Research in improving the effectiveness of the IT artifact, within the context of solving real-world business problems. As such, design science is a relative young discipline in IS that tries to create innovations (i.e., ideas, practices, technical capabilities and products), through which the analysis, design, implementation, adoption and use of IS can be accomplished effectively and efficiently (Denning, 1997; Tsichritzis, 1998). We use Design Science Research in our research because it *'is consistent with prior literature, it provides a nominal process model for doing DS research, and it provides a mental model for presenting and evaluating DS research in Information Systems (IS)'* (Peffers, Tunanen, Rothenberger, & Chatterjee, 2008, p. 46).

Design Science Research is to be distinguished from the typical behavioral or natural science approaches. March and Smith (1995) introduced a framework in which they related design science in IS to Natural Science Research (NSR) and Design Science Research (DSR) possibilities, while focusing on building or examining IT artifacts that serve human purposes. They identified two activities that are crucial: 1) the construction of the IT artifact, and 2) the evaluation and the development of criteria and performance of the IT artifact. Hevner, March, Park, and Ram (2004) took the framework of March and Smith a step further and added seven guidelines for DSR: 1) design as an artifact,

2) problem relevance, 3) design evaluation, 4) research contributions, 5) research rigor, 6) design as a search process, and 7) communication of research.

Related to this context, this study focuses on the development of the IT artifact, which should take both the importance of the expected utility and the values of multiple stakeholders into account. Hence, the evaluation of the designed IT artifact should play an important role in the design process, which means that the design should meet a set of design criteria. Generally speaking the challenge for real-world problems lies in defining those criteria, while not yet fully knowing and understanding the context, which will be shaped at the same time as the IT artifact. Multiple DSR publications propose ways to tackle the latter problem. For instance, Verschuren and Hartog (2005) propose using design cycles as a counterpart of the intervention or policy cycle in business and policy administration. Based on a systematic analysis of the design process, they identified six stages that together form one design cycle: 1) first hunch, 2) requirements and assumptions, 3) structural specifications, 4) prototype, 5) implementation, and 6) evaluation. One of the most important remarks is that even though the stages are presented as a linear process, they are part of an iterative process. Moreover, Verschuren and Hartog (2005) mention the importance of evaluating the goal (i.e., the plan), the means (i.e., the process) and the relationship between those two or (even) the product.

According to Verschuren and Hartog (2005) design science has always been recognized both as an art and as science, and the focus could be either on the improvement of what exists in reality, or on the creation of something new. In design science literature, the classification of the two types of improvements is often referred to as *normal or incremental* (Eder, 1999) versus *radical* (Vincenti, 1990) or *innovative* (Dasgupta, 2009), while Verschuren and Hartog (2005) identify this as respectively improvement or construction problems, respectively. Others propose a way to *cross-fertilize* design research with *action research* (Cole, Purao, Rossi, & Sein, 2005; Figueiredo & Cunha, 2007). Action research is a combination of theory generation and the intervention of the researcher, designed to solve immediate organizational problems (Baskerville & Wood-Harper, 1998). Within the context of IT design, Sein, Henfridsson, Purao, Rossi, and Lindgren (2011) have elaborated in detail how DSR can be fully combined with action research and thus provide explicit guidance for combining building, intervention and evaluation of the IT artifact in a concerted research effort. They use the term Action Design Research (ADR) for their method to be able to combine both theory and practice.

Another key characteristic of design science is that it should draw on what we already know and be based on previous theories, which means that state-of-the-art design science and kernel literature need to be reviewed.

## 2.3 Research framework

As mentioned earlier, in IS research literature different aspects of DSR have been considered, like framework and guidelines (Hevner et al., 2004), paradigms (Iivari, 2007), design methods and processes (Peffers et al., 2008), patterns (Kuechler & Vaishnavi, 2008) and theory (Gregor & Jones, 2007). However, there is a gap in existing IS literature with regard to practical design studies that show how to apply empirical research methods in developing and testing design theory and kernel theories. We aim to study this gap using a DSR approach (Hevner & Chatterjee, 2010; Hevner et al., 2004; March & Smith, 1995; Vaishnavi & Kuechler, 2015; Winter, 2008), which provides a way to design, prototype, implement, and evaluate a digital service platform for Health and Wellbeing in a Living Lab setting.

In carrying out this study we identified two problems. Firstly, because a service platform for Health and Wellbeing to support people age-in-place has not yet been built, not all evaluation criteria would be fully clear in advance. Secondly, as explained for real world problems in general, while focusing purely on the design of the IT artifact, this would ignore the fact that the artifact should be evaluated by end-users in the first place. Hence, and starting with a traditional IT development process would leave a non-evaluated IT artifact, while starting with behavioral research before designing would not reveal the full problem in the context of the proposed service platform. To address these two problems, we used Action Design Research (ADR) as our overarching research method. ADR focuses on '*generating prescriptive design knowledge building and evaluating ensemble IT artifacts in an organizational setting*' (Sein et al., 2011, p. 40), and allows us to 1) address the problem encountered in a real-life setting by intervening and evaluating, 2) use theory and research to analyze the problem, and 3) construct and evaluate an IT artifact that addresses a class of problems typified by the situation encountered.

This study can contribute specifically to the design knowledge base involving service platforms. To that end, the design challenge will be addressed, by creating a specific solution for the Dutch Health and Wellbeing market, from which both practical and theoretical lessons can be learned. This type of research is in line with the DSR methodology, because it serves two goals, the first of which is to guide the design and evaluation of IT artifacts (Hevner et al., 2004; Sein et al., 2011) and the second to fill the gap between practical requirements and theoretical rigor (Gallupe, 2007). Although, there are various DSR methods, Iivari (2015) argues that two main strategies can be identified. In the first strategy, a researcher constructs a meta-IT artifact as a general solution concept to address a class of problem (i.e., Design Science Research Strategy 1), while in the second strategy the researcher creates a concrete IT artifact within a specific context (i.e., Design Science Research Strategy 2). Although the original paper of Iivari (2015) was more elaborated, table 3 provides a summary of the differences between the two Design Science Research Strategies.

**Table 3. Summary of differences between two DSR strategies, adapted from Iivari (2015)**

| Dimension | | Strategy 1 | Strategy 2 |
|---|---|---|---|
| **1.** | **Researcher – client relationship** | Client may be involved | Client involvement is inevitable |
| **2.** | **Major problem to be addressed** | General problem informed by specific problems in practice | Specific problem or a general DSR problem |
| **3.** | **Typical uncertainty of the DSR project** | Class of specific problems and solutions | Specific solutions and DSR contribution |
| **4.** | **IT artifact built** | Conceptual IT of real implementation | Real system implementation |
| **5.** | **Primary role of the real system implementation** | Proof in concept and possibly used in evaluation | Source of inspiration and proof on concept |
| **6.** | **Nature of the target IT artifact** | A priori designable system | Emergent system |
| **7.** | **Typical nature of the IT meta-IT artifact** | Innovative concept (system, method, technique) | New, innovative design principles |
| **8.** | **Innovativeness** | Varies | Mixed tendencies |
| **9.** | **Practical relevance** | General solution | Address immediate practical problems |
| **10.** | **Major process driver** | Experiences from the process | Experiences from the process of the specific solution to a problem |
| **11.** | **Research method:** | Constructive and empirical | AR or ADR, constructive and empirical |
| **12.** | **Generalization** | Included in problem statement | Different dimensions |
| **13.** | **Access to the client** | Not necessary | Necessary, but can be challenging |
| **14.** | **Expertise needed** | Often disciplinary | Multi or interdisciplinary |
| **15.** | **ADR Research team** | Varies | Usually 3 -10 members Additional members to reach implementation phase |
| **16.** | **Time and costs** | Varies depending on ambition and complexity | Intensive involvement over a longer period of time. Time-consuming and expensive |

As shown in table 3, Iivari contrasted two DSR strategies along 16 dimensions, representing the context, process, outcomes and resource requirements of the Design Science Research. According to Iivari (2015), considerable risks are involved for the researcher when opting in favor of strategy 2, related to 1) access to a client, 2) taking a leap of faith dark to solve a client's problem, 3) uncertainty about the DSR's contribution, 4) intensive involvement in the collaboration for a longer period of time, and 5) the time-consuming and expensive nature of the operation. On the other hand Iivari (2015) argues that the second strategy may be really rewarding for the researcher because it: 1) implies access to problems faced in practices, 2) is interesting and stimulating to work in a multi- or interdisciplinary project, and 3) may lead to a DSR contribution that is not only 'rooted' in practice, but also likely to be relevant for practice as well. Although the pros and cons still need to be better understood, we decided to adopt Design Science Research Strategy 2. Designing a Health and Wellbeing platform provides an opportunity to use this strategy, as it involves a design case study in a turbulent environment (i.e., healthcare domain), within a specific real-life setting (i.e., Living Lab). In such an uncertain environment, the questions that relate to the client's problem usually emerge in the course of the design process.

## 2.4 Action Design Research

In this section, we begin by discussing how the ADR approach is applied in this study, and then explain how we structured the thesis based on DSR principles proposed by Hevner. The term Action Design Research was first mentioned by Iivari (2007), who emphasized the influence of the relevance cycle of Hevner (2007) and provided explicit guidance how to combine building, intervention and evaluation. As such, ADR contains two basic activities: building and evaluation, where building is the process of constructing an IT artifact for a specific purpose and evaluation is the process of determining how well the IT artifact performs (March & Smith, 1995).

By following the ADR approach as well as conducting empirical and literature research, the design can be iteratively improved and lessons can be learned. As this approach both suits the need of the Living Lab setting and the need for more real-life cases to be described in literature with regard the second strategy mentioned above, we chose it as the main research approach. The inherent risk of ADR of not identifying interesting concepts is acceptable, due to applicability of ADR for this specific case. Fundamentally, ADR is a study of change and particularly appropriate for our study because 1) it combines action research (AR) and design research (DR) to generate prescriptive knowledge, 2) it is problem-driven and 3) it aims to build design principles based on iterative cycles (figure 1).

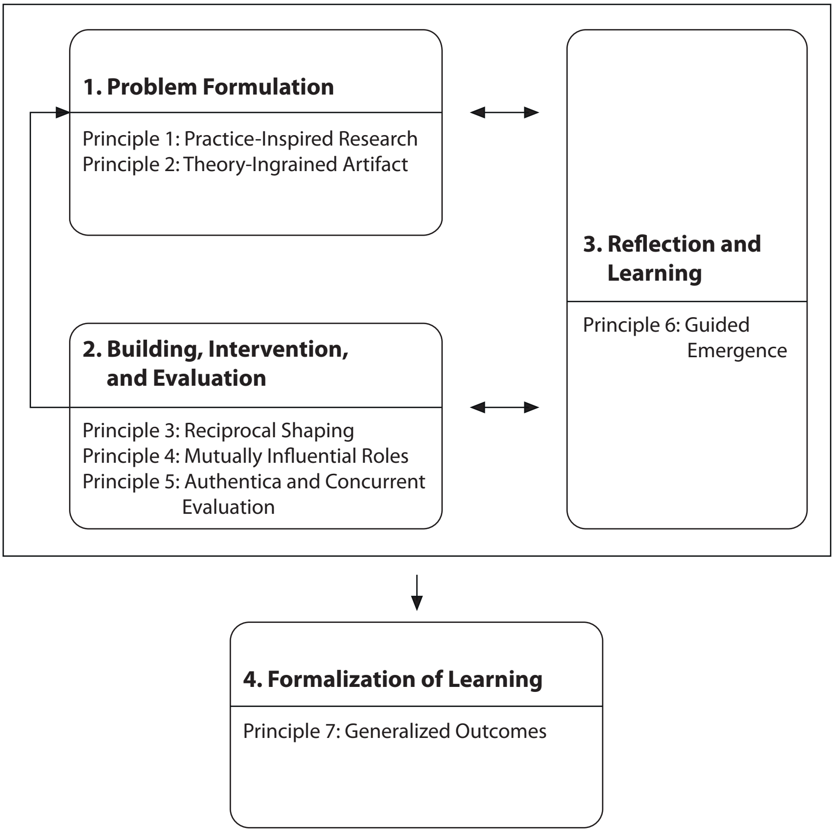



Fig. 1. ADR design stages and related principles adapted from Sein et al. (2011) page 41.

According to Sein et al. the ADR method can be divided into four stages: 1) Problem Formulation, 2) Building, Intervention and Evaluation (BIE), 3) Reflection and Learning, and 4) Formalization of Learning. Each stage is anchored by design principles that capture the underlying assumptions, beliefs and values. The method allows for a systematic design of our service platform, while using the knowledge from the context (i.e., Social Innovation) to shape the platform. ADR recognizes that an IT artifact emerges from the interaction within the context, even when the initial design idea was guided by the researcher's intention. Sein et al. (2011) emphasize that a design project has no separate phases like Peffers et al. (2008) and Kuechler and Vaishnavi (2008) suggest, or neat research and design steps as Hevner (2007) proposes, but that the research steps are 1) less structured than that, 2) executed concurrently and 3) can be regarded as an iterative process.

The first block (figure 1), called *Problem Formulation*, mainly adheres to two principles: practice-inspired research and a theory-ingrained IT artifact. The first principle refers to the fact that the research in ADR approaches field problems as knowledge-creation opportunities, instead of theoretical puzzles. The second principle refers to the fact that the IT artifact can be seen as the carrier of theoretical traces, and iterations are based on the theoretical insights that have been obtained.

The second block (figure 1) focuses on the *Building, Intervention and Evaluation* (BIE) of the IT artifact. ADR acknowledges that these phases are interwoven. There are three principles that are adhered to in this research. First, the reciprocal shaping, which means that there should be an emphasis on the influences from two domains: the IT artifact and the organizational context. The term mutually influential roles, refers to the fact that all participants of the ADR project should learn from each other, where the term authentic and concurrent evaluation means that it should be made sure that the evaluation is formative, in order for the knowledge to be generalizable.

The third block (figure 1) contains *Reflection and Learning* and is related to principle 6: guided emergence. This principle consists three types of reflections on: 1) the intervention results, 2) the learning in terms of theories selected and, 3) the evaluation of adherence to the ADR principles. It provides a reflection of the seemingly incongruent perspectives. This reflection is represented in the outcome of the formative evaluations.

The fourth block (figure 1) of ADR is the *Formalization of Learning*, which follows the principle that the learning should be abstracted to a class of field problems that should be properly communicated. Sein et al. (2011) describe that learning is best done, by providing design principles and specific contributions to theory (i.e., ex-post).

In order to not only design an IT artifact, but also create prototypes by which the research is conducted a certain development approach has to be adopted. According to Sein et al. (2011) there are two approaches to this development process either an IT-Demand Dominant or an Organization-Demand Dominant approach. Sein et al. represent two end-points for the research design continuum. They put IT-Demand Dominant BIE (to generate innovative technology design from the outset) at one end of the spectrum, and Organization-Demand Dominant BIE (to generate design knowledge and the primary source of innovation is organizational intervention) at the other end of the spectrum. However, we would argue that the development process could also be approached from a more Societal-Demand Dominant perspective. Due to the fact that aging-in-place is related to a societal demand, which encompasses an entire population rather than a single organization, a Societal Demand-Dominant approach was adopted, which meant that instead of involving end-users after 'the arrow left the bow', we included them from the start of the project. This underlined the possibilities to implement and test all needed aspects from the platform both internally (with partners from the Living Lab) and externally (potential end-users outside of the Living Lab).

For that reason, we add an additional design continuum, Societal-Demand Dominant BIE, our rationale being that from a social demand perspective, end-users should be involved from the start of the process, to ensure a concerted effort with the other stakeholders (i.e., decision making process) rather than at the alpha version stage (i.e., Organization-Demand Dominant BIE), or at the beta version stage (i.e., IT-Demand Dominant BIE). In addition, to mirror the ADR designer, we established an Expert team (four participants) with affinity for the healthcare domain. The team, which could be regarded as representing the end-users (i.e., informal caretakers) as well, was able to function as a 'sanity check' throughout the whole research, although they were not part of the Living Lab setting. At least once every two months the team discussed the research progress and filled in practical gaps within the project.

As mentioned above, potential end-users of the platform were included in the Living Lab setting and thus were part of the decision-making process as well. Consequently, an adjustment was made to the model proposed by Sein et al. (2011), and one could argue that a hybrid focus was adopted, in which all low-fidelity prototypes (i.e., a paper prototype, a clickable model, a demo and a Minimal Viable Product) are both internally and externally evaluated by potential end-users. The full overview of the development approach, inspired by Sein et al. (2011) is shown in figure 2.

Figure 2 provides an overview of the design approach of the service platform. The process of creating the internal version took place iteratively within the Living Lab setting (i.e., researchers, practitioners and representatives of the end-users) Furthermore, the structural specifications of the platform and several low-fidelity prototypes were discussed with end-users who are relevant to the platform, such as informal caretakers and elderly people. This is done through intermediate testing using an agile-inspired approach that acknowledges that the problem cannot be fully understood or defined in advance. The best way to describe the agile developing process is based on the terms adaptability, simplicity and communication (Paulk, 2002). As such, it focuses

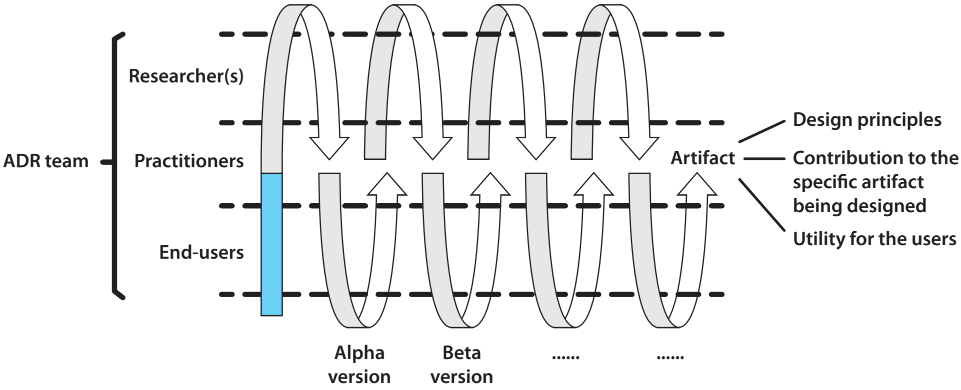



Fig. 2. BIE design iterations from a Societal-Demand perspective, extension (in blue) based on Sein et al. (2011).

on maximizing a team's ability to respond flexibly to changes in the requirements. The outcome of these design iterations in the study resulted in several low-fidelity prototypes of the platform, like a paper prototype, mock-ups and a clickable model. After having the first paper prototype tested outside the Living Lab with end-users, an internal evaluation was carried out inside the Living Lab setting, after which the follow-up prototypes (i.e., mock-ups and clickable model) were developed and tested again with different stakeholder groups (i.e., municipality, elderly people, informal caretakers and product and service providers) with the aim of improving the prototypes within the Living Lab. In all, four design iterations took place before entering the commercialization phase. See section 7.2 (figure 23).

While ADR gives guidance to the process, it provides little direction on how to structure research questions and write a research project. Therefore, to define the research questions, we use the DSR framework and guidelines provided by Hevner et al. (2004) as a starting point for the design (see section 2.5). Hevner's framework is used to understand, execute and evaluate IS research and to put the research questions into perspective (i.e., *the what*), while the ADR method is used mainly to guide the design process (i.e., *the how*) to design, prototype, implement and evaluate a digital service platform for Health and Wellbeing.

Hevner's framework compares behavioral and design science paradigms and positions them next to the problem space, referring to Simon (1996). This results in perceived *business needs* and *applicable knowledge*. In 2007, Hevner improved the framework, which now puts greater emphasis on the cyclical interaction between (and, for DSR, also within) the areas of *environment, design science research and knowledge base*. This approach provides researchers in the IS field with an opportunity to research design knowledge that is relevant to practitioners. We adopted the two DSR frameworks from Hevner (2004, 2007) and applied them to our research topic (See figure 3).

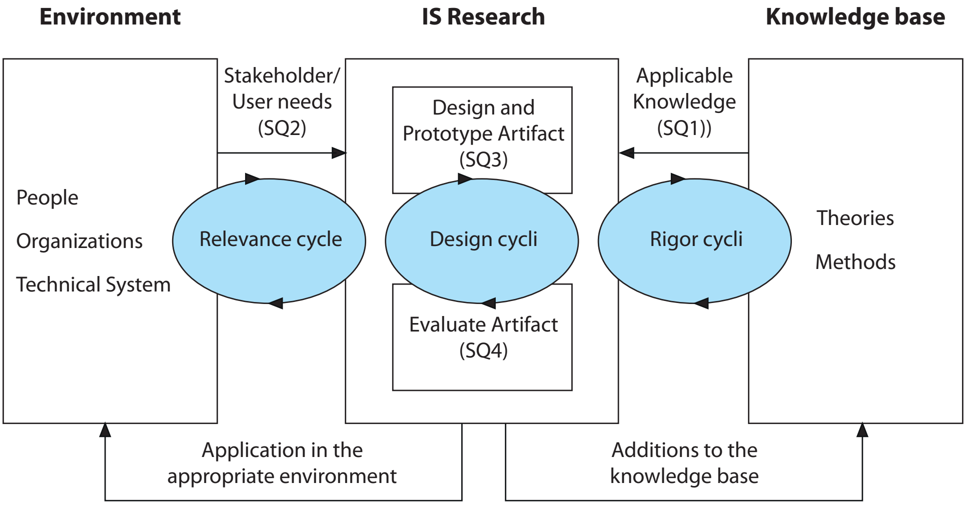



Fig. 3. Design Science Research (framework adapted from (Hevner, 2007).al. (2011).

The original framework in the context of the IS discipline is limited to the business environment, and does not include consumers (i.e., end-users). However, in a service platform it is crucial to have both sides (i.e., service providers and end-users) on board, which is why we take stakeholder/user needs instead of 'just' business needs into account (SQ2). This gives us a broader view of the user needs from a stakeholder perspective.

On one side, there is the existing *Knowledge base*. When designing IT artifacts a profound understanding of their nature is needed, which is why, the first sub-question (SQ1) addresses the definitions of Social Innovation (i.e., for the context), Platforms, and the Capability Approach (i.e., as kernel theories), by looking at existing scientific literature. Concepts that are closely related to Platform theory and are applicable to the design of a service platform (i.e., business model, user acceptance and stakeholder management) are also addressed when answering this question.

Scientific rigor is achieved by applying existing foundations, theories and methodologies. The *Rigor Cycle* connects the design science activities with the knowledge base of scientific foundations, experience and expertise that informs our research project. The rigor cycle generates new knowledge through the application of theories and methods. While, in behavioral science, methodologies are typically rooted in data collection and empirical analysis techniques, in design science the creative process (i.e., set of activities) is related to the design of an IT artifact, and the build-and-evaluation loop is iterated a number of times as part of the research effort.

On the other side, the *Environment*, which is composed of people, organizations and the technical system, is positioned. People perceive different user needs which are defined in terms of goals, problems and opportunities. The second sub-question (SQ2) is expected to produce: 1) an overview of challenges in the smart living domain (i.e., awareness of the problem), 2) an identification of the stakeholder groups involved and 3) guidance to suggested solutions (i.e., first hunch). Furthermore, the second sub-question aims at identifying whether stakeholder groups perceive particular user needs in relation to the service platform. Input from the environment is crucial for defining the goals of the IT artifact, which is done during the first steps of the platform design.

The *Relevance Cycle* bridges the contextual environment of the research project and the design science activities. This includes activities that study the context in which the IT artifact is positioned.

In the center we find the domain of the *IS research* where the design process phase of the ADR cycle of Sein et al. (2011) is started. The third sub-question (SQ3) directly addresses these stages, by asking for the goals and requirements of the service platform before designing and prototyping begins.

The fourth sub-question (SQ4) addresses the formulation of learning related to the designed IT artifact and to the design process. This phase provides feedback with regard to the service platform and a better understanding of the problem, with the aim of improving both the quality of the platform-to-be and the design process.

The central *Design Cycle* iterates between the core activities of building and evaluating the design IT artifact and the design process. Again, this build-and-evaluate loop is iterated a number of times before the final design of the IT artifact is generated (Markus, Majchrzak, & Gasser, 2002). In our study, the design cycle consists four design iterations.

## 2.5 Research phases

To achieve the objective of the research, we divided our research approach into four phases (see table 4).

| Table 4. Overview of the design approach | | | |
|---|---|---|---|
| **Research phase** | **Design input phase** | **Kernel theories and related concepts** | **Evaluation method** |
| **Phase 1: Problem Formulation**<br><br>SQ1 | Literature review<br><br>11 in-depth interviews with stakeholders | Social Innovation (as the context)<br>- Stakeholder involvement<br><br>Platform theory<br>- Multi-sided platforms | 59 semi-structured interviews with stakeholders and end-users |
| **Phase 2: Design Requirements**<br><br>SQ2 | Personas<br><br>Focus groups (28 participants In 4 rounds) | Social Innovation (as the context)<br><br>Platform theory<br><br>Capability approach | Starting point Living Lab (12 partners)<br><br>User stories<br><br>Scenarios |
| **Phase 3: Building, Intervention and Evaluation**<br><br>SQ3 | 2 end-user surveys N = 626<br><br>Workshops:<br>- Design issues<br>- Project Start Architecture | Platform theory<br>- Platform architecture<br>- Multi-sided business models<br><br>Capability approach | Workshops:<br>- Business model<br>- Design sprint<br><br>Design iterations 1 -3<br><br>User tests |
| **Phase 4: Formalization of Learning**<br><br>SQ4 | Design iteration 4<br><br>User tests | Summarize Action Design Research process | Design Principles<br><br>Minimal Viable Product |

The overview encompasses the four research phases, the (evaluation) methods being used, kernel theories, related concepts and the empirical research steps (see section 2.5.1 – 2.5.4). A simplified overview of the ADR process and the different design iterations and validation steps is presented in figure 4.

The ADR process does not follow a waterfall approach as such, but is much more iterative in nature and, to evaluate the data we consequently looped back in the relevance and design cycles.

Although the four stages of the typical design cycle from Sein et al. (2011) are entered in our design (i.e., the how): 1) Problem Formulation, 2) Building, Intervention and

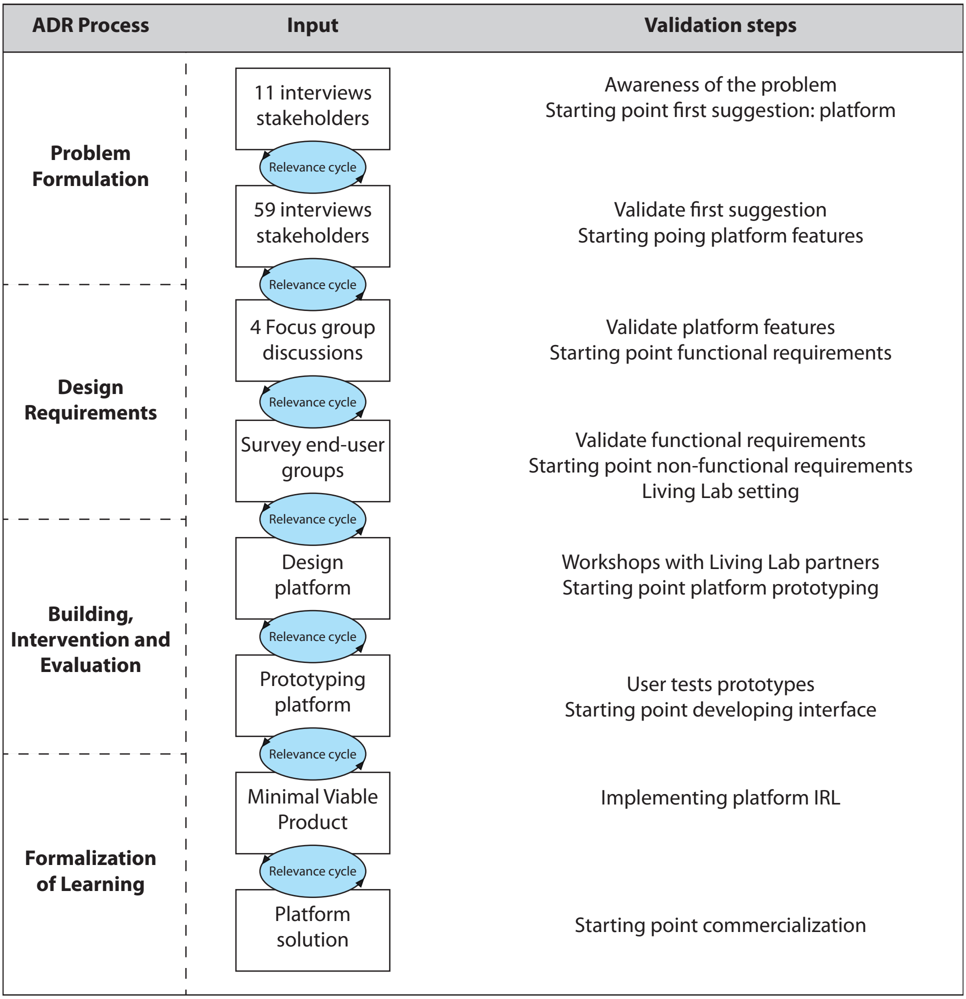



Fig. 4. Overview of the ADR process and the design iterations.

Evaluation (BIE), 3) Reflection and Learning, and 4) Formalization of Learning, and we wanted to validate this research method, as mentioned above, we needed more guidance with regard to the process (i.e., the what). To obtain a more detailed view of the different stages we expanded this design cycle with insights from Hevner (2007) and Verschuren and Hartog (2005) which resulted in the the following ADR research framework (see figure 5):

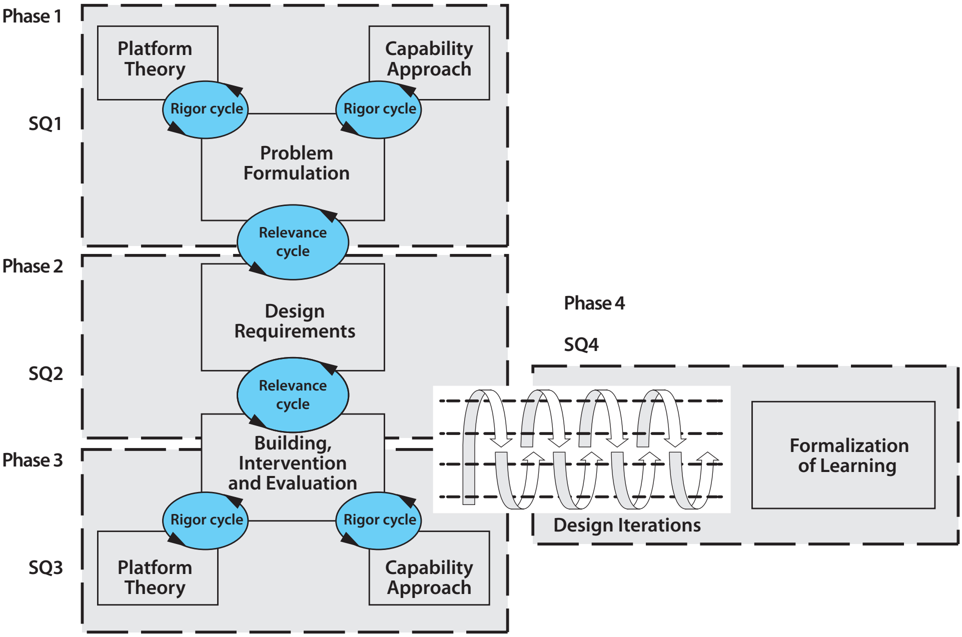



Fig. 5. Revised ADR framework (Hevner, 2007; Sein et al., 2011; Verschuren & Hartog, 2005).

### 2.5.1 Research phase 1: Problem Formulation

The input for the first research phase (Q1 2013 – Q4 2013), the Problem Formulation stage, came from multiple sources: review of the research domain (see Chapter 3); literature review involving the core concepts from Platform Theory and the Capability Approach (see Chapter 4) and insights from eleven in-depth stakeholder interviews, followed by 59 semi-structured interviews (see Chapter 5). The resulting output consisted of a proposal for a new research effort in the smart living domain. Within the Problem Formulation stage we developed the initial outline of the suggested service platform. Because the goal of this research is to design, prototype, implement and evaluate a digital service platform for Health and Wellbeing to help people age-in-place, the design requirements (i.e., functional, user and context) should be set up accordingly. These requirements are not developed at once, but are shaped during the ADR process. The main focus of presenting requirements and assumptions (Verschuren & Hartog, 2005) is to show the development of the design process (Gregor & Hevner, 2013), which was a non-linear process of interaction with interviewees, focus groups, Living Lab partners, potential platform users and the Expert Team.
Before focusing on the first stage of the ADR design cycle (i.e., Problem Formulation) we explored existing literature regarding the core concepts of Platform Theory and

the Capability Approach, to build our theoretical framework. The findings from literature helped us to formulate a tentative problem description as interpretations of the smart living phenomenon within a social innovation context. Subsequently, using the concepts from literature, we studied existing services, service platforms, involved actors, their strategic interests and their role in the smart living domain from the smart living domain in eleven in-depth interviews with experts, who suggested that we explore the possibilities of a digital platform to exchange information about smart living products and services (i.e., from business to consumer – b2c).

The first phase answers sub-question 1: *What do Platform Theory and the Capability Approach prescribe on how to design a service platform for matchmaking in a social context, which supports different stakeholder groups?* See Chapter 4.

To evaluate the suggestion from the 11 in-depth interviews (Q1 2013), and to gain initial insight into the platform requirements we organized 59 follow-up discussions (i.e., semi-structured interviews in Q2 2013) with 1) strategic level stakeholders (i.e., decision-makers on a strategic level from knowledge institutes, government and funding partners), 2) affiliate level partners (i.e. decision makers on a technical level from the industry and service providers) and 3) end-users (i.e. elderly people, informal caretakers). The main focus was on validating the suggestion from the previous eleven expert interviews and to elaborate on the platform requirements. The main result of the first research phase was a small set of goals to be realized with the designed platform. In addition, we explored which theories were relevant and what this meant for the design process.

### 2.5.2 Research phase 2: Design Requirements

In the second research phase (Q1 2014 – Q3 2014), the Design Requirement stage we refined the platform requirements suggested in research phase 1, in four focus group meetings (Q2 2014) with 28 participants as an iterative step in our design cycle (see Chapter 6). To elicit and specify user requirements, focus group interviews (Caplan, 1990) are a feasible option and using multiple experts in a group setting is recognized as a viable knowledge acquisition tool. Potential advantages of group knowledge acquisition over individual sessions include: 1) groups can provide a broader range of skills and knowledge, 2) groups can provide more effective divisions of labor and 3) groups can legitimize a result (Massey & Wallace, 1991).

According to Verschuren and Hartog (2005), we need to 1) understand how to design an IT artifact that meets end-users needs (i.e., requirements) and, 2) understand the needs of the users and their context in order to make a fruitful use of the design possible (i.e., assumptions). Although the Design Requirement phase is not part of the original ADR design cycle, we added this phase because we needed to structure the *platform-to-be*, based on the requirements that were derived from the first phase. It answers sub-question 2: *What are the main design requirements for a service platform for Health and Wellbeing that supports three different stakeholder groups (i.e., end-users, service providers and local governments) in related to aging-in-place?*

The main goal of the focus groups was to validate the assumptions that were raised during the 70 interviews conducted in research phase 1 with different stakeholder groups and to explore the platform features of a service platform for Health and Wellbeing (see Chapter 6). In this research phase the four main platform features became clear 1) information exchange, 2) online community, 3) portal and 4) health intervention instrument.

### 2.5.3 Research phase 3: Building, Intervention and Evaluation

In the third research phase (Q4 2014 – Q1 2016), the Building, Intervention and Evaluation (BIE) stage, we entered the Living Lab setting (see Chapter 7), elaborated on the planning phase (see Chapter 8) and focused on developing the design (see Chapter 9) after which we tested the various low-fidelity prototypes with stakeholders (i.e., end-users, informal and professional caretakers and local government) see Chapter 10.

One way to find out what end-users need and want from technology (Burigat & Chittaro, 2007; Nielsen, 2003) is to involve them in the development process from an early stage. Examples of methodologies that do so are Participatory Design (e.g., Bansler, 1989; Bødker, Kensing, & Simonsen, 2010) and User-Centered Design (e.g., Holtzblatt, Wendell, & Wood, 2004; Stone, Jarrett, Woodroffe, & Minocha, 2005). In the Living Lab setting, we were inspired by User-Centered Design to involve the end-users in the co-creation process of the service platform (see Chapter 7). However, identifying user needs related to new technological solutions is a complex process and can be regarded as the most difficult phase in the development process (Maiden & Hare, 1998). For one thing, asking end-users to tell developers about their needs is not so straightforward as it seems (Hyysalo & Lehenkari, 2003; Pitts & Browne, 2007). End-users are often not familiar with technical terms and lack the ability to articulate what they really want or need. On the other hand, developers are often poorly trained when it comes to gathering information and they tend to ignore the social context and want to curtail user involvement by developing the final product as soon as possible. To avoid some of these obstacles, we used several data collection methods to identify end-user needs (i.e., requirements) like interviews and focus groups, before bringing end-users in contact with the platform developers. Moreover, we aimed to triangulate end-user needs with a survey study to refine the requirements of the platform (Ward, Bertrand, & Brown, 1991). Therefore, to evaluate the suggestions extracted from the focus group sessions the outcomes are incorporated in two end-user surveys (N = 626) in Q2 2015 to gain a deeper understanding of the platform requirements (see Chapter 9).

Within the Living Lab setting we arranged five workshops in Q1 – Q4 2015 (i.e., Kick-off meeting, Project Start Architecture, Critical Design Issues, Design Sprint, Business Modeling) to guide the development phase (see Chapters 8 – 10). Multiple low-fidelity prototypes of the service platform were developed and tested in this phase: 1) mock-ups, 2) paper prototype, 3) clickable model, 4) platform demo, and 5) a Minimal Viable Product (i.e., a product that has just enough features to provide validated insight into the product and its continued development). In the prototyping phase, the platform theories are used again to design the technical parts of the platform and set up an experimental test setting (see Chapter 11).
To check whether the short-term and long-term effects of using of the platform matched the design goals and met the expectations of the Action Design Researcher as well as the various stakeholders as well, we focused on questions like: *'To what extent does the platform match to the requirements?'* *'Who are the key actors in obtaining and providing information?'* Once constructed, the platform prototypes were evaluated according to criteria that were made explicit in the first phase. Deviations from expectations, both qualitative and quantitative, are noted and tentatively explained.

This phase answers sub-question 3: *How to design and prototype a service platform for Health and Wellbeing to support three different stakeholder groups (i.e., end-users, service providers and local governments) related to aging-in-place within a real-life setting?*

As mentioned above, in the final design iteration (Q1 2016) we developed a Minimal Viable Product (MVP) and subsequently tested the prototype in an experimental setting (see Chapter 11). As such, the output of this research phase is a tentative design and a tested prototype of the platform. For the technical perspective of the design it was mainly the core platform theories that were used, taking both requirements and assumptions into account, for instance *'what kind of qualities the users and the context should have in order to make a fruitful use possible?'* Like the design requirements, the assumptions may refer to the future users, the context and the functions to be fulfilled.

### 2.5.4 Research phase 4: Formalization of Learning

In the fourth and final research phase (Q2 2016), we entered the Formalization of Learning stage from Sein et al. (2011). See Chapter 12.

This phase answers sub-question 4: *What can we learn from the design process of a service platform for Health and Wellbeing related to aging-in-place within a real-life setting?'* After evaluating the platform, the final conclusion on the research project is formulated. In the final research effort of the platform design process, the results were written down leading to applied as well as new design principles, which can be regarded as a kind of blueprint and may serve as the subject of further research. The main results of the fourth research phase include how the seven ADR design principles are materialized, followed by new and refined principles for the specific case of platform development for social innovation.

### 2.5.5 Summary

To summarize, our research approach is a design-oriented approach to constructing a prescriptive IT artifact (i.e., service platform) to a specific problem (i.e., societal demand), which is subsequently taken through several specified phases in which it is constantly evaluated. To that end, we expanded the framework from Hevner (2007) by incorporating the ADR method from Sein et al. (2011). ADR stresses the influence of the relevance cycle of Hevner (2007), by providing explicit guidance for combining building, intervention and evaluation in a concerted research effort. Since, the ADR method lacks a detailed process description, we enriched the ADR method with insights from Verschuren and Hartog (2005) and accordingly revised the original ADR research framework from Sein et al. (2011). See section 2.5.

Despite the popularity of DSR, most well-known methodologies (Hevner, 2007; Hevner, March, Park, & Ram, 2004; Peffers et al., 2008; Sein et al., 2011) are based on secondary data or reconstructions (Cronholm & Göbel, 2015). While secondary data collection involves the re-use of pre-existing research, which can be used to explore new or additional research information or to verify findings from previous research, primary data is related to the collection of original data under control of the researcher. Key limitations of secondary data are the problem of 'data fit' and 'not being there', as well as 'the problem of verification'. In addition, there are ethical and legal issues (i.e., confidentiality, copyright and data protection). By using primary data in our ADR study, we tried to avoid these limitations that are typically associated with secondary data (Thome, 1998).

The design input, throughput and output of the study is summarized in table 5.

| Table 5. ADR methods: design input, throughput and output | | | |
|---|---|---|---|
| **Stage** | **Design input** | **Throughput (i.e., ADR activity)** | **Design output** |
| **Phase 1: Problem Formulation (Q1 2013 – Q4 2013)** | Literature review | 70 stakeholder interviews | First hunch (initial idea of the IT artifact) |
| **Phase 2: Design Requirements (Q1 2014 – Q3 2014)** | First hunch<br>Interview data | Focus groups<br>Expert team | Specific set of requirements and assumptions |
| **Phase 3: Building, Intervention and Evaluation (Q4 2014 – Q1 2016)** | Focus group data (i.e. requirements and assumptions) | Living Lab<br>End-user surveys<br>IT artifact Design and Development | Refined requirements<br>4 low-fidelity prototypes<br>Minimal Viable Product |
| **Phase 4: Formalization of Learning (Q2 2016)** | Prototypes<br>Requirements | Usability tests<br>Implementation IT artifact in experimental setting | Process description<br>Set of design principles |

# 3. Research domain

We are entering an era of smart living, where our homes are changing into smart environments. As mentioned in Chapter 1, ICT solutions can help us to arrange daily activities in a smarter way. Although the focus of our study is not on smart homes as such (i.e., with advanced automated appliances), the term aging-in-place reflects how to integrate smart solutions in our daily life. The concept is related to the concept of smart living, which can be defined as '*an integrated design of our homes and neighborhoods in which functional and non-functional requirements come together in an integrated design*'.

In this chapter we describe the research domain and position the platform to support people age-in-place, within that domain. To that end, we describe the smart living context, which determines the information used to characterize the situation of an entity (i.e., person, place or object) and is considered relevant in the interaction between a user and a certain application (Dey, 2001). In our opinion, the characteristics of the smart living domain influence the interaction between a service platform and the (elderly) end-users, which is needed to determine the purpose of our research and allow designers to decide what context to use in their applications. We begin by describing the evolution from smart homes to smart living (section 3.1), subsequently followed by an overview of the Health and Wellbeing domain in the Netherlands (section 3.2), which is related to independent living and aging-in-place.

## 3.1 Smart living domain

For 50 years smart homes have been considered a highly promising field for citizens. Since the 1960's, the use of ICT to support people in their home environment has increased. Starting with basic home automation systems (i.e., domotics), in the last two decades smart homes have moved to advanced intelligent services for the domestic environment. Home automation covers a broad range of 'intelligent' electronic or mechanical devices in the home environment[1].

### *3.1.1 From smart homes to smart living*

Through advanced intelligent services 1) people are able to receive care (e.g., from a distance), 2) energy savings can be realized, 3) safety can be guaranteed, and 4) issues

*1. An earlier extensive analysis of the smart living domain was published in Solaimani, S., Keijzer-Broers, W., & Bouwman, H. (2013). What we do - and don't - know about the Smart Home - An analysis of the Smart Home literature (IBE-13-0120) Indoor and Built Environment.*

about social communication and entertainment can be taken care off. Consequently, we argue that smart living is not about smart homes as such, but about integrating smart solutions in everyday life, both at home and on the move. In the 1980's smart homes merely involved a predefined automation of appliance tasks (Goumopoulos & Kameas, 2008). Since 2000, smartness involves more flexible task automation adapting to the situation based on past usage data, user preferences and interaction with other devices (Solaimani, Bouwman, & De Reuver, 2010). According to Weiser (1996), what is meant by a smart house evolves over time and he stated that *'the smart house of 1935 had an electric light in every room, followed by a telephone and a television (1955). 'The next step',* he wrote in 1996, *'is that by 2005 we will have a computer in every room'.* According to Aldrich (2003), a smart home is not only limited to the property itself (Cong, Wei, & Hu, 2013; Gann et al., 1999), but allows smart applications to be controlled remotely (e.g., domotics, telecare, telemedicine, central locking and alarm systems). In addition, the Internet allows us to make smart home applications accessible, regardless of the device or the user's location (Barlow & Venables, 2003; Rohracher, 2002).

Since the first reference to smart homes in 1984 by the American Association of House Builders (Harper, 2003), the smart homes concept has been used in different contexts of comfort, leisure, energy management and health support. In recent years, many researchers also studied different application domains of smart homes. Barlow and Venables (2003), for instance, focused on mobile applications, while Chan, Campo, Esteve, and Fourniols (2009) examined healthcare services for smart homes. Fensel et al. (2013) explicitly looked at the energy sector, while others (Gerwen, Jaarsma, & Wilhite, 2006; Park, Kim, & Kim, 2011; Weiss, Mattern, Graml, Staake, & Fleisch, 2009) discussed smart metering projects all over the world. In addition, smart homes pilots have also been initiated to explore the possibilities of smart technologies in the urban environment (Chen & Chang, 2009).

Over the years, different terms have been used interchangeably to refer to a home with advanced automated appliances, including *smart home* (Aldrich, 2003; Lorente, 2004; Marsh, 1998), *connected home* (Harper, 2011), *intelligent home* (Skrzypczak, 1987), *networked home* (Chetty, Sung, & Grinter, 2007) and *integrated home* (Roberts, 2009). Furthermore, the terms are not precisely defined and it is not clear how they differ from each other. Although there are several definitions for smart homes, we adopt the broad definition proposed by Aldrich (2003) who defines a smart home as *'a residence equipped with computing and information technology which anticipates and responds to the needs of the occupants, working to promote their comfort, convenience,* *security and entertainment through the management of technology within the home and connections to the world beyond*' (Aldrich, 2003, p. 17), noting that, in our opinion, besides the terms comfort and convenience, the definition can be expanded by including the term Health and Wellbeing (see section 3.2). In addition, the phrase *connections to the world beyond*, leaves room for exploration of the world outside the home, which is in line with the notion that the smart homes concept evolved from a specific area of home automation, into the much broader concept of smart living.

Thus, smart living is primarily about connecting our daily activities '*at home, along the way, or anywhere else*', which can be supported by integrated ICT (Baken, 2010). It encourages us to look outside the house and involve the neighborhood as well (Koudstaal & Bijloo, 2010). Socio-economic conditions in neighborhoods can affect people by providing him with access to employment opportunities and public resources such as efficient transportation and infrastructure, but also facilities like schools, supermarkets etc. As such, smart living can be seen as '*an integrated design of our homes and neighborhoods in which functional and non-functional requirements are woven into an integrated value-sensitive design*' (Baken, 2010, p. 212). Whereas functional requirements describe what the system should do, non-functional requirements describe how the system should behave or work.

### 3.1.2 Smart living services and products

Although smart living has been on the agenda of policymakers for decades and despite the commercial actions taken in different sectors (i.e., Health, ICT, Building and Energy), smart living services have not yet reached the diffusion phase or mass market, yet (Balta-Ozkan, Davidson, Bicket, & Whitmarsh, 2013; Peine, 2009; Solaimani et al., 2010; Wichert et al., 2012). In business and economics, services can be seen as the non-material equivalent of goods, that is intangible by nature and that is offered by providers to consumers as a value (Grönroos, 2008). Although services are important in IS research, there is no universal definition available (Spohrer & Maglio, 2010). We adopt the definition proposed by Vargo & Lusch (2004, p. 326) '*A service is the application of specialized competences (skills and knowledge), through deeds, processes, and performances for the benefit of another entity*'.

Related to this definition, smart living services can be seen as mediators for (product and service) providers to create value for households (Grönroos & Ravald, 2011) and address a wide range of applications, from mobile connection, video and audio services to online applications for healthcare, energy management, entertainment and surveillance. In addition, smart living services are related to the Internet of Things (IoT), which can be interpreted as *'a worldwide network of interconnected objects uniquely addressable, based on standard protocols'* (Vermesan & Friess, 2011). Thanks to advanced sensor technologies and integrating sensors, devices are transforming into smart objects (Kortuem, Kawsar, Fitton, & Sundramoorthy, 2010) that have a huge impact on peoples' lives.

### 3.1.3 Related work

At the start of our study (Q1 2013), we conducted a literature review about the research domain (Solaimani, Keijzer-Broers, & Bouwman, 2013), to gain insight into state-of the art literature about smart homes and smart living. Starting with the year Weiser's seminal work (1991) was published, 154 publications between 1991 and 2013 were collected and analyzed. Although smart living explicitly promotes the comfort, convenience, security and entertainment of citizens, the literature seems incoherent. Most papers either focus on specific technological aspects or on sector-specific developments, like assistive technologies (LoPresti, Mihailidis, & Kirsch, 2004), e-health projects (Chan et al., 2009; Chan, Estève, Escriba, & Campo, 2008; Koch, 2006), design requirements (Solaimani, Bouwman, & Secomandi, 2013), laboratories (Aldrich, 2003), technologies for aging societies (Demiris & Hensel, 2008), energy management (Kailas, Cecchi, & Mukherjee, 2012), location-based systems (Ha, Kim, Lee, & Lee, 2007) and user studies in healthy Smart Home (Kim, Oh, Cho, Lee, & Kim, 2013).

To analyze existing literature, we borrowed a generic and comprehensive framework that aims at reconstructing the logic of a business and its surrounding ecosystem (Bouwman, de Vos, & Haaker, 2008). We used the four STOF domains as the starting point to cluster (Miles & Huberman, 1994) existing smart living literature in one or more dimensions. Gradually, the STOF classification (i.e., Service, Techology, Organization, Finance) of publications evolved into a more detailed tree of topics, with branches and sub-branches. In total, 15 core clusters and 52 sub-clusters were identified (see figure 6).

Analysis of the papers revealed that the technology domain is by far the most prevalent domain, while non-technological topics have attracted far less attention from smart living researchers. Most topics in the non-technological domains are covered as side issues, which is in line with the repeated observation of several researchers, that the smart living domain is still primarily dominated *by technology push* (Aarts & Encarnação, 2006; Aldrich, 2003; Gann et al., 1999; Chan et al., 2009).

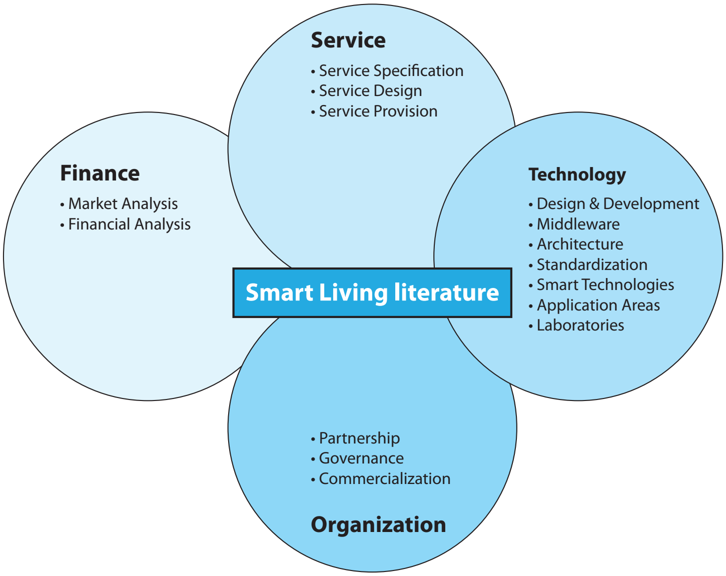



Fig. 6. Representation of 15 core clusters of the smart living literature (1991 – 2013) using STOF (Bouwman et al., 2008).

The lack of attention to more socio-technical and socio-organizational issues can be explained by 1) the smart living domain is still the domain of technicians and 2) it is easier to acquire funding to conduct technical research and experiments. The EU-FP7 program, for instance, funds a number of projects involving smart living and eHealth with a strong focus on technology, mainly to be accepted by mono-disciplinary technical publications. In addition, there are more technical-oriented conferences and conference tracks, which again further stimulates a focus on technical issues, experiments and publications about technology. Finally, smart living projects and experiments are predominantly conducted within an R&D environment. While smart living is still in its exploratory phase (Gilsing, 2003), this would explain the relative absence of socio-technical, socio-organizational and economic studies. On the other hand, the fact that smart living concepts have not yet been commercially exploited indicates that there are areas for further research. From an organizational perspective, there are several promising topics that have thus far been overlooked, one of which is the initiation of strategic collaboration within a networked-enterprise setting, for instance to examine how collective action theories may be useful in networked-enterprise collaborations in the smart living domain (Nikayin, 2014), or actors can be motivated to invest time and effort up front, while the benefits can only be reaped in the long run. From a strategic ecosystem perspective, research questions with regard to the role of dominators or key players are relevant. From a business management perspective, it is essential to investigate how viable and feasible business models can be formulated and how these collaborations can be facilitated in such a way that they can be sustained at an operational level as well. From a service marketing and design perspective, an evaluation of actual market demand is a fruitful area for investigation. Most studies to date have a design-driven character that is highly focused on user requirements, rather than being interested in the service demand, people's willingness to pay and other financial issues. Some crucial questions in this regard are how big are the smart living target groups that are actually interested in different smart living concepts, and what characteristics can be attributed to these groups?

## 3.2 Health and Wellbeing domain

Although smart living covers a broad area and is related to different industries (i.e., Health, ICT, Building and Energy) this study focuses extensively on smart living from a health and wellbeing perspective and emphasis on people who prefer to live independently in their own home. Independent living is described as people having control over their own life and choosing how they should lead their own lives, even when they are no longer able to everything themselves (Brisenden, 1986). This definition is in line with Bedaf et al. (2014), who refers to independent living as a situation where people are not doing everything on their own, but are still in control and able to make their own decisions. As such, independent living can be grouped as physical, mental, social and financial independence (Huang & Dong, 2014). Physical independence refers to the ability to perform daily tasks without having to depend on others, while mental independence related to an individual's decision making, such as thinking and communication. Moreover, social independence is closely related to social constructions, including assessing community resources, feeling valued and connected with others (Plath, 2008) and financial independence also plays an important role in influencing the ability of the elderly to maintain people's physical and mental wellbeing (Huang & Dong, 2014). However, since everyone may have a different interpretation of the concept of independent living, it is important to look at the individual level to capture the actual needs of elderly people to achieve this goal (Huang & Dong, 2014; Schwanen, Banister, & Bowling, 2012). In addition, Bedaf et al. (2014) argue that self-care activities, mobility, and social isolation are three types of activities that may threaten the independence of elderly people. And although there is a little agreement about what independent living means exactly, most scholars do agree that it can add value to the lives of elderly people (Huang & Dong, 2014; Leeson, Harper, & Levin, 2004).

Another concept, which is closely related to independent living, is what the World Health Organization (WHO) has referred to as active aging: *'the process of optimising opportunities for health, participation, and security in order to enhance quality of life as people age'* (WHO, 2002). In this context, the term 'active' means not only physically active, but also staying involved in social, economic, cultural, spiritual and civic affairs. This concept is based on three foundations: participation, health and security. In fact, it is not about adding years to life, but about adding life to years.

In addition, according to WHO (2002) four key aspects of active aging are:
1. **Autonomy**: perceived ability to control, handle with and make personal decisions about how one lives on a day-to-day basis, according to one's own rules and preferences
2. **Independence**: ability to perform functions related to daily living, which is the capacity of living independently in the community with little or no help from others
3. **Quality of life**: an individual's perception of their position in life in the context of the culture and value system where they live, and in relation to their goals, expectations, standards and concerns
4. **Healthy life expectancy**: *'how long people can expect to live without disabilities'*

One of the main demanding markets in the health and wellbeing domain is that of the elderly. Aging is accompanied by an increasing demand for healthcare resources, due to the associated increase in chronic conditions. This means that the profound changes in demography present new social challenges, but they also bring new opportunities. The World Health Organization, the European Commission and national governments all promote the concept of 'active aging', which they define as the process of optimizing opportunities for health, participation and security designed to enhance quality of life as people age (Eurostat, 2012; UN, 2013). If elderly people become more vulnerable, it becomes harder to take responsibility. This requires solidarity (and not just financially) from society. Neighbors, friends, family, elderly people themselves and volunteers can help each other. Given these challenges, there is broad consensus that innovative ICT solutions are required to both reduce costs and help people live longer on their own (EC, CoR, & AGE, 2011).

To overcome the societal health problems mentioned above, different approaches integrating the medical and the social domains have been proposed. The Chronic Care Model by Wagner, Austin and Von Korff (1996) and the expanded Chronic Care Model by Barr et al. (2003) are still central to the formulation of European healthcare policy. Both model envisage an important role for social support organizations, informal caretakers and their community, and indicate self-management and support by the community as key elements. The proposed paradigm shift in healthcare systems comprises a transition: 1) from a mainly mono-disciplinary towards a multi-disciplinary care provision, 2) from a curative approach towards preventive medicine and public health, 3) from institutional care towards community care, and 4) from professional towards informal care (Barr et al., 2003). Healthcare services are thus increasingly becoming localized to the area of the user and care providers are no longer well-known large players but can increasingly be small organizations, or even other citizens providing informal care.

Despite the attractiveness of the integrated and more bottom-up care system in terms of costs and patient focus, the fragmented healthcare market makes it more difficult for elderly people to find relevant services. In a situation where public (health) service is minimized, end-users are increasingly expected to find health and wellbeing services themselves and, without support and guidance, large groups of users are likely to be unable to make informed choices on what services to use.

### *3.2.1 Key definitions*

Since there is a growing realization that these community settings have a greater impact on the quality and duration of people's lives, compared what could be accomplished in healthcare facilities (Adler, Boyce, Chesney, Folkman, & Syme, 1993; Marmot, 2001), smart living can make a difference related to peoples' health, wellbeing and quality of life. Although the key definitions related to smart living (i.e., health, wellbeing and quality of life) are still under debate, we will provide a brief overview of the terms and how they are related.

***Health***

Since 1948 the World Health Organization (WHO) has defined health as '*a state of complete physical, mental and social wellbeing and not merely the absence of disease or infirmity*'. However, recognition of the interrelatedness of mental and physical health, the recent national policy interest in quality of life and wellbeing issues and ideas of 'social capital', community assets and resilience have encouraged new ways of thinking about what 'wellbeing' means to communities. Unintentionally, the definition contributes to the medicalization of societies, because the term 'complete health' leads to expensive interventions. In addition, the demography of populations and the nature of diseases have changed considerably over time. With improved nutrition, hygiene, sanitation and healthcare intervention, chronic diseases no longer lead to an early grave. On the contrary, aging with chronic illnesses has become the rule rather than the exception. Therefore, Huber et al. (2011) introduced a new formulation of the definition, describing health as *'the ability to adapt and to self manage in the light of the physical, emotional and social challenges of life'*. From this concept the term 'positive health' is derived, in which health is viewed as people's ability to adapt and manage their own wellbeing. Shifting the emphasis towards resilience and wellbeing helps people to focus on ways to improve their quality of life and, ultimately, lead a high-quality and meaningful life with an illness. Although the definition is still under debate, it is the starting point of a new discussion about the concept of health.

***Wellbeing***

Wellbeing is a complex concept, as shown by the countless dimensions and descriptions found in academic literature (Dodge, Daly, Huyton, & Sanders, 2012). Nordbakke and Schwanen (2014) describe three different dimensions of wellbeing: subjective/objective, hedonic/eudemonic (i.e., pleasure and satisfaction versus pain and dissatisfaction) and universalist/contextualist (i.e., stable versus change). In our study we will focus on the subjective, hedonic and contextualist aspects of wellbeing, also known as subjective wellbeing (SWB). Some argue that subjective wellbeing is 'de-medicalizing' the concept of health (Statham & Chase, 2010) and is therefore related to quality of health (Rees, Goswami, & Bradshaw, 2010; Zikmund, 2003), while others refer to subjective wellbeing as 'happiness' (Dolan, Peasgood, & White, 2008; George, 2010; Layard & Layard, 2011), an important indicator of personal health conditions (Frey & Stutzer, 2012), or an interpretation of people's choices and behaviors (Deutsch-Burgner, Ravualaparthy, & Goulias, 2014).

***Quality of Life***

According to the World Health Organization (WHO, 1997) quality of life is *'an individual's perception of their position in life in the context of the culture and value systems in which they life and in relation to their goals, expectations, standards and concern'*. As the WHO describes it, this broad ranging concept is affected in a complex way by the people's physical health, psychological state, personal beliefs, social relationships and their relationship to salient features of their environment. The mainstream opinion is that quality of life is more holistic and involves both objective (e.g., life expectancy, GDP, crime and unemployment rate) and subjective (e.g., happiness, sense of safety, sense of community, relationships and satisfaction with life as a whole) social indicators (Felce & Perry, 1997; Rapley, 2003).

In 2009 the Stiglitz Commission (Stiglitz, Sen, & Fitoussi, 2009) proposed eight dimensions for quality of life: 1) material living standards, 2) health, 3) education, 4) personal activities including work, 5) political voice and governance, 6) social connections and relationships, 7) environment, and 8) insecurity (economic and physical), which ideally, should be assessed using subjective as well as objective measures. Although, quality of life can be assessed using objective indicators of wellbeing, this leaves room for normative judgments about what would be' good and bad' life conditions (Noll, 2004; Rapley, 2003). Consequently it would appear that quality of life is '*a dimension of wellbeing rather than an all embracing definition*' (Dodge et al., 2012).

To summarize, although the key constructs 'quality of life' and 'wellbeing' are closely related and are often used interchangeably, they are not the same. Generally speaking, objective indicators of wellbeing are still widely considered as a more accurate basis for decision-making, because they do not suffer from '*social biases related to people's happiness*' (Frey & Stutzer, 2002; Rapley, 2003). On the other hand, subjective indicators allow people to decide for themselves what makes them happy and whether they feel satisfied with their live 'as a whole' (Frey & Stutzer, 2002). Based on this, the Stiglitz Commission (2009) concluded that measures of '*subjective well-being provides key information about people's quality of life*' and should therefore be taken into account.

In this study, we adhere to the way Marks and Shah (2004, p. 4) described wellbeing: '*as well as feeling satisfied and happy, well-being means developing as a person, being fulfilled, and making a contribution to the community*'. Furthermore, we refer to subjective wellbeing as a movement towards 'the project of the self' in which individuals are encouraged to assume increasing personal responsibility for their wellness. As such, we connect wellbeing to ideas like personal independence, resilience, standards and skills.

### 3.2.2 Health and Wellbeing regulations in the Netherlands

In the Netherlands there has been a significant increase in the municipal responsibilities with regard to the health and wellbeing of citizens, related to the social policy domain. Since 2007 the Social Support Act (i.e., WMO = Wet Maatschappelijke Ondersteuning) provides government assistance to people with disabilities, regardless of their age or whether they are disabled or have mental health problems. The Social Support Act is designed to foster the life skills and social participation of citizens and to increase the social cohesiveness of Dutch society. Local authorities must compensate citizens in a number of areas for the consequences of their impairments, when and where appropriate, by providing equipment or services (e.g., domestic help, mobility and transportation, or engaging in social contacts). Thanks to the WMO these people have access to domestic support or specific tools, so they can take part participate in society and live as independently as possible in their own home.

The Social Support Act (i.e., WMO) is divided in ten performance areas:

1. Enhancing social cohesion and quality of life in local communities.
2. Offering preventive facilities for problems with young people growing up and parenting
3. Giving information, advice and client support
4. Supporting informal caretakers and volunteers
5. Promoting participation in society
6. Functioning of people with a disability or chronic mental problem and of people with psychosocial problems
7. Providing services to the elderly and people with a disability or chronic mental problem to allow them to maintain and enhance their independence or participation in society
8. Provision of social relief for homeless people and battered women
9. Public mental healthcare
10. Providing ambulant care and treatments for addicts

Although local governments carry out the Social Support Act, each municipality has a different approach. From 2015 onwards the government has shifted another three social policy areas to municipalities. This so-called 3D decentralization agenda comprises: 1) services for persons with disabilities (i.e., WMO), 2) youth policy, and 3) work and income. The overall goal of this agenda is to support citizens with their employment, empower them (i.e., participation) and provide them with active support if required. Although local authorities are free to decide for themselves how they set about meeting these targets, they are accountable at a local level for their performance. They receive an additional share of the national healthcare budget, but at the same time they are expected to provide services more efficiently and take a broader set of tasks. Unfortunately because lack of clarity has led to stagnation, in 2016 policy decisions have been postponed and new service deliveries put on hold.

### *3.2.3 The stakeholders involved*

New legislations in the Netherlands means new ways for municipalities to collaborate, but at the same time it is important to: 1) balance financial costs and benefits, 2) spread risks, 3) ensure service quality, and 4) manage and safeguard the social system. In the

Netherlands many stakeholders are involved in the social policy domain to support elderly and disabled people, including service providers like home care providers, welfare institutions, elderly associations, family care, care centers, social support offices. Figure 7 provides an overview of the three stakeholder groups included in our research (i.e., service providers, end-users and government).

To put these stakeholders into perspective, we can divide them in 1) elderly end-users and informal caretakers (like relatives and volunteers), 2) service providers in the health and wellbeing domain (from professional caretakers to insurance companies and renovators) and, 3) governmental parties (like the WMO desk and district nurse teams). From a consumer perspective the specific change is how: 1) elderly have opportunities to socialize (decrease isolation), 2) have more convenient basic healthcare tracking, and 3) have access to products and services in the context of Health and Wellbeing.

From a service provider and governmental perspective the service platform will support the creation of a more efficient model of delivering services and products in the context of Health and Wellbeing. These three stakeholder groups need to be taken into account in the research process and are incorporated in the stakeholder map (section 6.1.4).

## 3.3 Summary

To summarize, technological advancements over the past 30 years, combined with an exponentially growing interest from industry (i.e., Health, ICT, Building and Energy) has caused the concept of smart home to evolve from house automation and Internet of Things into smart living. As a result, houses are *'getting smarter'* and can be arranged in such a way that residents can age in their familiar environment in independence even when they are physically or mentally disabled. We argue that, to live up to expectations and realize a large-scale commercialization, the smart living domain has to reach a higher level of maturity, which can only be done by identifying, analyzing and leveraging a wide range of aspects, from both a technological and a non-technological perspective. In short, the smart living domain is a research area that includes various industries, disciplines and perspectives. Our comprehensive literature review shows how the body of knowledge in this domain has evolved and, moreover, what areas are in need of greater attention from both scholars and practitioners.

In the last decade, there has been promising academic research to address the challenges in the smart living field (Aldrich, 2003; Barlow & Venables, 2003; Lorente, 2004), which has also involved stakeholders, but as yet, there has been no research on how

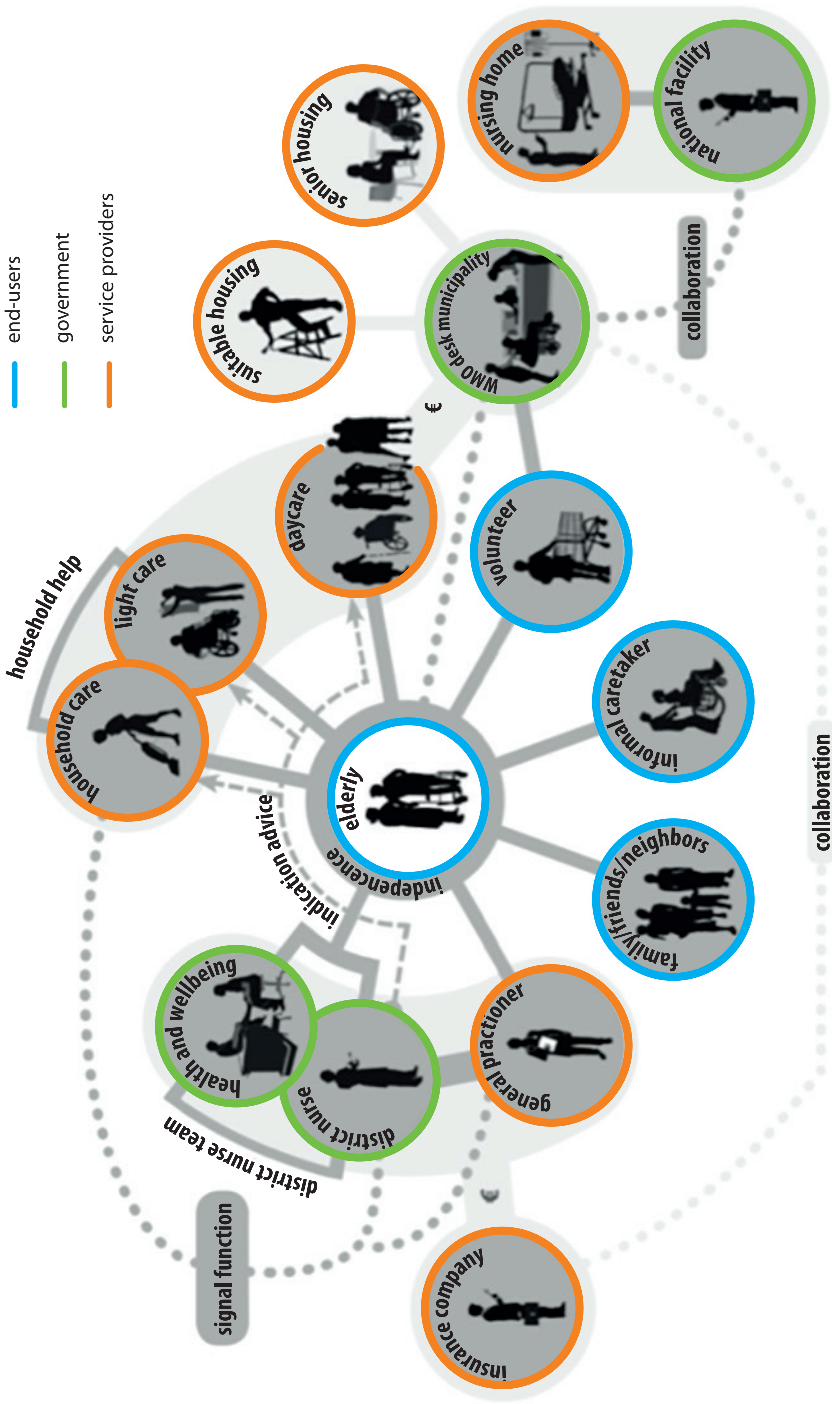



Fig. 7. Stakeholders surrounding disabled and elderly people (based on the sketch from ANBO 2015).

information sharing between different stakeholder groups can facilitate the awareness about smart living. The smart living domain is rapidly evolving and, although smart living is not just about technology, technology does have the ability to function as a catalyst for sustainability, energy saving and alternative possibilities in the healthcare domain. In particular, smart living draws attention to 1) the activities around our house, 2) the blurred boundaries between living, employment and mobility and, 3) the complex motivations and experiences of users and the need for cooperation. Therefore, smart living is related to the development of sustainable communities that are good places *'to live, to do business, to work, and to raise families'*.

As mentioned earlier, two decades ago Weiser (1996) envisioned a world where numerous of interconnected intelligent devices and networks would serve people in an unobtrusive way. Although, looking back, Weiser was right about computers, despite recent technological advancements his vision regarding interconnectedness has yet to become a reality in daily life (Solaimani, Keijzer-Broers, et al., 2013). In part due to the persistent technology push in the smart living domain. In Chapter 5 after discussing empirical research, we take a look at other possible explanations.

# 4. Theoretical framework

In this chapter we describe the theoretical background of the research, the origins of theories, and the underlying assumptions and definitions. The central aim of this chapter is to answer the first sub-question.

***SQ 1. What do Platform Theory and the Capability Approach prescribe on how to design a service platform for matchmaking in a social context, which supports different stakeholder groups?***

This chapter identifies the theoretical foundation and core concepts that are relevant to design service platforms in IS. We discuss the two applicable kernel theories as touched upon in the introductory chapter 1) Platform Theory, and 2) the Capability Approach and place them in the context of Social Innovation. The kernel theories provide input to our design process in terms of applying existing knowledge to position IT artifact-specific issues.

We started with the seminal work for the two kernel theories, after which we searched archives of peer-reviewed research journals, conference proceedings, books and online databases, using keywords in various combinations to identify relevant literature, like (service) platform, multi-sided, IT artifact, multi-actor, social-technical, social innovation, social entrepreneurship, business model, business ecosystem, elderly, capability approach, in search engines like Google Scholar, Scopus, JSTOR and Science Direct. Thirdly, we used back and forward snowballing technique to track related citations in the collected papers, as well as to find out who cited certain journal and conference papers. Based on the abstract, relevance and key concepts we decided whether or not to include the papers in our literature review.

## 4.1 Platform Theory

The term platform can have different meanings. *'Technically a platform can be viewed as a hardware configuration, an operating system, a software framework or any other common entity on which a number of associated components or services run. Economically, platforms and their providers mediate and coordinate between various stakeholder constituencies'* (Ballon, 2009, p. 4). Gawer (2009) created a typology of platforms, to organize and categorize the distinct meanings of internal platforms, supply chain platforms, industry platforms and multi-sided markets or platforms. Multi-sided service platforms intermediate between end-users and two or more groups of agents to bring them on board at the same time in profit and non-profit markets (Evans et al., 2006; Rochet & Tirole, 2003).

Because our design focuses on (product and service) providers, government agencies and end-users in establishing and governing a business ecosystem for smart living, we based our theoretical framework on concepts of platform theory from a multi-sided market perspective. However, most theoretical and empirical studies on multi-sided markets have so far focused on mature platforms (Gawer & Cusumano, 2008) paying less attention to critical issues facing start-ups trying to create a viable platform business (Evans, 2009). These critical issues include strategies for getting both sides on board and the role of the critical mass. In addition, empirical research on platforms developed by multiple stakeholders is still scarce (Gawer & Cusumano, 2014; West & Wood, 2013).

We follow Evans and Schmalensee (2007) who propose that a platform business is an 'economic catalyst' if it creates value by bringing different groups together and getting them to interact. From an economic point of view such a platform creates a multi-sided market and generally speaking faces a critical mass constraint that must be addressed if the business wants to be viable (Evans & Schmalensee, 2010). As stated by Gawer and Cusumano (2008, p. 29), a platform should bring value to all the stakeholders involved: '*it should be easy to connect to or to build upon to expand the system of use as well as to allow new and even unintended end-uses.*'

Parts of the Platform Theory also explain the business models of organizations acting as intermediaries between different market actors (Armstrong, 2006; Bouwman et al., 2008). Platform Theory explores how the interactions among different participants serve as the key driver of value creation (Lepak, Smith, & Taylor, 2007; Rysman, 2009). To define this value, Zeithaml (1988, p. 14) proposed that: *'value is the consumer's overall assessment of the utility of a product based on perceptions of what is received and what is given'*. Furthermore, value creation serves as a key factor for the generation of revenues for market actors.

Platform Theory has been applied within different industries. In the credit card industry, for instance, merchants interact with their customers via the credit card platform, while employers interact with jobseekers via recruitment portals (Eisenmann, Parker, & van Alstyne, 2006). Platform networks or ecosystems can be categorized according to the number of distinct user groups they encompass. For instance, networks with homogenous users are called one-sided networks, distinguishing them from two-sided networks, which have two distinct user groups. Rochet and Tirole (2006, p. 645) argue that *'two-sided (or more generally: multi-sided) markets are roughly defined as markets in* *which one or several platforms enable interactions between end-users, and try to get the two (or multiple) sides 'on board' by appropriately charging each side. That is, platforms court each side while attempting to make, or at least not lose, money overall.'* The term platform, as used in literature, ranges from social media websites to complete shopping malls.

Gawer (2009) defines platforms as building blocks (i.e., technologies, products and services), that act as a basis on which a business ecosystem (i.e., a group of firms), develops complementary products like technologies, products and services. As such, platforms 1) enable new services due to the reuse of the building blocks and thus allow service providers to lower fixed costs and enables shorter time to market, 2) create opportunities for complementary providers, 3) are built upon a set of standards and 4) offer APIs (i.e., application programming interface) or SDKs (i.e., Software Development Kits) to enable third parties to develop services.

Service platforms provide an intermediary role between end-users and service providers and can be defined as purely technical artifacts or as more socio-technical artifacts, which comprises not only technical elements but the associated organizational processes and standards as well (Tilson, Sørensen & Lyytinen, 2012). The structure of the platform and the prices that are charged influence not only the usage but also the volume of the transactions of the platform. For instance, YouTube, Facebook and Google offer services for free for end-users, while charging advertisers. The rationale behind this is to court both sides of the markets and at the same time scale-up the adoption of the platform.

The value of a platform can only be realized with a sufficient number of consumers and service providers on board (i.e. critical mass). As platforms bring multiple user groups together, network effects are core, which means that the usefulness of the technology will only increase if the installed base of users increases (Katz & Shapiro, 1985). Direct network effects refer to the number of users in the same user group (in our study: elderly and informal caretakers), while indirect network effects take different user groups (in our-study: elderly people, informal caretakers, service providers and government) into account.

### 4.1.1 Related concepts

Although Platform Theory is leading in our research, platforms are closely related to business ecosystems and business models. In our study, we use Platform Theory, mainly because of the ability to describe the central roles of the service platform and to find out which role and business model arrangements could create the most value for municipalities, (products and service) providers and end-users. A business ecosystem basically consists of a central hub, a platform and niche players, all elements that are all relevant to our research. The underlying logic is that the central hub is the owner of the platform and that niche players can use the platform to create value for themselves (Iansiti & Levien, 2004).

The concept of business ecosystems was first coined by Moore (1993) and is used to describe networks of organizations that work together and compete cross different industries and that co-evolve around a new innovation. A business ecosystem goes through different stages of *'birth, expansion, leadership, and self-renewal – or, if not self-renewal, death'* (Moore, 1993). As such, a network of companies and actors that emerge around a platform to offer services in the smart living domain can be viewed as a business ecosystem. A central actor, with a vision that is shared by all stakeholders, leads the business ecosystem. The actors in a business ecosystem often play different roles in the service delivery process. Based on the overload of data that is available, knowledge and information ecosystems will become increasingly important. One of the main challenges of any ecosystem is the *'complex interplay between competitive and cooperative business strategies'* (Moore, 1993).

Concepts related to business ecosystems are the stakeholder roles and governance dynamics of the value network (De Reuver, 2009). To ensure 'good' governance, the interactions between all the stakeholders should be based on integrity, mutual respect, responsiveness, accountability, collaboration and transparency. Both, stakeholder roles and good governance are relevant in terms of the complexity of managing the development of a multi-sided service platform with multiple stakeholders.

Generally speaking, it is not easy to design innovative entrepreneurial strategies and products that satisfy multiple stakeholders at the same time. The stakeholder perspective is more relevant than ever in Design Science Research (McVea & Freeman, 2005). In reality, starting up a service platform means having to select and involve multiple stakeholders in the design, requirements and implementation of the platform.

### 4.1.2 Business model ontology

How to position an IT artifact that generates value for multiple stakeholders is related to choices about the product or the service (Shafer, Smith, & Linder, 2005) and these choices can be implemented in business models (Osterwalder, Pigneur, & Tuggi, 2005; Solaimani & Bouwman, 2012), which means that business models in relation to Platform Theory are also relevant to this study because they show if (and how) a service platform is capable to create and deliver value to its customers and to the surrounding ecosystem. In addition, a business model makes explicit assumptions about 1) customers, 2) the behavior of revenues and costs, 3) the changing nature of user needs and 4) competitor responses.

We adopt the definition of a business model provided by Bouwman et al. (2008, p. 33) *'A Business Model is a blueprint for a service to be delivered, describing the service definition and the intended value for the target group, the sources of revenue, and providing an architecture for the service delivery, including a description of the resources required, and the organizational and financial arrangements between the involved business actors, including a description of their roles and the division of costs and revenues over the business actors'*.

Although there are a lot of business model frameworks, we describe three frequently used business modeling methodologies and frameworks: the STOF method (Bouwman et al., 2008), the Business Model Canvas (Osterwalder & Pigneur, 2010) and the VISOR method (El Sawy & Pereira, 2013), in order to make an informed choice. The selected ontology should provide sufficient detail in terms of CDIs to steer the platform development.

***<u>STOF</u>***

The purpose of STOF is to meet user requirements of services as well as deliver value to the users and providers of a service. The so-called STOF-model provides a basis for a DSR approach, which leads to a viable and feasible business model. The core approach of STOF is 1) to understand Critical Design Issues (CDIs) and Critical Success Factors (CSFs), 2) the interaction between the service, technical, organizational and financial domains, and 3) their interdependencies.

The STOF method provides an integrative design approach that includes four design domains:

1. The Service domain: the development of a specific service, user requirements as well as opportunities for providers to create value for users
2. The Technical domain: the technical resources needed at an infrastructural, middleware or service platform level
3. The Organizational domain: the organizations involved in delivering technical, managerial, marketing or human capital resources and capabilities

4. The Financial domain: the financial issues, including investments, risks and revenue models.

These four domains need to be designed in a balanced way, so that value is generated both for the end-users and the various actors from the value network.

***Business Model Canvas***

One of the better known business model frameworks is the Business Model Canvas (Osterwalder & Pigneur, 2010). Osterwalder defines the business model canvas as a framework for describing and visualizing business models and he argues that a business model can be best described by using nine building blocks, which show how a company intends to make money. Osterwalder (2010) proposed a nine-element business model framework, divided into four pillars: *Product, Customer Interface, Infrastructure Management and Financial Aspects.*

***Visor Method***

El Sawy and Pereira (2013) divide business model components into five categories: *Value proposition, Interface, Organizing model, Revenue model, and Service platforms*, the latter of which pays explicit attention to IT platforms that can enable and support the business processes and relationships, and thus improve the overall value proposition. They argue that a successful business model aligns these components to deliver the best value to the targeted customers, while at the same time minimizing the costs of providing the services. Although, initially business model methods paid no explicit attention to platform issues, it was the Visor Method that first incorporated them.

We selected the STOF method as a framework to structure the research, because it provides the most detailed insights into the business model components for IT artifacts. Additionally, it is the only method that explicitly provides an extensive list of CDIs related to creating both customer and network value. The other two methodologies do not address the evaluation of the designed business model based on Critical Success Factors (CSFs) and Critical CDIs to the same extent. In the design process, CDIs and CSFs are crucial to the viability and sustainability of a business model (Bouwman et al., 2008). According to the STOF method these factors are equally important when looking at a business model from a customer value or a network value perspective. The service platform will bring different stakeholder groups together in a business ecosystem, in which service-offering aspects, like the creation and exchange of value, will be addressed explicitly. The business model for the service platform should be viable for all the stakeholders involved, which implies that there should be explicit attention to business model design. The viability and feasibility of the platform is part of our problem statement.

## 4.2 Capability Approach

While we focus on Platform Theory and related concepts like business ecosystems and business modeling, as applicable kernel theories from a stakeholder perspective (i.e., service providers and government), we use insights from the Capability Approach to take the end-user perspective into account (i.e., elderly people and informal caretakers). The Capability Approach is relevant to our research purposes since it deals with the effects that technologies have on the wellbeing of people, especially those with impairments such as elderly people.

The Capability Approach is a framework that can be used to evaluate the capabilities of people in terms of their actual ability to achieve several valuable functionings as part of living their lives (Sen, 1993). While Nussbaum and Sen (1993) developed the basis for the approach, a concise definition is provided by Robeyns (2003), who defines the capability approach as *'a broad normative framework for the evaluation of individual well-being and social arrangements, the design of policies and proposals about social change in society.'* The approach focuses in general on what people are actually able to do with the resources they have at a given moment. For instance, if people have a library full of books, but cannot read, they are not able to actually read the books. Focusing on capabilities as a measurement tool makes it possible to gather useful information about a person's wellbeing.

To conceptualize the Capability Approach in our study we propose the following conceptual model (see figure 8).

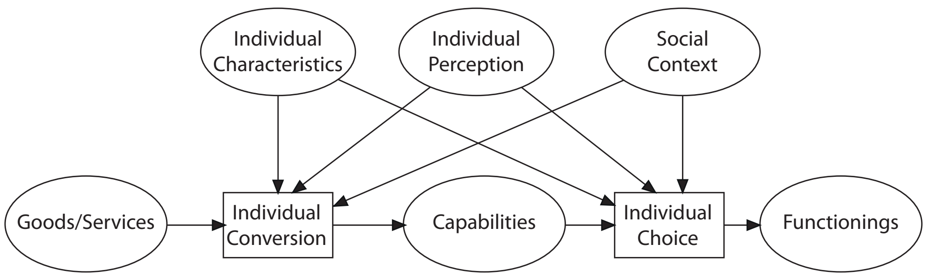



Fig. 8. Key elements of the Capability Approach inspired by Robeyns (2005), Vichitvanichphong, Talaei-Khoei, Kerr, and Ghapanchi (2014) and Talaei-Khoei, Lewis, Talaei Khoei, Hossein, and Vichitvanichphong (2015).

So-called **functionings** consist of 'beings and doings' (Sen, 1992); they are the person's potential states and activities. Examples of 'beings' are being happy, being healthy, being calm, being safe and having self-respect, while examples of 'doings' are traveling, caring for a child, voting, participating in demonstrations, but also taking drugs and eating animals.

**Capabilities** are conceived as a reflection of the freedom that a person has to achieve relevant functionings. Sen (1992) states that a person's chosen combination of functionings (*what they are and what they do*) is part of their overall capability set, in other words their potential functionings. Therefore capabilities are the chosen combinations of functionings that are feasible for a person to achieve. There are two important parts when it comes to formulating capabilities: functionings and the opportunity of freedom, where the latter is the actual freedom of a person to engage in different functioning combinations (Alkire & Deneulin, 2009). Ultimately, capabilities denote a person's opportunity and ability to generate valuable outcomes, also keeping in mind relevant personal characteristics and external factors. Thus, capability is concerned with the **freedom of choice**, which means it has an direct impact to a person's quality of life (Sen, 1992).

**Goods and services** have certain characteristics that make them of interest to individuals. Consider a bike: we may be interested in a bike, not just because of the bike itself but because it can help us reach other places faster. As such, a bike allows the 'functioning' of mobility. Although technology is not explicitly mentioned in the seminal work by Sen, many scholars do conceptualize IT artifacts as goods and services that can enhance the capabilities that people have (Hatakka & De, 2011; Heeks & Molla, 2009; Oosterlaken, 2009). Oosterlaken (2012) found that existing research about CA and IT varies from general cases (e.g. Alampay 2006) to empirical studies (Gigler, 2004; Kleine, 2010). She also found that some CA studies focus on specific IT artifacts, such as mobile phones (Sen, 2010), electricity (Dasuki, Abbott, & Azerikatoa, 2013), care robots (Coeckelbergh, 2012), and healthcare (Zheng & Walsham, 2008).

In a further development of the theory, Sen (1993) explains another important aspect of the Capability Approach, i.e. the notion of a **conversion factor**. Sen calls the relationship between a good/service and the achievement of beings and doings a conversion factor; it is the extent to which an individual can transform a resource into a functioning. In the example of the bike, it would be: '*How much mobility an individual can get out of a bike*', while in relation to ICT, it would be: '*How can ICT features affect capabilities of* *(elderly) people*' (Hatakka & De, 2011). CA suggests that goods affect the capabilities of an individual by a process of individual conversion. We expect that if people find the features of an IT artifact more important, they are more likely expecting to derive capabilities from using it.

In literature, there is no agreement on which conversion factors should be included. In the context of health and disability, Saleeby (2007) considers only personal (e.g., physical conditions, preference, cultural values) and environmental factors (e.g., geographical access, social forces). Talaei-Khoei et al. (2015) distinguishes individual characteristics (e.g., human being capacities, strength and limitations based on different demographics) and individual opinion about goods and services, while Talaei-Khoei et al. (2015) also stress social context as an important conversion factor. Since our research also focuses on health and wellbeing of elderly people, we follow the conversion factors proposed by Vichitvanichphong et al. (2014) and Talaei-Khoei et al. (2015) who divided the conversion factors into **individual characteristics, individual perceptions** and the **social context**.

With regard to individual characteristics, we argue that elderly people will face age-related challenges that may affect their ability to use ICT in their daily lives (Kapadia, Ariani, Li, & Ray, 2015; Nikou, 2015), which means that elderly people need to: 1) have a good functional condition, 2) be cognitively competent (Czaja et al., 2006) and 3) be literate enough to use ICT (Talaei-Khoei et al., 2015). Gender also plays a role in determining people's ICT-related needs and the use of ICT highly depends on their (former) occupation, which means that (former) 'professionals' are expected to use ICT more frequently (Alampay, 2006). Elderly people with a higher technological proficiency tend to use ICT more, compared to people who considered to be technophobic (Kapadia et al., 2015). Therefore, we conclude that individual characteristics include: (health) condition, technological knowledge, age and gender.

**Individual perception** about ICT is a second conversion factor. For instance, the perception of elderly people about the expected benefits of using ICT can be seen as a driver for using an IT artifact (Melenhorst, Rogers, & Bouwhuis, 2006). In addition, elderly people tend to use technologies that are easy and simple (Chen & Chan, 2011) and they will use ICT more often if they are satisfied while using it (Baroudi, Olson, & Ives, 1986). According to the psychological Health Belief Model (Becker, 1974, p. 355), regardless of actual or perceived health status, people undertake any activity for the purpose of promoting, protecting or maintaining health, whether or not such behavior is objectively effective. Thus, providing ICT solutions (e.g., a matchmaking platform), which can be used to the advantage of elderly people, increases their individual perceptions about the importance of the ICT solutions. Furthermore, their perception regarding their personal need for technology also influence their use of technology (Peek et al., 2014).

Finally, the **social context** also influences the conversion of goods/services into capabilities. The decision-making process of elderly people whether or not to use ICT could be influenced by people close to them, such as relatives, friends and professional care providers (Alampay, 2006; Kapadia et al., 2015; Talaei-Khoei et al., 2015). On the other hand, they could also feel embarrassed about using certain goods/services for fear of being labeled as people with special needs (Kapadia et al., 2015). In short, social context, in the form of recommendations from other people and social standards/ stigma are also important conversion factors.

According to Hatakka and De (2011), conversion factors play an important role in influencing the **individual conversion** from goods/services into capabilities. In addition, these factors influence an **individuals' freedom to choose** using the capabilities. Therefore, during the analysis we look at which conversion factors prevent or enable people when it comes to expanding their capabilities. In operationalizing capabilities, we focus on what people are effectively able to do and to be through the use of a digital service platform (Hatakka & De, 2011; Robeyns, 2005). See Chapter 10.

Using the CA we examine how and why an IT artifact (i.e. a service platform for Health and Wellbeing) can be developed as a way to create a social innovation designed to help people age-in-place. Because a multisided platform affects elderly people in profound ways, and is in fact intended to improve their capabilities to live meaningful and independent lives, we pay specific attention to the end-users by applying the capability approach. Therefore, operationalization of the CA for the other two stakeholder groups (i.e., service providers and government) is left out of scope.

## 4.3 Conclusion

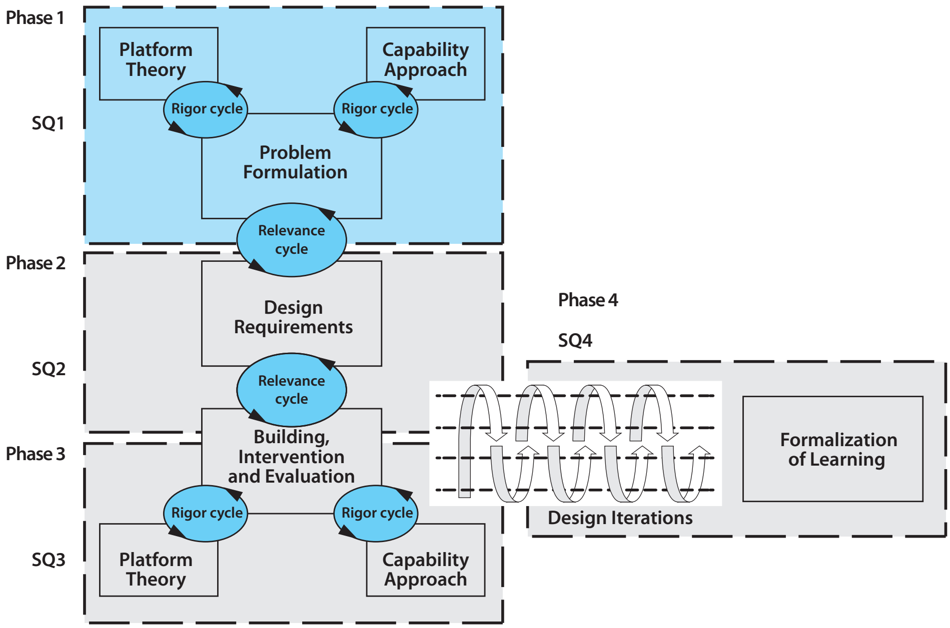
In this chapter we discussed business model and ecosystem theories that will help to make design choices on the platform. To summarize we want to design a potential Social Innovation – recapitulating on the aforementioned definition, that is an IT artifact (i.e., a service platform for Health and Wellbeing) that serves as a proxy and helps us influence, motivate or activate social change that is lasting and benefits the public. Using the STOF method we study if and how an IT artifact (i.e., a service platform for Health and Wellbeing) is able to create and deliver value to its customers and to the ecosystem. Using Platform Theory, we study how to design, prototype, implement and evaluate a socio-technical IT artifact (i.e., a service platform for Health and Wellbeing), which supports multiple stakeholders (i.e., end-users, service providers and government agencies).

However, the main focus of the platform is on the end-user (i.e., elderly people and informal caretakers). The designed platform (i.e., commodity) offers a podium, or is a resource of free choices to individuals (i.e., elderly people and informal caretakers) to achieve wellbeing, including socializing, engaging relatives, friends and caretakers, and having a convenient marketplace for products and services. In the long run, we are interested in improving the capabilities of those elderly people who could use this platform for their own wellbeing, which is why in this chapter, we talked about how the capability approach theory can help make the conversion from such a platform to capabilities for elderly people explicit.

Because we focus on a multi-sided platform, there are several potential bottlenecks. Adoption of the platform is critical, and the importance of achieving network effects by reaching to a critical mass of users is imperative for a service platform's success. Critical success factors for the platform are 1) it needs to be seamless (easy to navigate and access), 2) the platform has to be 'easy' to use to open room for many potential users, and 3) have the freedom of choice to use it and to improve the platform's conversion factor of the platform. Which is why platform-related considerations are included throughout the design.

Nowadays, service platforms are increasingly being transformed into components that are integrated into extensive digital infrastructures, with the aim of creating entire new digital services and products (Evans & Basole, 2016). This means there is not one single platform provider, but multiple actors trying to influence the development process. How to deal with these multi-actor settings and platform governance is not clear. As such, we need design theories that foster iterative shaping during the platform development process. Although ADR seems promising, it has not yet been applied on digital service platforms. Our study is the first attempt to apply ADR while designing, developing, implementing and evaluating a digital service platform intended to improve the capabilities of elderly to age-in-place.

# 5. Research phase 1: Problem Formulation




Research phase 1: Problem Formulation

In this chapter we describe the Problem Formulation. In a preliminary survey (Nikayin, Skournetou, & De Reuver, 2011; Nikayin & De Reuver, 2015) we examined potential hurdles for smart living innovation from the perspective of installer companies. We selected installer companies because they play a vital role in the smart living industry, already having a relationship with end-users for maintenance in households (i.e., electrical, mechanical, surveillance and domotics). Although we are aware that there are other companies that also play a role in the smart living industry (i.e., energy companies, healthcare providers and telecom operators), the installer is one of the few to be in regular contact with end-users about independent living. Hence, to explore the supply and demand mismatch outlined in Chapter 1, it makes sense to start with the installer.

Most survey respondents belong to a chapter within a Dutch branch organization that focuses on intelligent homes, building automation and ICT. This chapter includes both mechanical and electrical installers. Surprisingly, the 144 respondents in the survey are already in some way active in the smart living area, like smart grid, heat/cold storage, e-Health, independent living for elderly, home entertainment, and information and communication systems, smart and secure remote management, time and place independent works, green IT, smart air-conditioning systems and intelligent water management. Notable are the high scores for involvement in independent living, smart security and remote management, but also in smart climate solutions, while intelligent water management and smart grid receive the least attention. For most firms, trying out new technologies and being engaged in challenging projects are important motivators for becoming involved in smart living concepts.

The preliminary survey was conducted on a very specific sub-part of the ecosystem, to explore potential problems in the uptake of smart living services. As such, the survey is used as a starting point for a more qualitative research and will not be discussed in detail in this dissertation. Its main findings were that installers 1) have limited knowledge and lack information about smart living, and 2) struggle with collaboration issues.

The actors in a business ecosystem often play different roles in the service delivery process. Collaboration is even more important in knowledge- and information-intensive ecosystems. The role of small businesses is often limited to a niche player position, because their assets, innovative capabilities and knowledge are limited or very specific. In the increasingly complex business ecosystems for ICT innovations, small businesses will face cooperation-related challenges as they have difficulties relating to other relevant actors (Schubert, Fisher & Leimstoll, 2007; Corallo, Passiante & Prencipe, 2007; Zeng, Xie & Tam, 2010).

As a follow-up we selected the most challenging issues for small installer businesses from the survey to explore the outcomes in more detail, specifically knowledge and cooperation-related challenges, based on eleven in-depth interviews with stakeholders[1] (i.e., strategic decision makers from knowledge institutes, the installation sector and service providers) in the smart living business ecosystem in the Netherlands (Keijzer-Broers & De Reuver, 2016). The interviews focused on why smart living services are not taking off, and encompassed the broad area of services, consumer adoption, technology issues, business models, inter-organizational collaboration and knowledge sharing.

*1 An extensive analysis of the eleven in-depth interviews was published in Keijzer-Broers, W., De Reuver, 2016. "Cooperation and knowledge challenges in realizing smart homes: The case of small installer businesses" Indoor and Built Environment ID IBE-15-0102.R3*

The interviewees were selected from the installer businesses and adjacent parties, had a track record in the field of technological innovations within the home and were active in the health, safety, energy and entertainment domains to cover all aspects of smart living (see table 6). We interviewed mainly decision-makers who are involved in making strategic decisions, as well as four experts from the smart living field.

**Table 6. Eleven in-depth interviews**

| Category | Organization | Job description |
|---|---|---|
| **Installers** | Entron | Director |
| | BAM Techniek | Innovation manager |
| | Hogervorst Elektra | Director |
| | Domutron | Marketing director |
| **Opinion leaders** | TU Eindhoven | Professor |
| | TNO-ICT | Senior researcher |
| | TU Delft / KPN | Professor and strategist |
| | UNETO-VNI | Innovation manager (branch organization) |
| **Manufacturers** | ABB | Marketing manager |
| | Genexis | CEO |
| | Hager-Tehalit | Director Home & Building Solutions |

The interviews were transcribed and imported into Atlas-Ti, a qualitative analysis software tool, which we used to identify relevant concepts, and their properties and dimensions in the domain of smart living. We open coded the transcripts, with the core concepts of the survey in mind (i.e., knowledge and collaboration issues), but also paying attention to other possible explanatory factors that were not mentioned in the survey. In addition, we created code networks to structure the codes, store network views and retrieve codes and quotes at a later stage, which is a commonly accepted approach in qualitative interview analysis, as suggested by Muhr (1991) and Friese (2014).

## 5.1 Problem elicitation

The codes were used to structure the analysis of the mismatch between supply and demand. Because the smart living ecosystem is evolving rapidly, knowledge regarding technological solutions, user needs and business models is crucial for companies wanting to play a major role. Knowledge is a fluid mix of framed experience, values, contextual information and expert insight that provides a framework for evaluating and incorporating

new experiences and information (Baskerville & Dulipovici, 2006). Compared to larger organizations, average knowledge base in small businesses, especially micro-firms, is low (Hutchinson & Quintas, 2008), especially in terms of technical skills, managerial competency and poor marketing skills (Freel, 1999), as well as their absorptive capacity, level of education, staff development, growth orientation and propensity to innovate (Gray, 2006). Typically these skills and capabilities are knowledge-related.
As such, we focused our analysis what was hindering the rollout of smart living services (S), merely related to the Organizational (O) and the Knowledge (K) domain. Codes were hierarchically structured using coding networks. In each network, nodes represent a code, and the numbers between the parentheses represent the number of times each was mentioned in the interviews (N) and the number of links to other codes (M), respectively. Relationships between codes were derived from statements made by interviewees.

### 5.1.1 Organizational domain

With regard to cooperation challenges, the interview results indicate that the main issue is working together with organizations from other sectors (i.e., trans-sectorial collaboration). As figure 9 shows, the challenge of collaboration across sectors was mentioned 23 times during the interviews. Interviewees point to a lack of trans-sectorial collaboration (code O-2.1) and the failure to collaborate in general (O-2.4). There are three main issues that cause the problems in trans-sectorial collaboration: lack of commitment (O-1), lack of trust (O-3) and perceived risks (O-4).

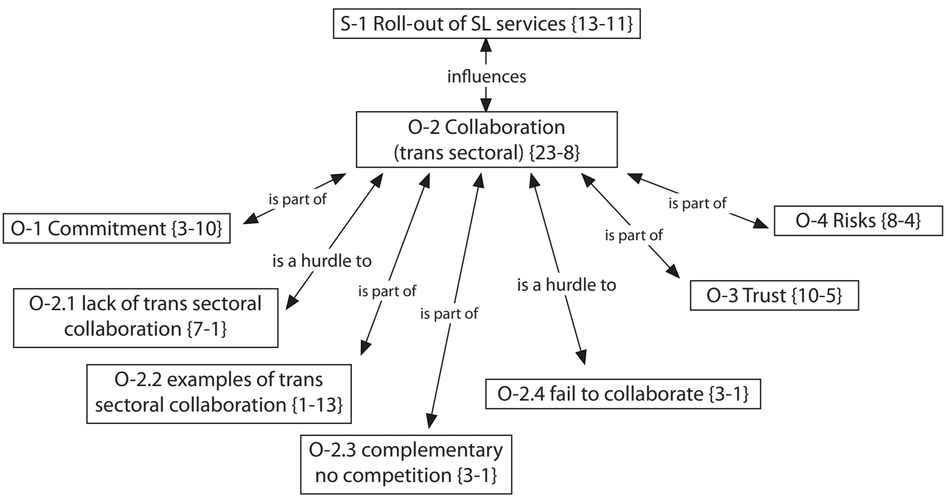



Fig. 9. Cooperation challenges.

Next, we explored cooperation challenges regarding commitment, trust and risks in more detail. At the commitment level (O-1) especially the interdependency of installers, housing corporations and developers (O-1.2) and the conservative construction sector (O-1.6) are seen as bottlenecks (see figure 10).

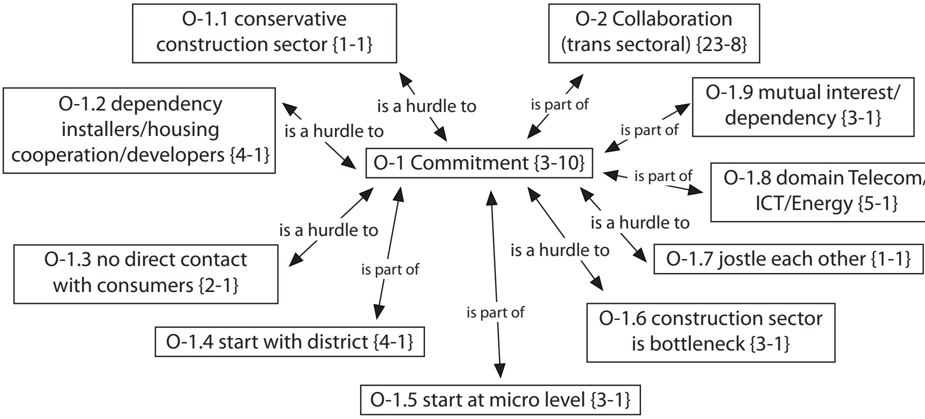



Fig 10. Commitment in the Organizational domain.

According to the most respondents, cooperation will be more rewarding if companies start to collaborate at a micro-level (O-1.5) or at least in their own region (O-1.4). Five interviewees pointed out that there should be more mutual commitment in the Telecom, ICT and Energy sectors (O-1.8) to foster trans-sectorial collaboration in the smart living domain.

At the trust level (O-3), people are scared to share information (O-3.1) and there is a lack of mutual trust (O-3.2). See figure 11.

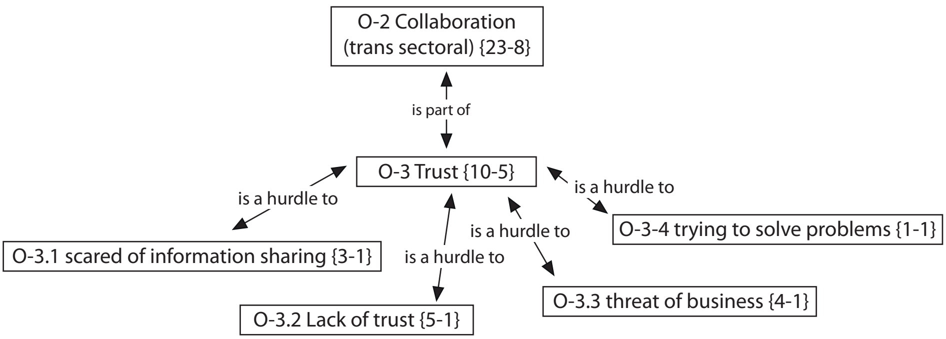



Fig. 11. Trust in the Organizational domain.

Four interviewees mentioned that many parties perceive collaboration as a threat of their business (O-3.1) and that they are afraid of losing their competitive advantage if they collaborate, but as one of the interviewees stated: *'firms that are afraid of sharing knowledge, slow down the innovations in the smart living business'* and *'cross-overs will increase your competitive advantage on the market.'* At the risk level (O-4), competition (O-4.1) and a failure to collaborate with reliable third parties in the first place (O-2.4) are the most frequently mentioned topics (see figure 12).

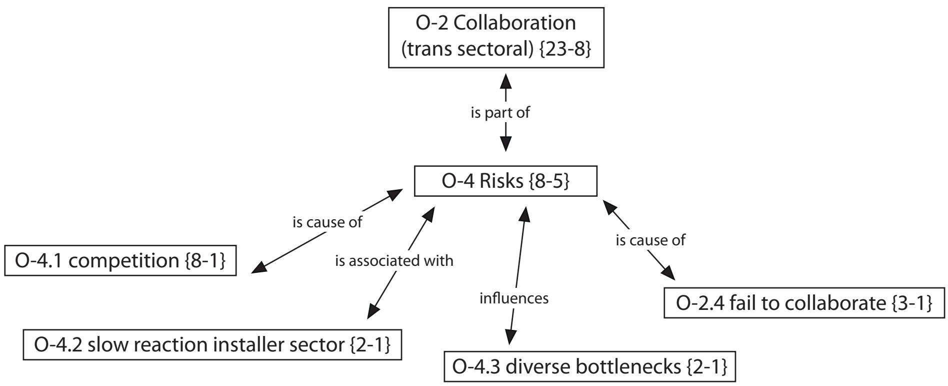



Fig. 12. Risks in the Organizational domain.

With regard to cooperation, the interviewees consistently mentioned the need to collaborate across different sectors, indicating that the lack of collaboration is the main reason that smart living services do not make it into the mass market, yet. Interviewees argue that installers should consider long-term strategic cooperation and commitment to reliable partners within and beyond their own industry. One interviewee stated: *'Collaboration costs money first, after a number of projects you reach the break-even point and then you can start to earn money'* and *'Collaboration is not a secondary priority.'* Another respondent noted that installers offering complementary services should not view each other as competitors: *'everything is based on mutual trust. As long as companies do not see smart living as a common interest, trans-sectorial collaboration is a utopia.'* Several interviewees emphasized the pivotal role installers play in reaching the end-user. As one manufacturer argued: *'It is a paradox: we supply components and hope that someone else can provide a system or a concept'* and *'a leading position is available for installers and innovative parties that do not necessarily operate on a national scale.'*

Interviewees suggested various forms of existing cooperation strategies. For instance, a regional party that serves as a service broker could mediate between installers and end-users. Alternatively, government agencies and policy-makers could stimulate cooperation in the ecosystem.

Within the organizational domain, overall, we found that small installer businesses face cooperation challenges, resulting from a lack of trust, lack of commitment and perceived risks of collaboration.

### 5.1.2 Knowledge domain

With regard to knowledge-related challenges, the findings suggest that small installer businesses generally lack the skills to bring smart living concepts to the market. Figure 13 shows that a lack of sales skills (K-1.6), the conservative environment (K-1.4) and a lack of pro-active installers (K-1.3) were indicated as being the main hurdles to implementing smart living services. Respondents argue that installers focus too much on technology, while commercial and marketing skills are lacking. The construction sector is seen as a conservative sector (K-1.4) that persists in traditional system concepts. Generally speaking, installers are not proactive when it comes to developing new knowledge and business opportunities (K-1.3). As the interviewees put it: *'Technology is still leading and installers are not pro-active in exploiting their sales skills'* and *'technology is not core, it is the effect of the technology that you sell to your customer.'*

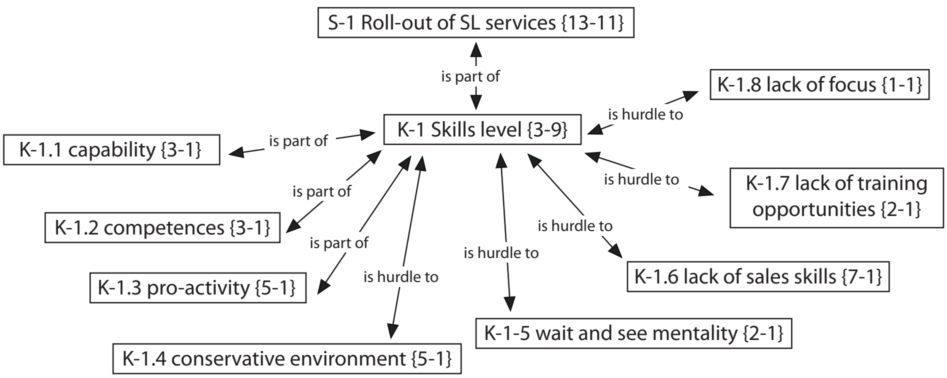



Fig. 13. Overall skills as part of the knowledge domain.

The analysis reveals several reasons why small installer businesses lack knowledge regarding smart living concepts. In addition, a lack of commercial skills and a tendency to focus on technologies, the conservative environment and lack of proactive nature are main reasons why installers fail to get access to knowledge and information. Knowledge-sharing challenges appear relevant on two levels: among installers themselves and between installers and other stakeholders. As one of the interviewees stated: '*knowledge sharing is required on different levels to raise awareness about reliable smart living products*'. With regard to knowledge-sharing among installers, interviewees point to a lack of information transfer (K-3.1) and knowledge transfer (K-3.3). Furthermore, there is hardly any knowledge-sharing taking place between installers (K-3.4). See figure 14.

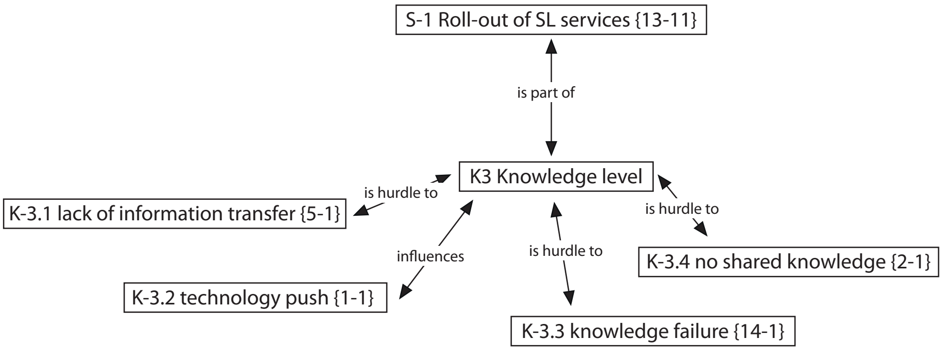



Fig. 14. Knowledge level as part of the knowledge domain.

As far as knowledge-sharing between installers and other stakeholders is concerned, interviewees refer in particular to the lack of awareness about smart living for end-users (K-2.9) and the need to elicit end-user requirements (K-2.10). They argued in favor of using different types of media and platforms to disseminate knowledge regarding smart living (K-2.2), which could also be used by the government or branch organizations (K-2.4). According to the interviewees, sharing knowledge across industries in the smart living domain could be facilitated by a platform for information and knowledge transfer (K-2.6) or an online database (K-2.5), see figure 15. As the interviewees stated: '*an information platform where products and services in the smart living domain are discussed between peers would be a helpful tool to gather knowledge*', '*we need an information platform to exchange ideas, combined with a database for reliable smart living products*' and '*there is an urgent need for a one-stop-shop within the smart living domain, accessible for providers as well as end-users.*'

Overall, there are challenges with regard to knowledge-sharing in many aspects in installer businesses, where little knowledge and information on smart living is being shared. When we look beyond the construction sector, we see that awareness about smart

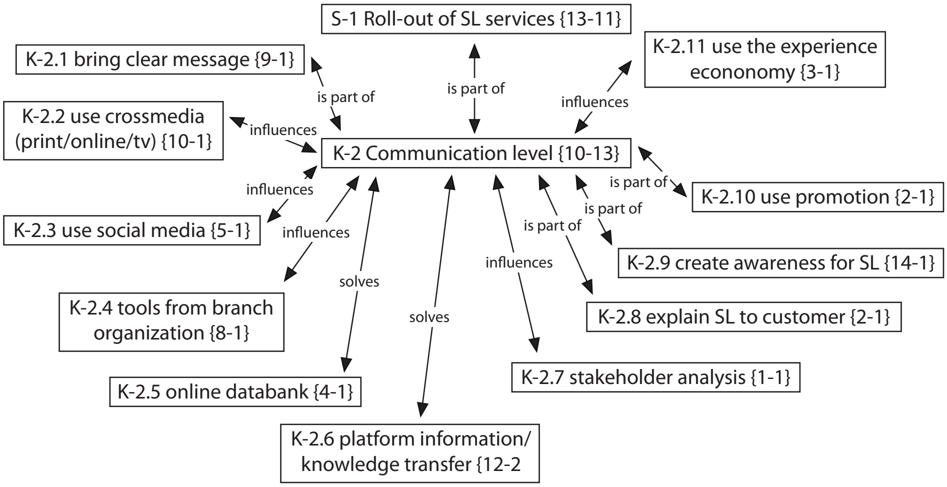



Fig. 15. Communication skills as part of the knowledge domain.

living involving end-users and other stakeholders is limited. The interviewees pointed out that shared service platforms and online databases about smart living are lacking.

### 5.1.3 Analysis

One of the main patterns in the findings is that, most of the time, small installer companies are not involved in providing smart living services. With the exception of a few innovative companies, most installer companies lack the technical as well as commercial skills to implement smart living services in the home. In addition, installers are conservative and persist in offering traditional systems and they keep focusing on technology, rather than on user experience, which prevents them from offering innovative concepts such as managed IT and integrated services or service bundles.

The lack of knowledge about the smart living domain and the low level of information transfer are currently seen as the main hurdles in terms of the rollout of smart living services, obstructing the end-user awareness and acceptance of technological innovations in and around the home. The installers and manufacturers we interviewed opt in favor of a digital service platform to ensure that the transfer of information throughout the supply chain would be unambiguous and consumers are able to choose the right products for the right purpose. Bottom-up sharing of knowledge and cooperation between small businesses may help them to establish a firm joint position, in relation to players in other industry sectors (business to business - b2b). On the other hand, such service-oriented b2b platforms may be more suitable for specialized system integrators or service brokers that can design innovative concepts with knowledge-intensive products and systems and customize solutions based on end-user demand.

Despite these challenges, the position of installer businesses could potentially be highly strategic. As described in section 3.1.2, smart living concepts have not yet reached the mass market, largely due to a lack of demand. To bridge the gap between the technology and end-user demand, installers could exploit their intermediary role more by focusing on solutions instead of the technology. If they manage to overcome the challenges involving cooperation and knowledge, this attitude could actually strengthen their relationship with end-users.

The survey and interviews revealed a number of possible reasons why small business installers struggle with their contribution to accelerate the diffusion of innovative products and services in the smart living market. Their lack of knowledge about the smart living domain and the degree of information transfer are currently seen as reasons why the acceptance of smart living products and services lagging behind. With the exception of the innovative companies, the construction sector as a whole lacks both the technical and commercial skills needed to implement smart living services. In 2013, there was not that much information transfer regarding smart living, so no 'awareness' was created among end-users. Basically, what the sector is missing is a service platform for smart living to: 1) address the mismatch between supply and demand, 2) share knowledge about the domain and 3) acknowledge the expertise and advisory role of experienced installers.

As suggested by the interviewees one of the possible new roles for installers is that of system integrator: integrating knowledge-intensive products and systems suitable to life (custom) solutions in specific housing needs. They design innovative concepts in which the housing needs of the end-user are paramount in terms of safety, care, comfort, communication, energy and entertainment. Since this way of designing and installing is completely different and often requires new knowledge on the part of the installer, including knowledge of programming languages, installers have to broaden their horizon and develop their advisory role in practice with regard to end-user's needs, in particular if they want to operate in the smart living domain.

Although this part of the research focuses on the role of installers in the smart living ecosystem, their position is not unique. When faced with high-tech innovations, many (service) providers in the smart living domain struggle with similar issues, as we will show in section 5.2.

### 5.1.4 Conclusion

Based on the findings, we identified information exchange and awareness as the main problems in the smart living domain. Interviewees suggested exploring a service platform for smart living to 1) address the mismatch between supply and demand, 2) exchange knowledge about the smart living domain, and 3) acknowledge the expertise and advisory role of experienced installers.

The next step is to verify if (service) providers from other disciplines (e.g., ICT, healthcare) face similar issues. To that end, we interviewed 59 new stakeholders from different disciplines to explore the feasibility of the service platform idea on a broader scale. As a result the problem formulation phase is divided into two parts: 'Problem elicitation' (section 5.1) and 'Exploration of feasibility of the suggested platform solution' (see section 5.2).

## 5.2 Exploration of the suggested platform solution

To evaluate the platform solution suggested in the eleven in-depth interviewees, we arranged a second round of semi-structured interviews with various stakeholders, ranging from providers, end-users and local governments to potential funding partners and research fellows[2] . The underlying aim was to explore the possible platform solution to address the mismatch between supply and demand in the smart living domain (Keijzer-Broers, De Reuver, & Guldemond, 2013) but also to collect support from potential stakeholders in solving a societal problem (i.e., aging-in-place) described in section 7.2.

The interviewees were selected from the researcher's network, because they: 1) were affected by the societal problem from an end-user or provider perspective, 2) could potentially support exploration of the platform, 3) could be involved in the jumpstart of the social innovation, and 4) could embed the topic in research or knowledge exchange related issues. We managed to conduct 59 explorative interviews, with 23 strategic level stakeholders (i.e., local governments, funding and research fellows), 17 affiliate level stakeholders (i.e., service and technology providers) and 19 end-users (i.e., informal caretakers and citizens). See table 7. All conversations were transcribed and bundled in a logbook (i.e., Evernote application).

*2 An earlier extensive analysis of the second round of semi-structured interviews was published published in Keijzer-Broers, W., De Reuver, M., & Guldemond, N. (2014). Designing a multi-sided Health and Wellbeing platform: Results of a first design cycle. Paper presented at the ICOST 2014 - Denver*

**Table 7. Second round of semi-structured interviews.**

| Interviewees | Organizations | Amount | Rationale of interview candidate |
|---|---|---|---|
| Strategic level stakeholders | Local governments | 5 | Explore hurdles to support citizens aging-in-place<br><br>Explore launching customers (i.e., platform pilot) |
| | (Funding) partners | 8 | Explore funding options for the platform idea (i.e., platform pilot) |
| | Universities | 5 | Explore research options to embed research topic |
| | Knowledge institutes | 5 | Explore content and research options to embed the research topic |
| Affiliate level stakeholders | Technology Providers (i.e. platform developers) | 5 | Explore feasibility of a service platform (i.e., platform pilot) |
| | Service Providers (i.e., suppliers of smart living services) | 6 | Explore matchmaking with end-users (i.e., smart living) |
| | Product suppliers (i.e., suppliers of smart living products) | 6 | Explore matchmaking with end-users (i.e., smart living) |
| End-users | Citizens age 50 – 75 | 9 | Explore hurdles to age-in-place |
| | Informal caretakers | 10 | Explore hurdles while supporting others to age-in-place |

We started by explaining the practical problem involving the mismatch between supply and demand in the smart living domain to the interviewees and clarified the suggested solution as follows:

*What if a service platform could provoke various experts to be active in the smart living environment? Could such a platform be a spin-off for further developments and accelerate the diffusion process of smart living in the market? And if so, how should such a platform look like?*

In addition, three questions were posed, with some follow-up questions and discussions: *1) What should be the main purpose of a Health and Wellbeing platform, 2) Who would benefit from such a platform, and 3) What are Critical Design Issues when developing such a platform.* The interview transcripts were summarized and clustered into categories based on the type of answers (i.e. each interviewee could provide multiple answers). Table 8 provides the clustered answers of the interviewees and how many times related suggestions are given.

**Table 8. Q and A by interviewees**

**1. What should be the main purpose of a smart living platform?**

| Strategic level stakeholders | Affiliate level stakeholders | End-users |
|---|---|---|
| Information exchange about smart living between (service) providers and end-users (i.e. matchmaking) (9) | Portal (one stop shop) for communication about smart living (7) | Community (i.e. contact, solutions, social wellbeing, marketplace) (10) |
| Inter sectorial knowledge exchange about smart living (7) | Information exchange about smart living between (service) providers and end-users (i.e. matchmaking) (7) | Portal (one-stop shop) for communication about smart living (4) |
| (Health) Intervention instrument to get in contact with citizens about smart living needs (5) | (Health) Intervention instrument to support citizens with smart living services (6) | Help citizens to find smart living services (5) |
| Online community (4) | (Inter sectorial) knowledge exchange about smart living (3) | |
| Portal (one stop shop) for communication about smart living (3) | Online community (2) | |

**2. What is crucial to start a viable smart living platform?**

| Strategic level stakeholders | Affiliate level stakeholders | End-users |
|---|---|---|
| Collaboration between parties (i.e. inter sectorial), (6) | Usability for end-users and service providers (ease of use, fulfilling needs) (6) | Usability (i.e. ease of use, fulfilling needs, practical, accessibility) (17) |
| Business Model (i.e. revenues, investments, viability on the long term) (6) | Get both sides on board and reach critical mass (i.e. end-users and service providers) (5) | Safe to use (i.e., privacy issues) (8) |
| Usability for end-users and service providers (ease of use, fulfilling needs) (5) | Collaboration between parties (i.e. linking data, working together), (6) | Helpdesk available to get familiar with the platform (3) |
| Added value for service providers and end-users (5) | Business Model (i.e. revenues, investments, viability on the long term) (5) | Next to online platform, also provide offline information about gatherings in the neighborhood (3) |
| Get both sides on board and reach critical mass (i.e. end-users and service providers) (4) | Scalability. Start small before rolling out in the Netherlands (3) | Tailor made solutions (i.e. profiling, small scale) (2) |
| Scalability. Start small (i.e. municipality) before rolling out in the Netherlands (1) | | |

| 3. For whom this platform will be beneficial? | | |
|---|---|---|
| **Strategic level stakeholders** | **Affiliate level Stakeholders** | **End-users** |
| Both end-users (i.e. contact/ attention, one-stop shop needs, solutions) and industry (i.e. contact end-user, publicity, turn-over) (11) | Both end-users (i.e., contact/ attention, one-stop shop needs, solutions) and industry (i.e. contact end-user, publicity, turn-over) (13) | Elderly people who want to stay in their own home environment (10) |
| End-users (i.e. citizens/patients/ consumers/ elderly) (10) | End-users (i.e., citizens/ patients/consumers/ elderly) (3) | Citizens (i.e. consumers in general) (8) |
| Industry (turn-over, publicity) (1) | | Patients (4) |

Depending on the type of discussion partner (i.e. strategic and affiliate stakeholders), two additional questions were asked, to gauge the level of interest in the future plans for the platform idea.

| 4. Would you or your organization want to be involved in such a platform? | |
|---|---|
| **Strategic level stakeholders:** | **Affiliate level Stakeholders:** |
| Partner (i.e. enabler, financial, strategic, content) (9) | Partner (i.e. enabler, financial, strategic, content) (7) |
| Research (i.e. PhD, research projects) (7) | Enabler of the platform (i.e. technical, content) (5) |
| Project (i.e. subsidy, advice)(4) | Advertisement on the platform/add words (5) |
| Pilot (i.e. showcase for municipality) (2) | Project (i.e. subsidy, advice) (1) |
| I don't want to be involved (1) | |

| 5. Would you or your organization invest in such a platform (money, in kind or content)? | |
|---|---|
| **Strategic level stakeholders** | **Affiliate level Stakeholders** |
| Invest money in research (8) | Invest money in platform/project (7) |
| Invest money in platform (10) | Advertisement/add words (5) |
| In kind (advice, content) (7) | In kind (advice, content) (1) |
| I don't want to be involved (1) | |

The last two questions (i.e., 4 and 5) provided insight into the potential of the platform and the willingness on the part of the interviewees to be involved in future plans. Looking at the reactions of the interviewees, the potential of the platform seemed promising, at least promising enough to carry on with the digital service platform idea.

### 5.2.1 Stakeholder analysis

The analysis of the stakeholder interviews can be seen as a starting point in addressing the practical gap between (product and service) providers and end-users in the smart living domain to design a smart living platform.

The *strategic level stakeholders* mainly argued how a service platform for smart living could add value to different stakeholders (e.g. BM, revenues, investment), the organization of such a platform (i.e., collaboration with third parties) and how to get both sides (i.e., service providers and end-users) on board.

The interviewees from local governments suggested if and how a platform could support the intervention role from municipalities involving the health and wellbeing of citizens. They referred to new regulations in the Netherlands where municipalities take the lead in providing care to citizens. As such, the government stakeholders were interested in a smart living platform that could help them with their intervention task.

The *affiliate level stakeholders* raised issues about the viability of the platform and how to reach critical mass (i.e., to find a sufficient number of adopters of the platform, to support further growth). They were skeptical about cooperation between different parties and the willingness to link their content to the databases of other providers. On the other hand, the affiliate level stakeholders showed an interest in the smart living platform idea as a possible solution to solve the supply and demand mismatch in this domain.

The *end-users* mentioned more practical issues, like how you to access the platform (i.e. safety and privacy issues), whether the online platform combines online functionalities with offline activities, which skills are needed to navigate the platform and, last but not least, how easy it would be to use such a platform.

Core suggestions made by the three stakeholder groups, reflected: 1) the need of a practical and easy-to use solution that could help people age-in-place while using smart living products and services, 2) the opportunities for a one-stop shop to communicate about smart living to enhance the quality of life of citizens, and 3) the need to start with a small (local) but scalable service platform.

### 5.2.2 Main purpose of the platform

The question 1: *what should be the main purpose of the platform?* yielded four main clusters of answers (see figure 16).

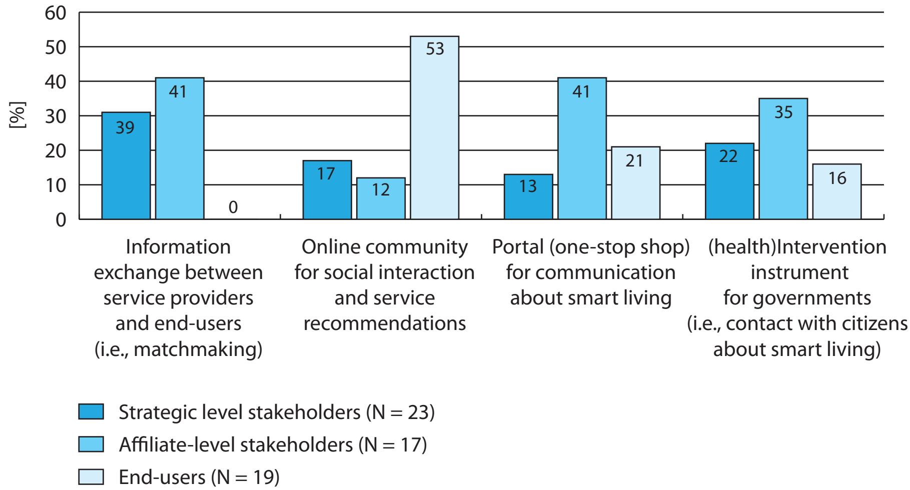



Fig. 16. Main purpose of the platform according to interviewees.

Most frequently mentioned functions are **information exchange** between providers and end-users. This was mentioned especially by the strategic and affiliate stakeholders, but interestingly enough not by end-users themselves. In addition to exchanging information about services and products, interviewees pointed out that matching end-user needs and services automatically, would certainly add value. Affiliate stakeholders were mainly interested in communicating their offerings to potential user groups (i.e., b2c), rather than communicating about smart living at a provider level (i.e., b2b). An **online community** for social interaction was often mentioned by end-users. Such a community should 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 mentioned often as well. Such a portal would be a marketplace for solutions and a 'one-stop shop' to access products and services. A feature that was mentioned less often was an **intervention instrument** for the municipality to contact citizens about needs for services and questions about healthcare legislations. However, all five interviewees from the local governments suggested this feature, which confirms that as early as in 2013 they were aware of their role in relation to the health and wellbeing of citizens.

### 5.2.3 Platform users

To question 2: *who would benefit from the platform*, the strategic and affiliate stakeholders agree that the platform should be beneficial to both end-users and the industry. The platform could function as a 'one-stop shop' for smart living needs and solutions, but also as an intermediary between the industry and end-users. The governmental interviewees argued that the platform should mainly be beneficial to end-users, like citizens in general, patients and elderly. End-users were more specific about the target group and argued that the platform would be most beneficial for elderly people who want to stay in their own home environment (i.e., aging-in-place), citizens in general, informal caretakers and patients with chronic conditions or impairments.

### 5.2.4 Critical Design Issues to develop a platform

To question 3: *what are Critical Design Issues when developing such a platform*, the stakeholder groups had different opinions (See figure 17).

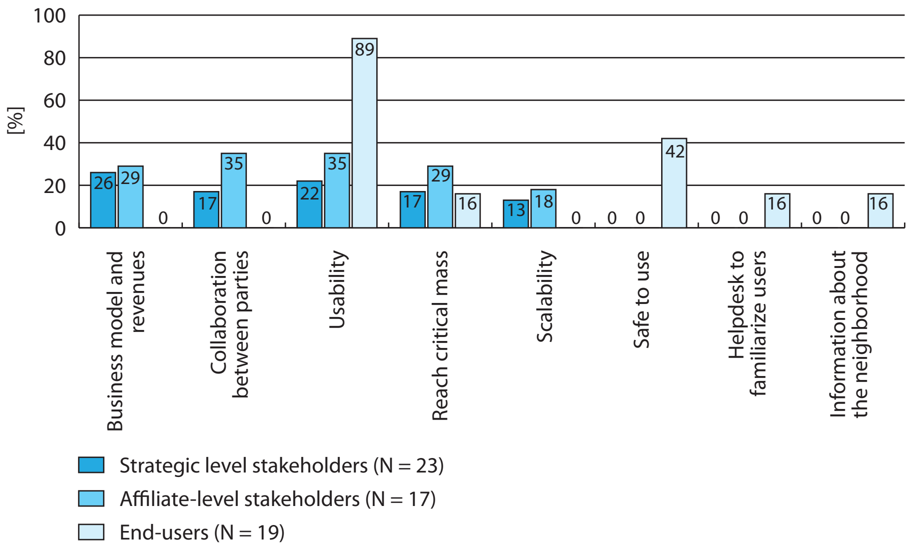



Fig. 17. Critical Design Issues for developing a Health and Wellbeing platform.

The strategic level stakeholders were mainly concerned with how a smart living service platform could add value to different stakeholders, i.e. what would be sustainable **business models and** how to achieve **revenues**. They were concerned with how to organize such a platform (i.e., **collaboration between parties**) and how to reach a **'critical mass'** (i.e., a sufficient number of adopters of the platform, to support further growth). This group paid less attention to the **usability** of the platform, although they mentioned that easy access to the platform through multiple devices is required. The affiliate stakeholders raised issues about the **usability** for the consumers of such a platform and how to reach critical mass. They were skeptical about the **revenues** and **collaboration between different** parties, especially because of competitive considerations (i.e., linking content with databases, free-riding issues). On the other hand they expected such a platform could to help them reach customers in the domain. The strategic level and affiliate stakeholders preferred a **local** (i.e., postal code-based) but **scalable** platform, starting on a micro-scale before rolling out on a national level. The end-users had more concerns about practical issues, like the **usability** of the platform (i.e., ease of use, full filling needs, practical, accessible), **safety and privacy** (i.e., trustworthiness), whether the online platform combines online with offline information, especially in their own neighborhood (e.g., information about gatherings and activities), and finally, if there would be a **helpdesk** available on the platform.

### 5.2.5 Requirements and assumptions

As a next step, the first platform suggestions from both rounds of qualitative research (i.e., 70 interviews) are translated into three main types of requirements, in line with Verschuren and Hartog (2005):

A. Functional requirements [$R_f$] indicate the functions that, given the goal, the service platform should fulfill or enable to perform once it is realized.
B. Users requirements ($R_u$] will be fulfilled on behalf of the future users of the platform.
C. Contextual requirements [$R_c$] are prerequisites and are set by the political, economical, legal and social environment.

The functional requirements should describe the functions of the IT artifact and stem from the *first hunch* of the platform, the phase in which the initial idea of the design has been formed. In the design requirement phase, there have been multiple internal discussions between the Action Design Researcher, research assistants and the Expert Team, to cluster the suggestions from the interviewees into functional, user-related and contextual requirements. See table 9.

| **Table 9. Requirements for the platform** | |
|---|---|
| **Id** | **Functional Requirements** |
| **$R_f1$** | The platform should provide information exchange between (service) providers and end-users (i.e., matchmaking) |
| **$R_f2$** | The platform should provide an online community for social interaction and service recommendations |
| **$R_f3$** | The platform should provide a portal (one-stop shop) for communication about smart living |
| **$R_f4$** | The platform should provide a (health) intervention instrument for local governments (i.e., contact with citizens about smart living needs) |
| **Id** | **User Requirements:** |
| **$R_u1$** | The platform should provide local information (i.e., matchmaking products and services, local activities and contacts) |
| **$R_u2$** | The platform should be easy accessible (low entry barrier) |
| **$R_u3$** | The platform should be perceived reliable |
| **$R_u4$** | The platform should be perceived as useful for local governments, end-users and providers |
| **$R_u5$** | The platform should be perceived as being easy to use by local governments, end-users and providers |
| **$R_u6$** | The platform should be perceived as having high levels of privacy protection |
| **Id** | **Contextual Requirements** |
| **$R_c1$** | The platform should support people to age-in-place |
| **$R_c2$** | The platform should match supply and demand for smart living products and services (i.e., Health and Wellbeing) |
| **$R_c3$** | The platform should add value for local governments, providers and end-users (i.e., revenues, information) |
| **$R_c4$** | The platform should start in a local setting but should be scalable |

When defining the requirements, also numerous assumptions about those qualities that the users and the context should possess to turn the IT artifact into a success. These assumptions are created by the ADR Researcher to check the feasibility and credibility of the IT artifact. The three main types of assumptions that are distinguished are:

A. Functional assumptions [$A_f$] are related to the problem, which the IT artifact solves.
B. Users assumptions ($A_u$] indicate what qualities the users of the platform should have to make a fruitful use possible.
C. Contextual assumptions [$A_c$] indicate what the political, economical, legal and social environment looks like.

As Verschuren and Hartog (2005) explain, the credibility and acceptance of the assumptions need to be verified. As this was done in an iterative and sometimes implicit way throughout the whole ADR process, they are listed according to functional, user-related and contextual assumptions and evaluated in different parts of this dissertation.

| Table 10. Assumptions about the platform ingredients according to the ADR researcher | | |
|---|---|---|
| **Id** | **Functional Assumptions** | **Validation** |
| **$A_f1$** | Smart living services have not reached the diffusion phase and did not reach the mass market | Chapter 3 |
| **$A_f2$** | The lack of knowledge transfer and fragmented availability of information about smart living services makes it difficult to create 'awareness' among end-users | Chapter 5 |
| **$A_f3$** | Supporting people is a heavy burden for informal caretakers | Chapter 3 |
| **Id** | **User Assumptions** | **Validation** |
| **$A_u1$** | Users need digital skills to handle a digital device | Chapter 9 |
| **$A_u2$** | Users have to be able to understand the platform functionalities | Chapter 9 |
| **Id** | **Contextual Assumptions** | **Validation** |
| **$A_u1$** | New legislations require solidarity (not just financially) from society. | Chapter 3 |
| **$A_u2$** | End-users will increasingly be expected to find health and wellbeing services themselves | Chapter 3 |
| **$A_u3$** | Citizens have to age-in-place according to new legislation | Chapter 3 |

The requirements and assumptions are not developed at once, but shaped during the development and use of the platform. In Chapter 6, the refinement of the requirements is described.

## 5.3 Analysis Problem Formulation phase

The Problem Formulation phase elicited four main features of a platform for Health and Wellbeing: 1) information exchange, 2) online community, 3) portal and 4) (health) intervention instrument (see figure 18). Verschuren and Hartog (2005) call this the first hunch and initiative for constructing a new IT artifact. This phase should lead to a small set of goals for the future IT artifact. It also illustrates the multifaceted nature of platforms and the diversity of features they may support. Importantly, we show that different stakeholder groups emphasize different platform features as their core focus. By showing potential platform features and indicating the Critical Design Issues in the design of such a service platform, this study contributes to the design knowledge of digital service platforms. During the alternating discussion cycles about smart living, the input from different angles leads to a general first idea (proposal) about a new IT artifact that can be applied in the smart living domain: the development of a smart living platform that supports matchmaking between different stakeholder groups, a socio-technical platform to create, retain, transfer and exchange information in the smart living domain, to enable end-users to age-in-place.

As described in section 5.2 we started our research in 2013 from a business-to- business (i.e., b2b) perspective, to examine why smart living services were not taking off. As such, the survey and the first eleven interviews encompassed the broad area of smart living services, consumer adoption, technology issues, business models, inter-organizational collaboration and knowledge sharing from the perspective of intermediary businesses between end-users and smart living providers (i.e., small installer business). However, when we evaluated the initial platform idea in 59 follow-up interviews, the purpose of the multisided service platform shifted towards the customer side. Interviewees suggested an information exchange and a portal (business-to-consumer – b2c), an online community (consumer-to-consumer - c2c) and a health intervention instrument (government-to-consumer - g2c) as a purpose of the smart living service platform. Consequently, we decided to focus our research on the end-user on the customer side and study the service platform from a b2c, c2c and g2c perspective. See figure 18.

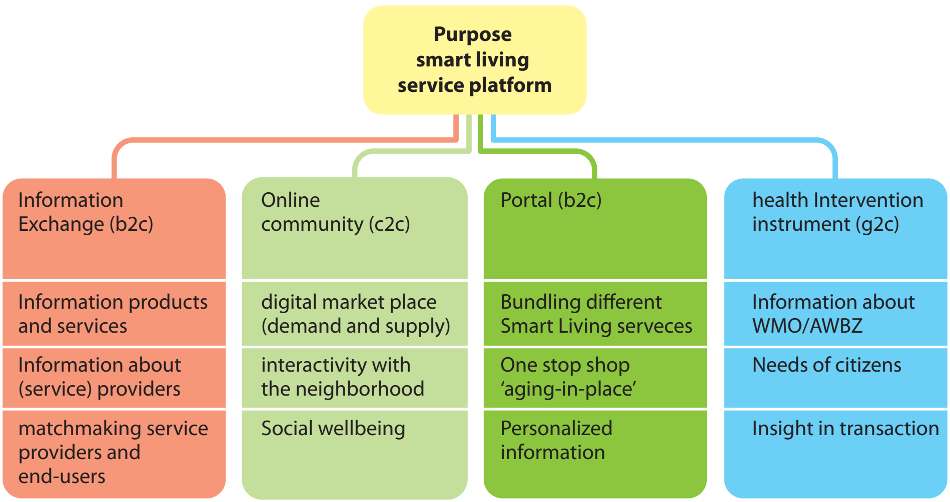



Fig. 18. Tree diagram first general idea about the smart living service platform.

According to the interviewees, the main purpose of the Health and Wellbeing platform should be to provide: 1) an **information exchange platform** between providers and end-users (business-to-consumer), driven by the need for matchmaking between service providers and end-users, 2) an **online community** for contact, solutions, social wellbeing and interaction with the neighborhood, and a digital marketplace for applications (consumer-to-consumer). The need for this functionality is driven by the need for social cohesion, and 3) a **portal** for bundled services and solutions (business-to-consumer), driven by the one-stop shop philosophy for aging-in-place, where end-users can find all the relevant applications in the smart living domain (i.e., health and wellbeing products and services), but also can create a personal profile, and 4) an **intervention instrument** for the municipality (government-to-consumer) to get in contact with citizens about needs for services and questions about healthcare legislations (i.e., AWBZ, WMO legislations), debt restructuring, advice and support.

Although it is not clear yet whether or not all features elicited by the interviewees will be included in one and the same platform, it is a feasible option to combine suggestions to create, retain, transfer and exchange information in the smart living domain. Ultimately, such a platform should 1) enable end-users to enhance their quality of life, and 2) support matchmaking between different stakeholders. While end-users stress the social and communication elements of a smart living service platform, providers focus on the information exchange and transaction features. To attain a critical mass of providers as well as end-users, the platform should thus integrate the communication, information and transaction features. Another potential tension is caused by the focus of the local government. The changed regulations on healthcare in the Netherlands (from 2015 onwards, see section 3.2.2) have led to a narrower focus of government stakeholders on tools that support the regulatory transition. The results indicate that such a narrow focus may not be acceptable by the more commercial providers and end-users.

Strategic and affiliate stakeholders and end-users stress different design issues, which warrants the most attention when designing the platform. To a large extent, these differences can be explained through the interests and objectives of these stakeholder groups. However, the findings do suggest that, to develop a viable smart living platform, a variety of design issues have to be taken into account.

Our results illustrate the multiplicity requirements for platform functions, ranging from basic information exchange towards active recommendations for services and matchmaking, and from pure focus on transactions towards communication among users on one side of the platform.

## 5.4 Conclusion Problem Formulation phase

As discussed in section 5.2.1, one of the first outcomes of our research was that end-users have a lack of awareness of what smart living services are available and how these services could meet their needs. The highly fragmented market makes it difficult to find the right services, and the predominantly technological focus of service providers makes it hard for them to understand how services meet end-user needs. Especially people in need of healthcare services go through different stages in the progression of their disease or impairment, which means that their need for healthcare interventions at home changes over time, and end-users are often unaware as to what services they could use at a certain point in time. At the same time, product and service providers in the smart living domain find it difficult to reach end-users and to commercialize and promote their products and services. Another reason why the awareness process in the smart living area is complex is the large number of stakeholder groups involved (e.g., product and service providers, manufacturers, facilitators and end-users, etc.). Creating awareness is particular difficult in light of the complex interaction between the different stakeholders with regard to 1) the cooperation between the many key actors that in some way are involved in this domain, 2) the number of services and products, 3) the diversity of service providers from different sectors who focus on the house (i.e., Health, ICT, Building and Energy), and 4) a lack of integrated systems. This means that information sharing and collaboration in the smart living domain have to be encouraged, keeping in mind that the actors involved are from different sectors.

Technological innovations in and around the house are part of smart living and can play a role in solving societal questions, such as energy efficiency, cost savings in healthcare, sustainability and safety, but also the increased convenience needs of citizens. This by achieving the demand sets of citizens to: 1) increase their independency, autonomy and aging-in-place, 2) help them to break with social isolation, 3) provide comfort needs (i.e., cocooning and comfort) and 4) use the home as energy generator (i.e., self-supporting). In the opinion of citizens, the home environment has to be sustainable over time, it has to provide comfort, use energy responsibly and provide them with access to the world.

While the focus of the first eleven interviews was on eliciting problems in the smart living domain, the 59 follow-up interviews looked at possible solutions from a stakeholder perspective and extracted the first requirements, which should be included in the service platform, clustered as: for profit products and services (i.e., domestic, health and wellbeing); a marketplace for non-profit products and services (i.e., exchange or local supply and demand); contact with others (e.g. friends, family, neighbors and end-user groups); the integration of existing platforms for health and wellbeing (i.e., local and national) and information about local activities.

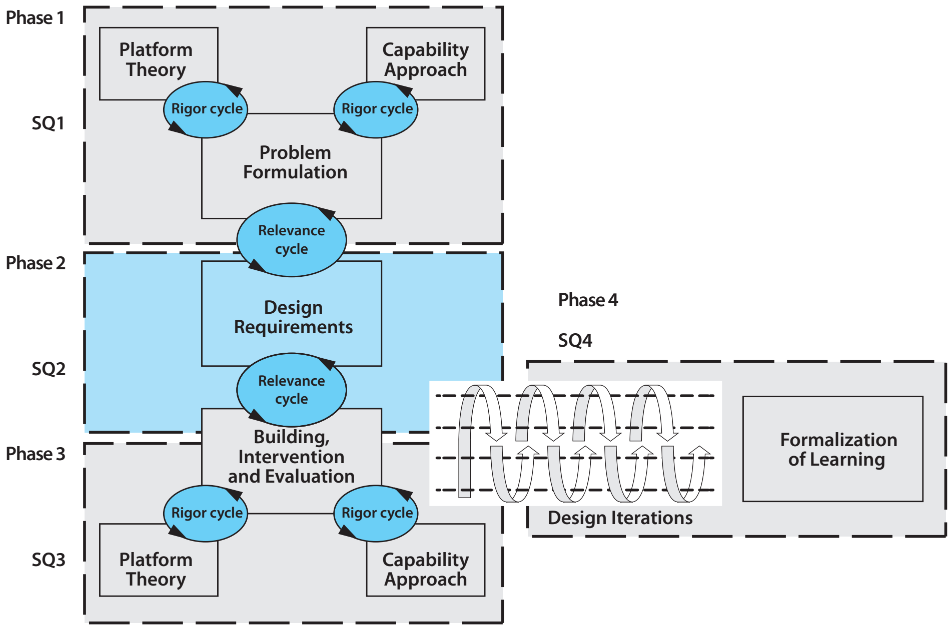
Based on all 70 interviews, we assume that a smart living service platform with a focus on health and wellbeing could persuade various experts to become active in the smart living environment and, at the same time, such a platform could accelerate the diffusion process of applications in the smart living domain with a focus on health and wellbeing. Therefore, we propose a smart living service platform with a focus on Health and Wellbeing to create awareness among end-users as to which products, services and technologies can help them age-in-place; satisfy the requirements of end-users, service-providers and local governments; and assist in matchmaking between (latent) needs and (yet unknown) services.

If we look at the initial idea for a service platform, we see that it requires the collaboration of (product and service) providers in multiple sectors, to contribute the resources required and to find catalyst innovators to start and accelerate a catalytic reaction. To persuade different groups to get on board, at the same time, to create value in a service platform, is a challenge. Moreover, issues such as access methods, information storage, and the control and protection of data, as well as user-adoption, are important topics. In addition to privacy and security, business models and pricing strategy, as well as the technical characteristics of the platform provide further challenges, which we discuss in the next chapters.

An overview of the various research activities we conducted in the Problem Formulation phase is presented in table 11.

| **Table 11. Research phase 1: Problem Formulation** | |
|---|---|
| **Research input** | Societal problem: aging population<br>(Chapter 1 and 3) |
| **Research throughput** | 11 in depth interviews (section 5.1)<br>59 semi-structured interviews (section 5.2) |
| **Research output** | Initial requirements and assumptions (section 5.3)<br>Four main platform features: (1) information exchange, (2) online community, (3) portal, (4) health intervention instrument |

# 6. Research phase 2: Design Requirements




Research phase 2: Design Requirements

To design and prototype a service platform that enables people to age-in-place, the design requirements need to be set up accordingly. According to Verschuren and Hartog (2005), the design requirements consist of functional, user and context requirements. Because our research was carried out in an Action Design Research context, the requirements were shaped during the design and development of the IT artifact (Sein et al., 2011), which means that they were not developed at once. The same applies to the assumptions, which, according to Verschuren and Hartog (2005), also consists of functional, user and contextual assumptions. The requirements and assumptions are discussed a number of times (inside and outside the Living Lab) in what be regarded as a non-linear process.

This chapter[1] answers the second sub-question (SQ2), which identifies functional and non-functional requirements for the platform to support the different stakeholders.

*1 An earlier extensive analysis of the requirement elicitation is published in Keijzer-Broers, W., Nikayin, F., & De Reuver, M. (2014). Main requirements of a Health and Wellbeing Platform: findings from four focus group discussions. Paper presented at ACIS 2014, Auckland.*

***SQ 2. What are the main design requirements for a service platform for Health and Wellbeing that supports three different stakeholder groups (i.e., end-users, service providers and local governments) in related to aging-in-place?***

Therefore, the main focus in presenting the requirements and assumptions stated by Gregor (2006) is to show the design science development process, resulting in a small set of goals [G] to be realized with the designed platform.

Based on the Problem Formulation phase (Chapter 5) the three design goals [G] are:

[G.1] Create awareness among end-users as to which products, services and technologies can help them age-in-place. The platform supports the exchange of information and knowledge regarding smart living, with the aim of creating awareness among citizens (i.e., end-users)

[G.2] Satisfy the requirements of end-users, service-providers and local governments. The platform supports the development and description of standard processes around value exchange, information exchange and physical processes, as well as communicating about it.

[G.3] Support the matchmaking process between (latent) needs and (as yet unknown) services. The platform brings relevant stakeholders together to allow for the emergence of collective action in the smart living domain, with an emphasis on interconnection.

## 6.1 Focus groups

To evaluate the Problem Formulation phase and explore the suggested platform requirements mentioned by the interviewees (Chapter 5), we used four focus group meetings, with a total of 28 participants, as an iterative step in our design cycle. Focus groups can be viewed as an exploratory research method (Milena, Dainora, & Alin, 2008) designed to gather additional information in addition to quantitative data collection methods. As explained in section 2.1 we used mixed data collection methods within our study (i.e., interviews, focus groups, and surveys) to increase the validity of the findings (Creswell & Clark, 2007). Although focus groups can be regarded as a qualitative data-collection method, we enriched the focus group sessions with questionnaires to generate in-depth discussions about the platform requirements derived from the interviews, as well as improve the efficiency of the sessions (i.e., time-management). See section 6.1.4.

We can define a focus group as '*a carefully planned discussion, designed to obtain perceptions on a defined area of interest in a permissive, non-threatening environment*' (Krueger, 1994, p. 6). 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 group interaction (McGraw & Seele, 1988).

To elicit and specify requirements, we used multiple experts in a group setting, as a tool for knowledge acquisition. Potential advantages of this approach over individual sessions are that groups can 1) provide a broader range of skills and knowledge, 2) provide more effective divisions of labor, and 3) legitimize a result (Massey & Wallace, 1991; Caplan, 1990). Therefore, focus group interviews allow groups of individuals to present and discuss problems and different solutions to predefined problems under the guidance of a moderator (Caplan, 1990). To do so, the groups need to be large enough to generate rich discussion, while the moderator's goal is to generate as many ideas and opinions as possible from as many different people in the allotted time. 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 & Vreede, 2000). However, a disadvantage of a focus group is that participants may be hesitant to express their thoughts if they think it opposes the views of other participants. In addition, group influences can have an inhibitory effects, like social desirability bias (Evers, 2007). To prevent this, the participants completed a questionnaire, prior to every topic in the group discussion, using a 7-point Likert scale. See section 6.1.4.

In this study, we used the focus group method to validate the basic platform features from the Problem Formulation phase of the design cycle, and to validate the platform's initial functional and non-functional requirements. An explicit goal of the sessions was to evaluate and prioritize the four identified features (i.e., online community, information exchange platform, portal and intervention instrument) of the smart living platform as identified in the stakeholder interviews (see section 5.4), to shape the tentative design of the platform. The outcomes of the focus groups were subsequently used as input for a survey with different end-user groups (e.g., elderly people and informal caretakers). See Chapter 7.

### *6.1.1. Selection focus group participants*

We arranged four focus group meetings, divided into pre-selected sessions (i.e., 1a and 2a) and more opportunity driven sessions with healthcare experts (i.e., 1b and 2b). See table 12.

| **Table 12. four focus group meetings** | | | |
|---|---|---|---|
| **Focus group 1a** | | | |
| **Participant** | **gender** | **role** | **age** |
| **1** | F | Administrator healthcare organization 'Arts en Zorg' | 45+ |
| **2** | F | Director Informal caretakers SWMD | 40+ |
| **3** | F | Project leader Informal caretakers/volunteers 'Tympaan' | 40+ |
| **4** | M | Retired/potential end-user | 65+ |
| **5** | M | General Practitioner | 60+ |
| **6** | M | Consultant and advisor government | 60+ |
| **7** | M | Strategist KPN/advisor 'good life' | 55+ |
| **Focus group 1b** | | | |
| **Participant** | **gender** | **role** | **age** |
| **8** | M | Senior manager Age-UK | 50+ |
| **9** | M | Director Health and Design Institute – UK | 50+ |
| **10** | F | Senior manager Coventry University – UK | 30+ |
| **11** | F | Lecturer Coventry University – UK | 40+ |
| **12** | F | PhD Researcher University of Applied Science NL | 30+ |
| **Focus group 2a** | | | |
| **Participant** | **gender** | **role** | **age** |
| **13** | M | Retired (emeritus professor) | 65+ |
| **14** | M | Financial consultant | 60+ |
| **15** | M | Senior consultant ICT | 35+ |
| **16** | M | Director Homecare organization | 45+ |
| **17** | M | Retired (engineer) | 65+ |
| **18** | M | Retired (lecturer) | 65+ |
| **19** | F | Healthcare and Horeca professional | 50+ |
| **20** | F | Care and nutrition professional | 50+ |

| Focus group 2b | | | |
|---|---|---|---|
| **Participant** | **gender** | **role** | **age** |
| **21** | M | Manager Elderly projects– NL | 60+ |
| **22** | M | Manager Mextal/ Viedome – NL | 55 + |
| **23** | M | Director HOIP – UK | 55+ |
| **24** | M | Consultant Actimage – LUX | 25+ |
| **25** | M | Project manager IROM – RO | 55+ |
| **26** | M | Project manager TP Vision – NL | 30+ |
| **27** | M | Consultant Singular Logic – RO | 30+ |
| **28** | M | Consultant BRE – UK | 50+ |

The rationale behind those two rounds is to obtain input from a broad range of potential end-users (i.e., practitioners, researchers and end-users) who 1) are in different stages of their lives (i.e., 25 until 70 years old), 2) have no particular health conditions, 3) are familiar with health and wellbeing as a topic, either as part of their profession or as (informal) caretaker, and 4) represent one of the three archetypes of potential platform users (i.e., end-user, care provider and government).

The candidates of focus group *1a* were pre-selected based on gender, education level, background and age group and were representatives of the three stakeholder groups (i.e., end-users, providers and government). The candidates of focus group *1b* were not pre-selected, but are all healthcare professionals (both business and academia) from the UK and the Netherlands and were participating in a workshop during an exchange meeting between the two countries. They are familiar with the aging population from a practical and a research point of view. The candidates of focus group *2a* were again pre-selected, with a focus on potential end-users of the platform (i.e., young elderly 55 – 75 and/or informal caretakers). The candidates of focus group *2b* were project partners from a European Ambient Assistant Living (AAL) project (i.e., Care@Home) from different countries (UK, Romania, Luxembourg, the Netherlands) and are all working as intermediaries in the healthcare sector (i.e., ICT enablers, technical healthcare system providers and consultants). By including participants from countries outside of the Netherlands, we were able to discuss the aging population in other Western countries, to generate as much ideas as possible related to aging populations.

### *6.1.2 Personas*

During the focus group sessions we used 'personas' as a design tool, to figure out if we really understood the potential customers of the platform. The personas helped us make decisions during the study and they changed over time with the maturity of the project.

A persona is an archetypal representation of a user and can be seen as a vivid description of a potential platform user (Long, 2009). Designers have been using the idea, which was first proposed by Cooper (1999), to improve their user experience. Together with the Expert Team (Chapter 2) the ADR researcher created eight personas as part of four user archetypes (see table 13), which on the one hand represent the elderly people, and on the other hand, the stakeholders who surrounding them (i.e., informal caretakers, service providers and government).

**Table 13. Four archetype descriptions, which encompasses the Personas.**

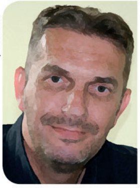
| Type | Description |
|---|---|
| **Elderly people** | Divided into young elderly (55 – 75 years old) and people above 75 |
| **Informal caretakers** | People who support other people |
| **Service providers** | Delivering products and services for Health and Wellbeing |
| **Representatives of local government** | Working at the local government and supporting citizens with Health and Wellbeing issues |

The underlying reason for using this design tool was that personas: 1) as fictional characters could serve as a reminder of who our intended users are, and 2) could function as a vehicle for engagement and to communicate more than design decisions to designers and clients (Pruitt & Grudin, 2003). Although each persona has its own story to tell, they represent the main target population for the platform. The richness of the persona is in the tool itself, because 1) characters are based on interviews, 2) the persona is developed as a character, which emphasize the actual user, 3) the persona can perform in scenarios (see section 8.1.1), 4) the persona is used for communication, and 5) the persona is used by the designers to keep the end-user in mind (Cooper, Reimann, & Cronin, 2007). In our study, the personas helped us to reflect constantly on the target group of the service platform.

The more believable the story is, the better, and the more accurate the representation is, the more likely our decisions will reflect user requirements. With that in mind, every persona's story consists of a name and photo, title, byline, and, most importantly, goals and frustrations. Each character is developed in detail, with different characteristics, including gender, age, background, health condition and culture, and is more or less familiar with the digital world (see figure 19). To anonymize the personas, we used fictional names and pictures. See appendix A for the detailed personas.

Two personas represent elderly end-users (2 and 8), two personas represent informal caretakers (3 and 4), two personas (1 and 5) represent service and product providers, and two personas (6 and 7) are representatives of the local government. Although the

**Persona 1 : Frans Berkhout**



| | |
|---|---|
| Age | 49 years |
| Place of birth | Schipluiden |
| Home environment | residential area |
| Marital status | married, 2 children |
| Profession | home care products supplier |
| Social class | average income |
| Internet use | work and private |

Persona 1 represents a product provider.

**Persona 2 : Annie Ammerlaan**

| | |
|---|---|
| Age | 79 years |
| Place | Schipluiden |
| Home environment | rural |
| Marital status | single, no children |
| Profession | housewife |
| Social class | below average |
| Internet | has no internet |

Persona 2 is single and isolated.

**Persona 3 : Kees van de Ende**

| | |
|---|---|
| Age | 81 years |
| Place of birth | Maasland |
| Home environment | residential area |
| Marital status | married, no children |
| Profession | retired engineer |
| Social class | average income |
| Internet use | private |

Persona 3 takes care of his partner with dementia.

**Persona 4 : Ria van Marrewijk**

| | |
|---|---|
| Age | 55 year |
| Place of birth | Den Hoorn |
| Home environment | terraced house |
| Marital status | husband and 3 children at home |
| Profession | part time care giver at Buurtzorg |
| Social class | average income |
| Internet use | private |

Persona 4 takes care of relatives (sandwich generation).

**Persona 5 : Ellen van de Windt**

| | |
|---|---|
| Age | 47 years |
| Place of birth | Delft |
| Home environment | city center |
| Marital status | married, 3 children |
| Profession | coördinator Foundation Welfare Elderly |
| Social class | average income |
| Internet use | work and private |

Persona 5 represents a service provider for healthcare.

**Persona 6 : Anton Gielissen**

| | |
|---|---|
| Age | 62 years |
| Place of birth | Delft |
| Home environment | terraced house |
| Marital status | single, 2 children living away |
| Profession | civil servant Social Affairs Delft |
| Social class | more than average |
| Internet use | work and private |

Persona 6 represents the department of social affairs.

**Persona 7 : Petra de Kort**

| | |
|---|---|
| Age | 25 years |
| Place of birth | Den Haag |
| Home environment | city center |
| Marital status | living together with a boy-friend |
| Profession | advisor WMO office Midden Delfland |
| Social class | average income |
| Internet use | work and private |

Persona 7 represents the WMO desk at a municipality.

**Persona 8 : Hakkan Bitez**

| | |
|---|---|
| Age | 55 years |
| Place of birth | Delft |
| Home environment | poor neighbourhood |
| Marital status | married, 6 children, 1 living away |
| Profession | unemployed |
| Social class | below average |
| Internet use | private (with help of the children) |

Persona 8 is foreigner and unemployed

Fig. 19. Fragments of the eight pre-defined personas. See appendix A for full description.

possible combinations to describe a persona are countless, we based our personas on several face-to-face interviews with possible end-users from different backgrounds and with different wishes. The interviews were analyzed and the personas discussed and refined with the research assistants and the Expert Team in the healthcare domain.

Ultimately, the personas helped us focus on the user's needs more clearly throughout the entire service platform design process.

### *6.1.4 Results of the focus groups*

The focus group sessions lasted approximately two to three hours, and were led by the same moderator (i.e., ADR researcher) and were audiotaped and transcribed for analysis. The degree of structure imposed on the discussion and the composition of the group are functions of the session's objective. The moderator facilitated the process and stimulated the interaction among the focus group members, to gain specificity, range and depth. Although there was little content control, the moderator made sure that all members participated, tempering some members and motivating others to take part in the conversation. The focus group meetings included a presentation and a Q&A session. Four questions were asked using a 7-point Likert scale, followed by discussions.

The first question was: *What should be the main purpose of a Health and Wellbeing platform?*

In the light og the saturation effect and to save time, this question was only asked in the first two focus group meetings (i.e., 1a and 1b). According to the twelve members of the first two focus group meetings all combinations of platform features (online community, information exchange platform, portal and intervention instrument) are possible, because the features being suggested are more or less related. Some features are considered more valuable at the start of the platform than others, and, at the end of the first two meetings, the participants agreed on the overall suggestion to start with a small transition platform and scale up if necessary. Although the feature that gained the most support was a portal ($\tilde{x}$ 6.2 and SD = 1.0), seven participants (#2, #7, #8, #9, #10, #11 en #12) suggested combining the information exchange platform and the portal, and graded both as equally important. The rationale behind the suggestion is that both platform features support 'business to consumer' and can be used interchangeably. As an additional suggestion, three participants (#5, #6 and #7) came up with a specific intervention feature for district nurses, acting from a community center for elderly people. The UK participants (#8, #9, #10 and #11) were not thinking about an intervention feature for municipalities, because the local governments in the UK are not directly involved in healthcare. Furthermore, two participants (#1 and #6) suggested a kind of follow-up system (i.e., SOS) for elderly people. According to the participants, it is necessary for all the stakeholders (end-users, service providers and government) to collaborate to help people stay at home as long as possible, arguing that a service platform is a viable tool to help the stakeholders interact with each other. Although an intervention instrument was seen as the least important feature according to participants #2, #8 #9, #11, and the participants are also more divided about this feature ($\tilde{x}$ 4 and SD 1.7), after a discussion in particular the Dutch participants agreed that a platform could help municipalities stay in direct contact with their local citizens. The rationale behind this assumption is the changed Dutch healthcare legislation from 2015 onwards and the new healthcare-related tasks facing the municipalities.

The second question was: *Who would benefit from the platform? See table 14.*

**Table 14. Potential users of the platform (1 = absolutely not and 7 = absolutely) N = 28**

| Potential users of the platform | Mean ($\tilde{X}$) | Standard Deviation (SD) |
|---|---|---|
| **Young elderly (55 – 75)** | 6.43 | 0.63 |
| **Service providers** | 6.36 | 0.91 |
| **People with physical limitations** | 6.29 | 0.90 |
| **People with chronic conditions** | 6.21 | 0.92 |
| **Product providers** | 6.18 | 0.90 |
| **Informal caretakers** | 6.07 | 1.11 |
| **Elderly people (75+)** | 6.07 | 1.22 |
| **Citizens in general** | 5.96 | 1.04 |
| **Volunteers** | 5.93 | 1.15 |
| **Local government (i.e., municipality)** | 5.68 | 1.63 |
| **People with mental limitations** | 5.21 | 1.50 |

All the participants (n = 28) have strong beliefs about the usefulness of the platform for a broad range of potential end-users (see table 15). The highest scores are related to **young elderly** in the age of 55 to 75 ($\tilde{x}$ 6.43 and SD 0.63) and **people with physical limitations** ($\tilde{x}$ 6.29 and SD 0.90), but also to product ($\tilde{x}$ 6.18 and SD 0.90) and **service providers** ($\tilde{x}$ 6.36 and SD 0.91). Some of the participants (#12, #14, #20, #27) are not convinced of the usefulness of the platform for **elderly people** (i.e., 75+), because they are less tech-savvy ($\tilde{x}$ 6.07 and SD 1.22). According to nine participants (#5, #7, #8, #13, #14, #17, #18, #22, #23), **people with mental limitations** should be excluded as potential end-users ($\tilde{x}$ 5.21 and SD 1.50), unless they under the supervision of an intermediary. The usefulness of the platform for this group of people is related to the platform's content and the person's mental capacities.
As such, the main target group for the platform is assumed to be that of the young elderly (i.e., 55 to 75 years old). According to the participants, the rationale behind this

assumption is that 1) this group of people is used to living a comfortable life and wants to continue their lifestyle in the (near) future, and 2) they take care of their relatives and can function as intermediaries between the platform and their relatives.
The third question was: *Which requirements are beneficial according to you or someone closely related to you?* See table 16 (participants refer to themselves) and table 15 (participants refer to their parents or grandparents).

| Table 15. Requirements according to the participants themselves (N = 13) | | |
|---|---|---|
| **Requirements of the platform** | **Mean (~X)** | **Standard Deviation (SD)** |
| **Information about local activities** | 6.39 | 0.87 |
| **Integration local platforms** | 6.08 | 1.12 |
| **Contact with others** | 6.08 | 1.44 |
| **Health services** | 5.92 | 1.38 |
| **Wellbeing products** | 5.62 | 1.66 |
| **Information aging-in-place** | 5.54 | 1.45 |
| **Integration national platforms** | 5.46 | 1.66 |
| **Domestic products** | 5.39 | 1.80 |
| **Health products** | 5.23 | 1.96 |
| **Wellbeing services** | 5.15 | 2.19 |
| **Contact with end user groups** | 5.07 | 1.93 |
| **Domestic services** | 4.85 | 2.15 |
| **Marketplace** | 4.23 | 1.92 |
| **Requirements referring to (grand) parents (N = 14)** | | |
| **Wellbeing products** | 6.07 | 0.92 |
| **Wellbeing services** | 6.07 | 1.00 |
| **Contact with others** | 6.00 | 0.88 |
| **Health services** | 5.93 | 1.14 |
| **Health products** | 5.71 | 1.20 |
| **Domestic services** | 5.64 | 1.50 |
| **Information about local activities** | 5.43 | 1.50 |
| **Contact with end user groups** | 5.29 | 1.38 |
| **Domestic products** | 4,93 | 1.13 |
| **Integration local platforms** | 4.86 | 1.88 |
| **Integration national platforms** | 4.71 | 1.68 |
| **Marketplace** | 4.71 | 1.68 |
| **Information aging-in-place** | 4.64 | 1.34 |

During the focus group meetings, we discussed 13 basic requirements for the service platform as suggested by the interviewees in the Problem Formulation phase related to health, wellbeing and domestic products and services, contacts, and local activities (see section 5.4). Although the average score for all the requirements was between beneficial and very beneficial ($\tilde{x}$ between 4.23 and 6.39), there is a difference in perception when the participants (n = 27) take themselves into account (n = 13) and when they refer to their parents or grandparents (n = 14).

For instance, when the younger participants (age < 55) took themselves into account, it was clear that they were not ready to use a service platform for Health and Wellbeing, basically because they do not see themselves as the target group (yet). However, all the participants in this age group were fairly sure that a Health and Wellbeing platform could help them in the future. Participants who refer to themselves as potential users of the platform mentioned **information about local activities** ($\tilde{x}$ 6.39) and **contact with others** ($\tilde{x}$ 6.08) as being the most beneficial requirements. Also, the **integration of local** ($\tilde{x}$ 6.08) and **national platforms** ($\tilde{x}$ 5.46) for health and wellbeing in the platform is pointed out as beneficial, mainly to prevent developers from 'reinventing the wheel'.
Most participants prefer the integration of existing, reliable and well-known web applications for Health and Wellbeing. Participants below 55 (n = 6) who refer to themselves have no specific need for healthcare-related products and services, like **Health Products** (e.g., stair elevator, nursing aids), **Wellbeing Products** (e.g., entertainment, serious games), **Wellbeing services** (e.g., grocery, meal, cooking) and **Health services** (e.g., domestic help, personal care) or a **Marketplace** (i.e. local supply and demand) to share specific Health and Wellbeing goods (i.e., wheelchair, walker) with others. Instead, this age group appreciates the **Domestic products** (e.g., home automation, security) and **Domestic services** (e.g., installer, contractor, gardener), which they feel it can directly add something to their comfortable lifestyle.
While most of the participants agreed that the platform would benefit elderly people, some argued that their older relatives (i.e., parents or other family members) are not all that tech-savvy and would need help from 1) their relatives or other informal caretakers, 2) a kind of district nurse, or 3) someone from the local government. These participants argue that a platform, based on a one-stop shop principle can unburden family members in figuring out how to support their relatives. As one participant (#8) stated: '*Separate the question of benefit and likelihood of actually using the platform: who benefits (the elderly) is probably not the user (intermediary) of the platform*'. Participants that take their (grand) parents into account (n = 14), think that **Wellbeing products and services** (both $\tilde{x}$ 6.07) and **Contact with others** ($\tilde{x}$ 6.00) will be the most beneficial,

and then **Healthcare related services** ($\tilde{x}$ 5.93) and **products** ($\tilde{x}$ 5,71). On the other hand, **Information about aging-in-place** ($\tilde{x}$ 4.64) and the **Marketplace** (i.e., supply and demand) to share goods and services with others ($\tilde{x}$ 4.71) are seen as the least beneficial options for the elderly. Having said that, eleven participants indicated that they would use the platform themselves to help their (grand) parents find the right information.

For instance participants who refer to people aged over 75 who are not tech-savvy and need support with online searching, suggest: *'Match with young elderly who are looking for solutions for the third generation'* and *'Think about alternative ways for people to access the platform, for example through intermediaries like relatives'*. These suggestions indicate that the elderly people need some sort of extra support to make sure that a digital platform is a suitable solution for this specific target group. Additional suggestions were made like: *'Can it offer an online diary instead of the little book on the kitchen table?'* (#5) *and 'What about task management and an agenda for informal caretakers?* (#16) *'Could you integrate a sort of chatbot, who guides you through the system?'* (#21) *'Is it possible to give reviews of products, providers and activities like a rating system and also give qualitative feedback?'* (#13)
During the discussion the participants also mentioned a diversity of largely non-functional requirements for the digital platform. The clustered suggestions are: the platform has to be easy to use (n = 21) and accessible for everyone (n = 20). It has to have updated and complete information (n = 20). The platform has to unburden the target group (n = 19), and profiling has to be one of the features (n = 18). Furthermore, that the platform has to be reliable (n = 12) and secure (e.g., privacy) (n = 12). To reach a large target group the platform has to be multi-lingual (n = 11) and be based on a one-stop shop principle (n = 9). A local supply and demand marketplace will be beneficial (n = 9) but *'Timely matching supply and demand with trustful parties is key'* (n = 10), and the platform has to be independent (n = 8). Also the response time of the platform is important (n = 5), as are interaction and feedback (n = 4), and there has to be a control function for the end-user (n = 3).
Other suggestions were: *'The platform has to have a preventive effect'* (#9) and *'Make sure the platform really unburdens people'* (#11). After that, the participants discussed possible pitfalls when developing a Health and Wellbeing platform. The most frequently mentioned limitations are: the overall complexity (e.g. information overload, too broad) (n = 17), the illiteracy of the target group (n =16), developing a technology-driven rather than human-driven solution (n = 14), and a lack of awareness among the target groups (n = 14).

Other issues that were mentioned are the complex governance of the platform (n = 13), the likelihood that end-users will be to skeptical about using the platform (n = 10), there are no or not enough investors to scale up the platform (n = 8) and ownership of the platform in relation to independency is not clear (n = 6). Some of participants commented: '*The platform has to be human driven and not technology driven*' (#3) and '*Make sure that the 'wrong' agencies like insurance companies do not pick up the idea and develop the platform for the wrong reasons* (#2)' and '*How do you govern such a platform, with so many stakeholders?*' (#6).

The fourth question was: *Which requirements are beneficial according to a specific persona?* See table 16. For this question focus group members had to choose one of the personas (i.e., put face down on the table).

**Table 16. Requirements of the platform; focus group members referring to a certain Persona (1 = not beneficial and 7 = very beneficial). N = 27**

| | P 1 (N = 3) | P 2 N = 4) | P 3 (N = 3) | P 4 (N = 3) | P 5 (N = 4) | P 6 (N = 3) | P 7 (N = 3) | P 8 (N = 4) |
|---|---|---|---|---|---|---|---|---|
| **Domestic products** | 7.00 | 6.50 | 4.67 | 2.67 | 5.50 | 5.67 | 6.00 | 5.00 |
| **Health products** | 5.00 | 6.25 | 6.67 | 5.33 | 4.00 | 5.33 | 6.67 | 3.00 |
| **Wellbeing products** | 5.67 | 6.25 | 5.33 | 4.67 | 5.50 | 6.00 | 7.00 | 3.00 |
| **Domestic services** | 5.00 | 5.25 | 5.00 | 5.00 | 5.00 | 5.50 | 6.67 | 3.00 |
| **Wellbeing services** | 5.67 | 6.00 | 4.67 | 5.00 | 4.75 | 6.00 | 6.67 | 3.00 |
| **Health services** | 5.67 | 6.00 | 6.00 | 5.67 | 6.00 | 5.00 | 6.67 | 3.00 |
| **Contact with others** | 6.33 | 6.75 | 6.33 | 4.00 | 6.25 | 4.33 | 7.00 | 5.75 |
| **Marketplace** | 6.00 | 2.25 | 4.00 | 4.33 | 4.50 | 6.00 | 6.00 | 5.00 |
| **Information aging-in-place** | 4.00 | 4.25 | 6.33 | 4.33 | 6.25 | 4.33 | 7.00 | 5.50 |
| **Information local activities** | 5.00 | 6.00 | 6.67 | 5.00 | 6.75 | 5.67 | 7.00 | 5.50 |
| **Integration local platforms** | 4.00 | 5.75 | 6.00 | 5.33 | 6.75 | 5.67 | 6.67 | 4.25 |
| **Integration national platforms** | 3.33 | 4.75 | 5.00 | 4.00 | 6.75 | 6.00 | 6.67 | 4.50 |
| **Contact with end-user groups** | 6.33 | 6.50 | 6.00 | 4.67 | 4.50 | 5.67 | 7.00 | 2.25 |

According to the participants (N = 27), the eight different personas can all benefit from a digital Health and Wellbeing platform. In their opinion Contact with others ($\tilde{x}$ 6.07) is the most beneficial and a Marketplace the least beneficial ($\tilde{x}$ 4.48). For example, persona 1, as a product provider, will be less interested in the Integration of national platforms ($\tilde{x}$ 3.33), but likes to stay in contact with the end-user, preferable via End-user groups ($\tilde{x}$ 6.33) and the Marketplace ($\tilde{x}$ 6.00), while persona 2 (Annie) who is single and isolated, will be more interested in Contact with others ($\tilde{x}$ 6.75), and probably less interested in the Marketplace ($\tilde{x}$ 2.25) because she is not tech-savvy.

### 6.1.4 Analysis focus group sessions

It is not surprising that, according to the focus group participants, the main purposes of a Health and Wellbeing platform may vary across countries and that platform practices may not be easily translated from one country to another, due to differing legislations, rules and guidelines. However, the healthcare challenges for elderly people stay the same in the countries we examined. The importance of an intervention feature for the platform in the Netherlands implies that the government is becoming increasingly involved in providing healthcare services to its aging population. Such a feature would help the government to stay in contact with citizens and act as an intermediary between service providers and end-users. But, the government is not involved in healthcare in the same way in every country. For example, in the UK, healthcare service provision is outsourced to third parties and the government is less closely involved. Increasing involvement of the government in healthcare leads to a number of organizational questions such as whether the government should take the lead in developing such platforms and how that would affect the participation of other parties. Different perspectives on platform functions from public and private stakeholders make it more complex to define the range of services enabled by the platform and the related control aspects. Another relevant question is *who should be the platform leader*. These questions show the relationship between the platform's main purpose (i.e., platform design) and the organizational settings surrounding the platform (i.e., ecosystem design). The focus group participants suggested that a neutral party should be the platform leader, for instance a governmental party and not a commercial or an insurance company.

Although we found that the platform would be most beneficial to young elderly (age 55 - 75), elderly people above 75 years old can still benefit from the platform as long as they have the digital skills needed to use the platform or have proper support from their relatives, informal caretakers, district nurses or someone from the local government. As such, we can speculate that the platform would be both a long- and a short-term solution for challenges facing elderly people. The question *who benefits from and who uses the platform* posed by one of the participants, is enlightening. Distinguishing end-users from people who benefit from the platform is critical in the platform's development process. This implies that, instead of focusing on people over 75 years old, more attention should be paid to the requirements of the people who support them. It is only in that way, the platform can unburden family members in figuring out how to support their relatives in an efficient and effective way. Generally speaking, from the perspective of end-users, **contact with others** and **gaining information about local activities**, products and services are the main requirements of a Health and Wellbeing platform. Clearly, these requirements can be related to the issue of loneliness and

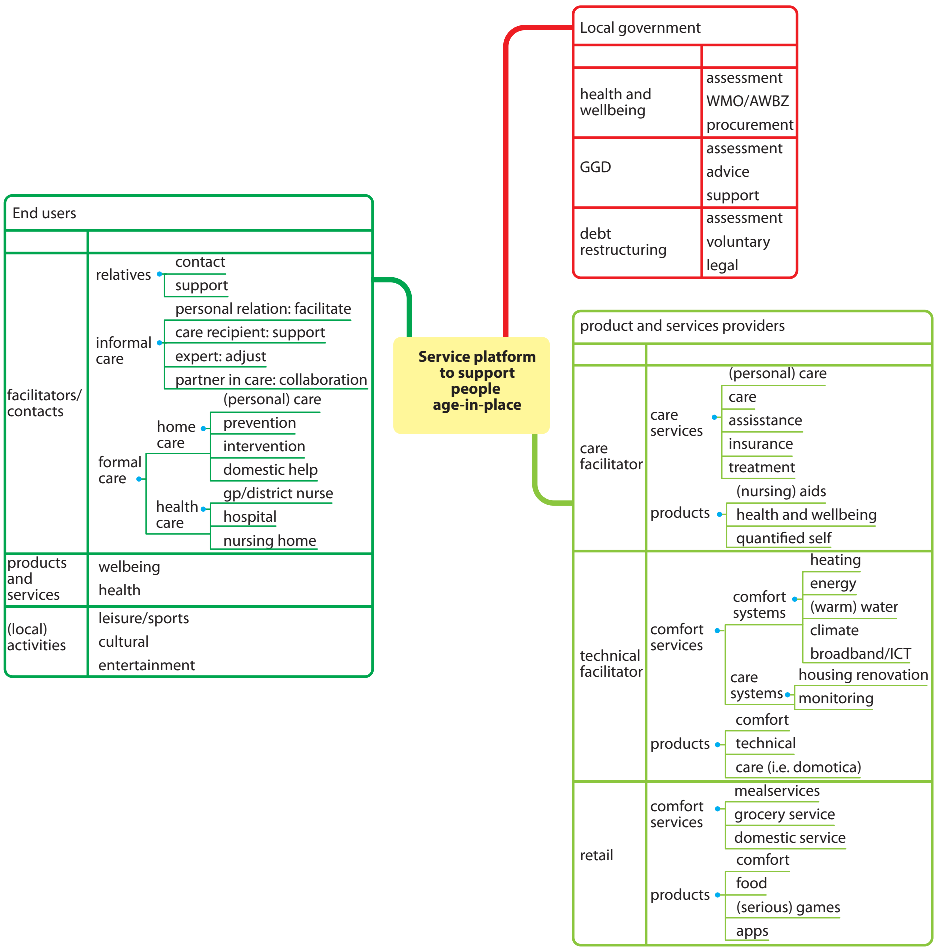



Fig. 20. User groups with clustered suggestions for the matchmaking functionality, collected during interviews and focus group meetings.

isolation of elderly people, which is in line with earlier studies highlighting cases of loneliness among that age group (Hawkley & Cacioppo, 2010). From the perspective of providers and the local government, **offering Health and Wellbeing products and services** can be seen as the platform's main function. Clearly, for service providers, the platform should be an intermediary to facilitate interaction with end-users, while reducing interaction costs. However, depending on who is the platform's main target group, requirements may be adjusted, which means that defining the main target group (i.e. user group) initially make it easier to determine the features and functions of the platform. Moreover, knowing the target group, which is one of the Critical Design Issues, can help to address the issue of **awareness** mentioned earlier and reduce the **overall complexity** by focusing first on the main requirements. Note that functions are extended later on in the process. After analyzing the input from the first two research phases (i.e., Problem Formulation and Design Requirements), we clustered suggestions for the matchmaking function (i.e., supply and demand) in relation to health and wellbeing, to obtain an overview of the different products and services, which, according to the stakeholders, can help people age-in-place. See figure 20 (p. 119).

These clusters gave the ADR researcher a first impression of the kind of products and services citizens were looking for in a service platform for health and wellbeing, and what in particular could be provided by third parties in the health and wellbeing domain, ranging from products and services (i.e., service providers) to assistance, as well as exchange of information about aging-in-place (i.e., local governments).

Subsequently, we summarized all the factors, that influenced aging-in-place according to the interviewees and focus group members, and divided them in 'needs' and 'hurdles' from different perspectives: citizens (divided in elderly people and informal caretakers), service providers and local governments. See table 17.

| Table 17. Summarized 'needs' and 'hurdles' from different perspectives | | |
|---|---|---|
| **Target groups** | **Needs** | **Hurdles** |
| **Elderly people (75+):** | • Have a care back-up system in case of emergency<br>• Find products and services<br>• Stay in contact with others<br>• Find local activities | • Health and mental condition<br>• Loneliness<br>• Missing back up system<br>• Complexity healthcare system<br>• Information overload<br>• Money constraint |
| **Informal caretakers (merely young elderly: 55 -75 years)** | • Find products and services to support loved ones<br>• Monitor system<br>• Back up system | • Complex healthcare system<br>• Information overload<br>• Time constraint<br>• Tools missing to monitor the people they are looking after<br>• Lack of interaction and back-up systems |
| **Service providers** | • Customers<br>• Communication channel | • Channels missing to reach customers<br>• Technology focus instead of sales focus |
| **Local governments** | • Harnessing healthcare costs<br>• Intervention task to support citizens to age-in-place<br>• Interaction with citizens | • Complexity of the health domain<br>• Tools missing to support citizens in the care transition phase<br>• Capacity at the WMO helpdesk (skills, people and time) |

These needs and hurdles are consulted during the design process of the platform (section 10.1) and used to enrich the personas with scenarios and user stories (section 8.1).

## 6.2 First refinement of design requirements

The functional requirements indicate the functions that the IT artifact should fulfill or enable to perform once it has been realized (Verschuren & Hartog, 2005).
Based on suggestions of, and discussions with, the focus group members, we refined and added new requirements for the platform, as shown below in table 18a - 18d.

| Table 18a. Refined functional requirements extracted from the focus groups | |
|---|---|
| **Id** | **Functional Requirements** |
| **$R_f$1** | The platform should provide a digital marketplace for products and services that could have a matchmaking function between providers and end-users within the context of health and wellbeing |
| **$R_f$2** | The platform should provide an online community for contact, solutions, social wellbeing and interaction with the neighborhood in the form of social activities and events and offer service recommendations to platform users |
| **$R_f$3** | The platform should provide a portal (one-stop shop) for communication about smart living |
| **$R_f$4** | The platform should provide a (health) intervention instrument for local governments (i.e., contact with citizens about smart living needs) |

Furthermore, we discovered (table 18a) that two of the four functional requirements (i.e., **$R_f$1** and **$R_f$2**) could elaborated in greater detail. Instead of 'the platform should provide information exchange between (service) providers and end-users (i.e., matchmaking)', the focus group members agreed that for **$R_f$1** '*the platform should provide a digital marketplace for applications in Health and Wellbeing as well as a marketplace for products and services in the same context, that is an information exchange podium between providers and end-users in the context of Health and Wellbeing (i.e., matchmaking)*'. The same for **$R_f$2**: instead of: '*the platform should provide an online community for social interaction and service recommendations*', the focus group members stretched this requirement: '*The platform should provide an online community for contact, solutions, social wellbeing, interaction with the neighborhood in the form of social activities and events and offer service recommendations*'. **$R_f$3** and **$R_f$4** did not change.

| Table 18b. Refined functional user requirements extracted from the focus groups | |
|---|---|
| **Id** | **Functional User Requirements** |
| **R1** | The platform should provide local information (i.e., matchmaking products and services, local activities and contacts) |
| **$R_{fu}$2** | The platform should offer a task manager mechanism. The task manager should be a guide (i.e., a chat bot) to guide the platform users through the system |
| **$R_{fu}$3** | The platform should allow reviews of products, providers and activities like a rating system and qualitative feedback |
| **$R_{fu}$4** | The platform should offer a diary for the end-users. A log in which they (or someone else on their behalf) can keep a daily record of events and experiences. |
| **$R_{fu}$5** | The platform should contain contact management, including a messaging functionality and an agenda function. |
| **$R_{fu}$6** | The platform should integrate existing, reliable and well-known web applications for Health and Wellbeing (i.e., local and national platforms and end-user groups) |
| **$R_{fu}$7** | The platform should contain a profile, like a care plan which can be stored |

Functional requirements that were already discussed in the interview round stayed intact, but after discussions within the focus groups new and refined suggestions (table 18b) expanded the purpose of a Health and Wellbeing platform. Like: **$R_{fu}$2** (*'guide' functionality*), **$R_{fu}$3** (*reviews*), Rfu4 (diary functionality), **$R_{fu}$5** (*contact management and agenda function*), **$R_{fu}$6** (*integration of local and national platforms*) and **$R_{fu}$7** (*profiling and a care plan*). Especially **$R_{fu}$2** (*'guide' functionality*) requires careful considerations how to encounter this functionality in the design process.

In addition, **$R_{fu}$6** (*integration of local and national platforms*) opens up possibilities for platform envelopment (i.e., combining functionalities in a multi-platform bundle, which leverage shared user relationships).

**Table 18c. Refined non-functional user requirements extracted from the focus groups**

| Id | Non-functional User Requirements |
|---|---|
| **$R_{nfu}$1** | The platform should be easy to access (low entry barrier) |
| **$R_{nfu}$2** | The platform should be perceived as being reliable |
| **$R_{nfu}$3** | The platform should be perceived as useful for local governments, end-users and providers |
| **$R_{nfu}$4** | The platform should be perceived as being easy-to-use for local governments, end-users and providers |
| **$R_{nfu}$5** | The platform should ensure seamless navigation |
| **$R_{nfu}$6** | The platform should be secured and perceived to have high privacy protection standards |
| **$R_{nfu}$7** | The platform should be accessible to everyone |
| **$R_{nfu}$8** | The platform should contain updated and complete information |
| **$R_{nfu}$9** | The platform should be multi-lingual |
| **$R_{nfu}$10** | The platform should allow for interaction and feedback |

New non-functional user requirements (table 18c) suggested by the participants, which should be taken into account, were: **$R_{nfu}$5** (*seamless navigation*), **$R_{nfu}$6** (*security and privacy*), **$R_{nfu}$7** (*accessibility*) **$R_{nfu}$8** (*updated information*) **$R_{nfu}$9** (*multi-lingual*) **$R_{nfu}$10** (*interaction*).

| Table 18d. Refined contextual requirements extracted from the focus groups | |
|---|---|
| **Id** | **Contextual Requirements** |
| **$R_c$1** | The platform should help people age-in-place |
| **$R_c$2** | The platform should match supply and demand for smart living products and services (i.e., Health and Wellbeing) |
| **$R_c$3** | The platform should add value for local governments, providers and end-users |
| **$R_c$4** | The platform should start in a local setting but should be scalable |
| **$R_c$5** | The platform owner should be independent (non-commercialized) |
| **$R_c$6** | The platform should unburden the target group (i.e., elderly people and informal caretakers) |

New contextual requirements (table 18d) were related to **$R_c$5** (*independent platform owner*) **$R_c$6** (*unburden target group: elderly and informal caretakers*).

## 6.3 Conclusion of the Design Requirements phase

In this second research phase, we focused on the main design requirements of the platform. To that end, we expanded the design cycle from Sein et al. (2011) by adding steps of the design cycle proposed by Verschuren and Hartog (2005), including the Requirements [R] and Assumptions [A] that are being defined by the frame of the first three platform goals [G] in section 6.1, like [G1] creating awareness among end-users on what products, services and technologies can help them age-in-place, [G2] satisfying the requirements of end-users, service providers and local governments, and [G3] matching between (latent) needs and (yet unknown) services.

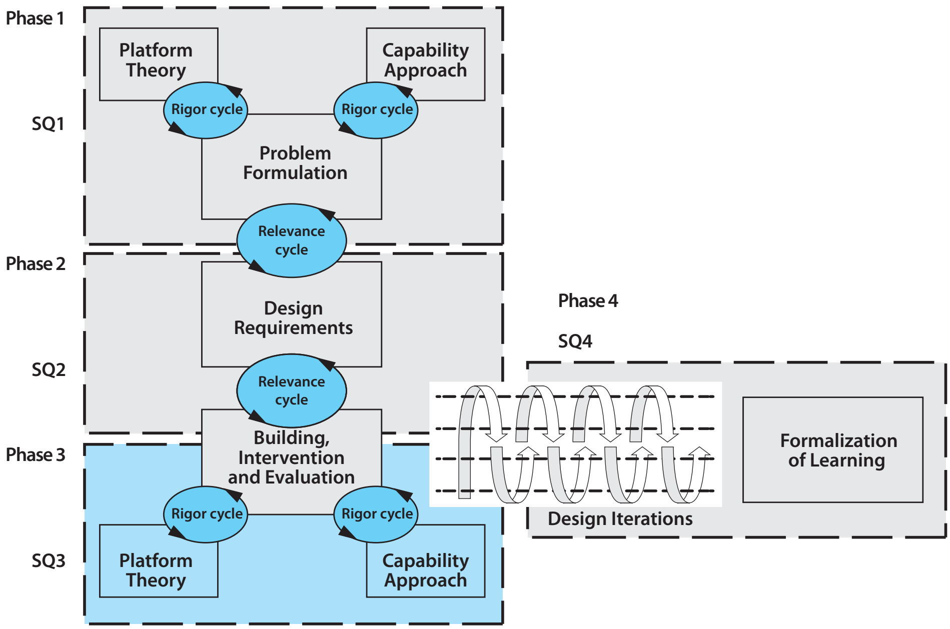
The results of four focus group discussions show that a digital health and wellbeing platform can help people age-in-place. Based on the participants' input we were able to refine the requirements. In addition, we found that the main end-user needs are related to: 1) contact with others, 2) finding smart living products and services, and 3) having access to information about local activities.

The personas, used during the sessions, allowed the participants to identify with potential customers, which made the intention of the platform more explicit and the discussion about the requirements livelier.

A summary of the different research steps in Research phase II: Design Requirements is provided in table 19.

| Table 19. Research phase 2: Design Requirements | |
|---|---|
| **Research input** | Initial idea about requirements and assumptions (section 5.3)<br>Four main platform features: (1) information exchange, (2) online community, (3) portal, (4) health intervention instrument |
| **Research throughput** | 4 focus group meetings (i.e., 28 participants). Section 6.1 |
| **Research output** | Refined requirements (i.e., functional, non-functional and context). Section 6.2 |

# 7. Research phase 3: Building, Intervention and Evaluation




Research phase 2: Building, Intervention and Evaluation

This chapter introduces the Building, Intervention and Evaluation phase, in which the service platform is being developed. One approach using the power of end-users and encourage them to become actively involved in an ICT development process as equal co-creators, is a so-called Living Lab.
The central aim of this research phase is to answer the third sub-question.

***SQ 3. How to design and prototype a service platform for Health and Wellbeing to support three different stakeholder groups (i.e., end-users, service providers and local governments) related to aging-in-place within a real-life setting?***

For a societal deployment of the proposed platform we needed to address both end-users' and external stakeholders needs. Feedback from end-users (i.e., elderly people and informal caretakers) at an early stage of the technology development phase, involving elements like relevance and usability, are crucial to provide a boost to the use and delivered value of the application (Abras, Maloney-Krichmar, & Preece, 2004). In addition, understanding (potential) users can help minimize the risks of a technology introduction.

Living Labs typically refer to the co-creation and co-design of an innovation between users, researchers and stakeholders (Ballon & Schuurman, 2015; Eriksson et al., 2005). Mulder, Velthausz, & Kriens (2008) argue that Living Labs are open innovation systems that attempt to integrate multiple organizations from different fields and users to accelerate the development of new technologies, while Bergvall-Kåreborn, Ihlström Eriksson, Ståhlbröst, and Svensson (2009) define Living Labs as innovation systems where firms and users interact within a real-world context. Guldemond and Van Geenhuizen (2012) described two conceptualizations about Living Labs, the first of which defines a Living Lab as an open innovation platform or network with strong user involvement and emphasizes the role of an intermediaries, while the Living Lab coordinates the network of actors in open innovation systems (Katzy, 2012). The second conceptualization narrows Living Labs to 'ambient assisted livings' with research support, combined with user involvement.

Living Labs exist to conduct innovation-driven research and allow researchers to capture tacit user knowledge, while at the same time exploring the ecosystem around the IT artifact under development. The Living Lab approach represents a research context for sensing, prototyping and validating complex solutions. Studying behavior in a real-world context allows researchers to gain a better understanding of how the creation of IT artifacts fit into the complexity of daily life (Niitamo, Kulkki, Eriksson, & Hribernik, 2006), essentially making Living Labs user-centric environments that provide an open collaborative innovation.

In our Living Lab approach, we attempt to harness the power of multiple stakeholders with voluntary user involvement, to develop an IT artifact as a social innovation to support people to age-in-place and at the same time explore how value can be created (i.e., business modeling). At the start of the Building, Intervention and Evaluation (BIE) phase, our goal was to move from a more controlled setting within the university towards an open setting with multiple stakeholders (i.e., public/private parties, end-users and the university) led by the ADR researcher. We adopted a user-centric approach in which an IT artifact could be co-created, tested and evaluated (Almirall, Lee, & Wareham, 2012).

## 7.1 Living Labs and Design Cycles

To provide guidance to the Living Lab activities, we used a methodology called FormIT, which was introduced by Ståhlbröst and Holst (2012) and is based on five cycles 1) planning, 2) conceptual design, 3) prototype design, 4) innovation design and 5) commercialization of the innovation. Ståhlbröst and Holst (2012) state that knowledge increases through design iterations and interaction with a variety of people.

At the **planning stage**, it is important to collect as much information as possible about the context of use, the technology, and the perceptions of the users and organizations. To that end, interdisciplinarity is required to stimulate knowledge generation as well as resource sharing between different stakeholders. The first challenge is to persuade stakeholders to play a role in the Living Lab setting.

After the planning stage, the **concept design stage** focuses on the observation of opportunities and stakeholder needs within the Living Lab (Ståhlbröst & Holst, 2012). At this stage, users can provide input for the development of the innovation, and organizations can help define the scope of the innovation and of the target groups. In the concept design stage, the scope of the innovation, the target user group, and their main characteristics are defined.

At the **prototyping stage**, it is important for the results of the concept design stage to be validated by end-users as stakeholders early on in the process, before reaching a beta version of the prototype (Bergvall-Kåreborn et al., 2009). Or like we suggest even before the alpha version of the prototype.

In the **innovation design stage**, the results of the analysis and the evaluation of the technology are integrated. At this stage, the platform prototype is tested iteratively by practitioners and end-users, until no new insights emerge. The researchers play an important role in communicating the findings throughout the network and share their knowledge to the Living Lab partners, challenging them to shape the technology and organization behind the Living Lab even more.

The final phase is the **commercialization stage**, where the innovation is ready for market introduction, while its potential for upscaling is assessed.

The FormIT methodology supports the '*what*' in our Action Design Research and is used as a guide for the Building, Intervention and Evaluation (BIE) phase, which is not executed within a single organization, but within the Living Lab setting. How the different stages are carried out in the BIE phase is explained in Chapter 8, but first we will explain which pre-arrangements had to be made to establish a Living Lab.

## 7.2 Pre-arrangements

Based on the exploration of the domain (Chapter 3), the suggestions made by the interviewees (Chapter 5) and the focus groups (Chapter 6), we identified four stakeholder groups that should preferably be involved in the Living Lab, see figure 21 provides an overview of these stakeholders.

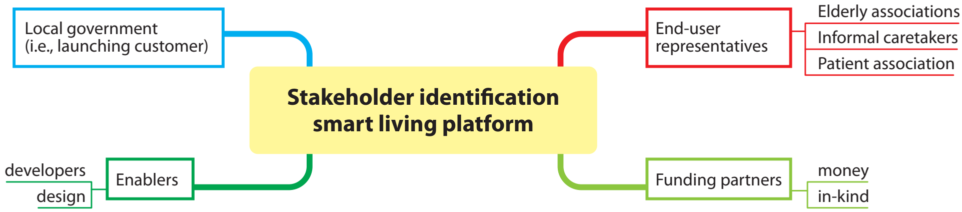



Fig. 21. Stakeholder identification according to interviewees and focus group members.

**Local government**: this so-called launching customer should be a municipality that wants to take part in the development of the service platform, designed to help citizens age-in-place.
**End-user representatives**: end-user groups that can reach a large audience, to speed up the 'critical mass' part of the platform, for example elderly and patient associations, or an organization of informal caretakers.
**Funding partners**: to invest money or in-kind (i.e., knowledge, time, energy) in the platform development.
**Enablers**: partners (i.e., design and developers) to enable the platform in terms of technology.

All these stakeholders have to be taken into account, for the ADR researcher to execute the BIE phase as suggested by Sein et al. (2011).
Before we could enter the BIE phase we had to properly arrange the Living Lab setting. Securing commitment from stakeholders to take part in the Living Lab took a great deal of effort and resilience of the ADR researcher, a process that has been recorded extensively in the ADR logbook (see table 23 for a logbook fragment). The healthcare domain is extremely complex and it took some time to gain understanding, especially when the stakeholders receive no (financial) compensation for their efforts. The initial attempt to secure commitment from potential partners in a Living Lab setting was made during the interviews (2013/2014) with the affiliate and strategic level stakeholders (as described in Chapter 5). See table 20 for a closer look at the stakeholder interviews.

**Table 20. Stakeholders visited to get involved in a pilot regarding a Health and Wellbeing platform (Q1 2013 – Q4 2013).**

| Stake Holders | Organization | Function of interviewee | Interest in platform | Strategic interest | RP/OP |
|---|---|---|---|---|---|
| End-user groups | **Elderly association 400.000 members** | **Policy advisor** | **Target group** | **Representing interest elderly** | **RP** |
| | Elderly association 200.000 members | Policy advisor | Target group | Representing interest elderly | RP |
| | Elderly association 100.000 members | Director | Target group | Representing interest elderly | RP |
| | Patient association | Policy advisor eHealth | Target group | Representing interests patients/increase impact force in governmental cases | RP/OP |
| | | | | | |
| Government | Municipality > 18.000 citizens | Major + alderman | Social intervention | Representing interest citizens/aging-in-place | RP |
| | Municipality > 100.000 citizens | Alderman | Social intervention | Representing interest citizens/aging-in place | RP |
| | Municipality > 600.000 citizens | Innovation manager | Social intervention | Representing interest citizens/aging-in-place | RP |
| | | | | | |
| Funding | Multinational-possible joint venture | Director | Reach critical mass | Wants to be number one of service providers | RP/OP |
| | Patient association - funding research | Policy advisor eHealth | Intervention health | Representing interests patients/increase impact force in governmental cases | RP/OP |
| | Multinational -funding research | Managing consultant Health | Intervention health | Wants to be number one of consultancy firms in the health sector, earn money (BM is core) | RP |
| | Multinational -micro-funding platform | Information architect | Branding | To be number one, earn money (BM is core) | RP/OP |
| | Wholesaler funding platform or even partner | Policy-maker Health | Support suppliers | Sell more products to be number one wholesalers/ overrule concurrent | RP/OP |
| | Subsidizer - micro-funding platform | Policy advisor ZonMW | Community development | Meet requirements for Ambient Assisted Living research | RP |
| | Research fund | Policy maker | Intervention socially | Awareness for municipalities | RP |

| Stake Holders | Organization | Function of interviewee | Interest in platform | Strategic interest | RP/OP |
|---|---|---|---|---|---|
| Enablers | Multinational - developing platform (scalability) | Information architect | Branding | To be number one, earn money (BM is important) | RP/OP |
| | Multinational-developing platform (scalability) | Director | Reach critical mass | Wants to be number one of service providers/overrule KPN | RP/OP |
| | Multinational – developing platform (scalability) | Managing consultant Health | Intervention Health | Wants to be number one in managing services/earn money | RP/OP |
| | Wholesaler - product description | Policy maker Health | Support suppliers | To sell more products and to be number one wholesaler | RP/OP |
| | Service provider developing | Director | Supplier | Sell products/ branding | RP |
| | Service provider – content | Director | Reach critical mass | Sell content/branding | RP |
| | Platform provider - content and usergroup | Director | Reach critical mass | Sell content/ branding. Wants to be number one in smart homes topic | RP/OP |
| | Wholesaler - Purchasing organization | Director | Partner (installer part) | National purchasing organization for installers/searching for a podium | RP |
| | Branch organization Installers | Director | Reach critical mass | Sell content/ branding. Wants to be number one at the smart homes topic | RP |
| | Consultancy - semantics software | Director | Reach critical mass | Sell semantics software | RP |
| | Service provider/ product suppliers | Director | Reach critical mass | Making money/ Advertising | RP |
| | Service provider marketing and acquisition | Director | Reach critical mass | Making money/ Advertising | RP |

Note: green = stakeholders agreed to be involved in future plans of the project (RP = Realization power, OP = Obstruction Power).

Although many of the stakeholders we interviewed were interested in the platform idea (see section 5.2), mainly due to finance/time-related constraints and other priorities within their organization, only a few of them were willing to join the Living Lab project. However, in Q3 2014, we had obtained provisional commitment (shown in green in table 22) from two multinational companies (i.e., developer and a telecom company), two SMEs (i.e., eHealth provider and a developer), an elderly people association (i.e., intermediary elderly), a governmental foundation (i.e., architecture and ICT department) and informal caretakers (possible end-users and intermediary for elderly people). In addition, we could rely on a number of service providers for follow-up discussions regarding content, development and reaching end-user groups. As such, the ADR researcher had to keep in mind that some organizations based on politics and hidden agendas, not only had Realization Power (RP), but also had Obstruction Power (OP) (as shown in table 20).

Despite the fact that the initial Living Lab partners had already committed themselves to developing, implementing and testing the IT artifact in practice, at the end of 2014 a pivotal stakeholder was still missing: a municipality (i.e., local government). Since municipalities were regarded as the launching customer (i.e., with regard to the funding, organization and provision of care to elderly people living at home see section 6.2), it was imperative to have a municipality participation of a municipality on board for access to end-users and to test the IT artifact in practice.

Although the municipalities understood the potential value of the platform idea in terms of helping their citizens to age-in-place, acting upon preliminary regulations (at least in 2014), did not appear to be a real priority. The first two attempts to persuade a municipality to come on board failed. The alderman of the first municipality (i.e., Midden Delfland: 18.000 inhabitants) argued that there was no need for a Health and Wellbeing platform in their district, because '*Everyone within our community is helping others out and if they need additional help they are able to find it themselves*'. The alderman of the second municipality (i.e., Delft: > 100.000 inhabitants) believed in the concept but was unable to join because of money and time constraints. Although we mentioned that the municipality did not have to invest money in the Living Lab, the alderman explained that, in 2015 the number of hours that the department could spend on Health and Wellbeing in relation to technical solutions dropped from 1500 hours a year to zero. The Innovation Manager of the third consulted municipality we consulted (i.e., Rotterdam: > 600.000 inhabitants) was much more convinced that the project offered a win-win situation and, after negotiations with the board of the municipality of Rotterdam, we embedded the platform development within the city's innovation department.

Thus, after several attempts and initial failures (as pointed out in table 21: fragment of the logbook) for reasons related to time, money and priority, the ADR researcher managed to assemble a consortium with multiple stakeholders from eight different disciplines (i.e., municipality, multinationals, SMEs and end-users), who committed themselves to the Living Lab, which officially in January 2015.

**Table 21. Fragment of logbook regarding pre-arrangements for the Living Lab**

| Date | Decision step | Preliminary outcome |
|---|---|---|
| **2013/02/04** | Keep up a diary to track iterative design steps of the research project | Logbook (>1.100 notes) |
| **2013/03/13** | Involve end-users from the beginning | Elderly and informal caretakers involved in Living Lab setting |
| **2013/04/17** | Midden Delfland as possible pilot municipality. Launching customer 1 | Separate discussions with Mayor/ Alderman/project leader and two pitches for project team |
| **2013/07/13** | Elaborate on propositions to involve public/private stakeholders in the project (SMEs/multinationals) | Living Lab setting (quadruple helix) |
| **2013/09/06** | Involve patient association NPCF in platform | Provider of information on the platform (i.e., zorgkaart) |
| **2013/09/18** | Delft as back up for Midden Delfland. Launching customer 2 for the platform | Separate discussions with two Alderman and project leader of social act |
| **2013/10/28** | Pitch for project team Midden Delfland | Rejected: Alderman foresees no problems caused by aging population in this village |
| **2014/02/18** | Pitch for governmental foundation | Partner Living Lab setting |
| **2014/03/18** | Second discussion round for pilot with municipality of Delft (Alderman and project team) | Rejected for now: time restraints 2014/04/24 New opening end 2014 |
| **2014/06/24** | Pitch for multinational | Partner Living Lab setting: multinational 2 |
| **2014/07/13** | Establish a non- for profit foundation for the platform (social innovation) | Foundation Zo-Dichtbij (2015/05/23) |
| **2014/07/20** | Third discussion round for pilot with municipality of Delft (Alderman and interim project leader) | Rejected: money and time constraints in care transition phase (2014/11/20) |
| **2014/07/26** | Explore Rotterdam as back up for Delft. Launching customer 3 for the platform | Partner Living Lab setting: Launching customer (2014/11/20) |
| **2014/11/20** | Pitch municipality Rotterdam | Living Lab started 2015/1/1 |

As mentioned earlier, a Living Lab setting contains a multi-disciplinary network of people and organizations, and requires collaboration of stakeholders from multiple sectors to contribute the necessary resources. Since the municipality was our launching customer, we needed to assemble the Living Lab within its local community.

In addition, we argue that a multi-sided service platform can only be designed by addressing the needs of both end-users and stakeholders. Taking into account the first hunch of a service platform, stakeholders in multiple sectors (i.e., local government, providers and enablers) have to work together and contribute the resources required and find innovators to start and accelerate a catalytic reaction.

**Table 22. Description of functions, roles and value propositions from the Living Lab partners perspective.**

| Stakeholder | Core function | Role in the project | Expected gains from the project |
|---|---|---|---|
| **Municipality** | Launching customer | Problem owner | Interaction with citizens<br>Lower transaction costs |
| **Multinational 1** | ICT firm | System integrator | Market access Health domain<br>Competitive advantage |
| **Multinational 2** | Telecom operator/ Cable company | Hosting and infrastructure | Market access Health domain<br>Competitive advantage |
| **SME 1** | eHealth solutions | Owner platform building blocks | Business opportunity<br>Competitive advantage |
| **SME 2** | ICT developing firm | Platform developer | Business opportunity<br>Competitive advantage |
| **Governmental Foundation** | Intermediary digital process | Architecture | Governmental pilot project<br>Use case Project Architecture |
| **Non-profit Foundation** | Intermediary process/ finance | Platform owner | Exploit platform idea<br>Capture the long-tail |
| **Elderly society** | Intermediary end-users | Elderly connection | Elderly engagement<br>Support elderly to age-in-place |
| **Informal caretakers** | Representatives of informal caretakers | End-users | Possible end-users of the platform and intermediary for elderly |
| **PhD researcher** | ADR | Overall project leader | Research and valorize platform idea |

Stakeholders can benefit from the Living Lab in the form of new and innovative ideas, more insight ino innovations, knowledge exchange and increased return on investment in innovation research. Based on a short questionnaire and additional interviews, we identified the functions, roles and expected benefits from the partners committing themselves to the Living Lab (see table 22, p. 129).

As shown in table 22, important drivers for the nine stakeholders to invest in the Living Lab setting had to do with 1) access to the Health and Wellbeing market, 2) competitive advantage, and 3) business opportunities (Keijzer-Broers, Florez Atehortua, De Reuver, et al., 2015). Importantly, the stakeholders in the Living Lab did not receive subsidies or other financial compensation for their efforts. In addition to public/private parties and academia we involved end-users as a fourth group of innovation actors to the Living Lab setting in a so-called Quadruple Helix: a collaboration between large, medium and small-sized enterprises, the university, public organizations and end-users (Arnkil, Järvensivu, Koski, & Piirainen, 2010; Følstad, 2008; Pallot & Pawar, 2012). In most Living Labs end-users are consulted later on in the process, but there are clear benefits to the including, for instance, citizens at the preliminary stage of the design (Brand, 2005; Holzer & Kloby, 2005). The focus of our public sector-oriented Living Lab is on the development of public services, allowing the municipality to increase its service-offerings to meet its citizens' needs. To do so, we incorporated elements from a user-centered design (UCD) approach: an approach that involves end-users (i.e. elderly people and informal caretakers) throughout the entire development process, to ensure that the proposed platform technology specifically meets their needs. Furthermore, in a Quadruple Helix model all partners have equal decision-making powers (end-users as well).

Because aging-in-place is related to a societal demand, that encompasses the entire population rather than a single organization, we decided to adopt a Societal Demand-Dominant approach for the BIE phase (see section 2.4). So, instead of involving end-users after developing the alpha or beta version of the prototype, we included them from the start, allowing us to implement and test all necessary aspects of the platform within the Living Lab, such as the usability of the features designed in low-fidelity prototypes. As such, this is an adaptation of the model proposed by Sein et al. (2011) and one could argue a more hybrid focus is taken, in which the end-users were part of the development process from the start and not after the alpha or beta version of the platform as suggested by Sein et al. See figure 22.

Design iterations (i.e., sequence of operations within one design cycle) are an integral part of the design process. Especially requirements and constraints become more

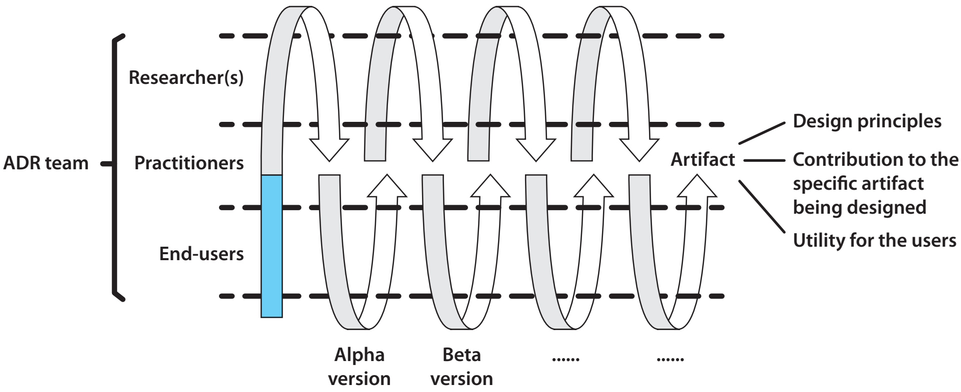



Fig. 22. BIE iterations from a Societal Demand Dominant perspective, extension based on Sein et al. (2011).

concrete after several iterations of problem clarification and problem definition, ranging from simple task repetition to heuristic reasoning processes (Costa & Sobek, 2003). To carry out the design iterations, we extracted three teams from the Living Lab setting (i.e., Development, Design and Research team), based on their specialization. Each team worked iteratively on the design, development and evaluation of the platform, under supervision of the ADR researcher (see figure 23, p. 132).

The workflow described in figure 23 is in line with the work of Da Silva, Martin, Maurer, and Silveira (2011) who emphasize the integration of Agile Development and User Centered Design (UCD) strategies. Although agile development methods strive to deliver small sets of features with minimal design effort in short iterations, while UCD requires more time and considerable research effort, we adapted insights from both design methods (Da Silva, Silveira, Maurer, & Hellmann, 2012; Preece, Sharp, & Rogers, 2015) and incorporated them in a design framework.

At the start of the Living Lab (Q1 2015), input from the interviews, contextual inquiry, results from four focus groups sessions and defined personas as described in Chapter 5 and 6 was available to inspire the three ADR teams (i.e., Development, Design and Research team) at the same time (Keijzer-Broers, Nikayin, et al., 2014).

The preliminary research effort (Chapter 5 and 6) from the ADR Research team could be viewed as **design iteration 0** (Da Silva et al., 2012). In the **first design iteration** (i.e., the planning phase Q 1 2015) the Design team worked on the first mock-ups

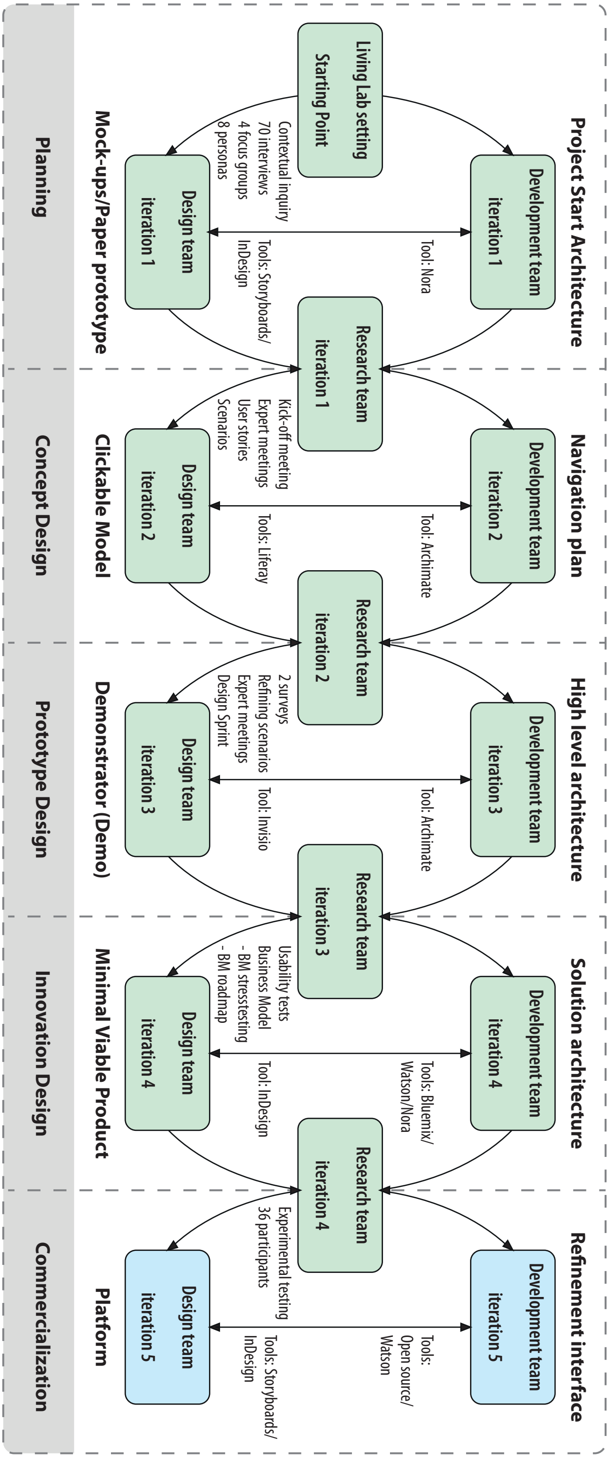



Fig. 23. Overview Design iterations within the BIE phase.

of the platform (section 8.2), while the Development team focused on defining a project plan to guide the platform architecture (section 8.3), and the Research team developed user stories and scenarios based on the eight previously defined personas (section 8.1.1) and refined the requirements based on the interviews and end-user surveys (Keijzer-Broers, De Reuver, et al., 2014; Keijzer-Broers, Florez Atehortua, & De Reuver, 2016).

In the **second design iteration** (i.e., concept design phase Q2 2015), the Development team worked on the initial version of the platform architecture (section 9.3), while the Design team translated the mock-ups into a clickable model (i.e., alpha version of the platform). Subsequently, the Research team conducted two end-user surveys (section 9.2) and evaluated the clickable model in two usability tests (section 9.1) with potential end-users (Keijzer-Broers, De Reuver, et al., 2015).

In the **third design iteration** (i.e., prototype design phase Q3 2015), representatives of each ADR team took part in a three-day Design Sprint workshop (section 10.2), after which the Design team delivered a platform demo (section 10.2.1), which was subsequently used for a user test with elderly end-users, informal and professional caretakers, service-providers and representatives from the local government (section 10.2.2). In parallel, the Research team conducted two business model workshops to be prepared to upscale the platform initiative (section 10.1).

The outcomes of the third design iteration were used for the **fourth design iteration** (i.e., design innovation phase Q1 2016), where the teams focused on the development of the Minimal Viable Product (i.e., interface) as described in section 11.1 and the Solution Architecture of the platform (as briefly explained in section 11.3).

Because preparations for the **fifth design iteration** (i.e., commercialization phase) are made, but is work in progress, it is not included in this dissertation.

Because of the limited resources within the Living Lab setting, we focused on time-efficient methods that could guide our design strategy, without losing sight of our intended research goals. To that end, we arranged five workshops in 2015 with the Living Lab stakeholders to elaborate on efforts prepared in different teams in parallel (i.e., Research, Development and Design team). See table 23 (p. 134).

| Table 23. Five workshops within the Building, Intervention and Evaluation phase | | |
|---|---|---|
| **Date** | **Workshop goal** | **Output** |
| **Workshop 1 January 2015 Section 8.1** | Kick-off meeting and evaluation main requirements of the platform | List of requirements which will be encountered in the prototyping phase of the platform |
| **Workshop 2 February 2015 Section 8.3** | Specifying technical architecture of the platform | Project Start Architecture |
| **Workshop 3 March 2015 Section 9.3** | Elaborating on Critical Design Issues and develop the first template | Refinement Critical Design Issues and first platform template |
| **Workshop 4 (divided in two parts) June 2015 Section 10.1** | Business Modeling, Business Model Stresstest and Business Model roadmapping | Business Model, Business Model Stresstest and Business Model Roadmap |
| | | |
| **Workshop 5 October 2015 Section 10.2** | Design Sprint to prepare a demonstrator version of the platform | Demo version of the platform |

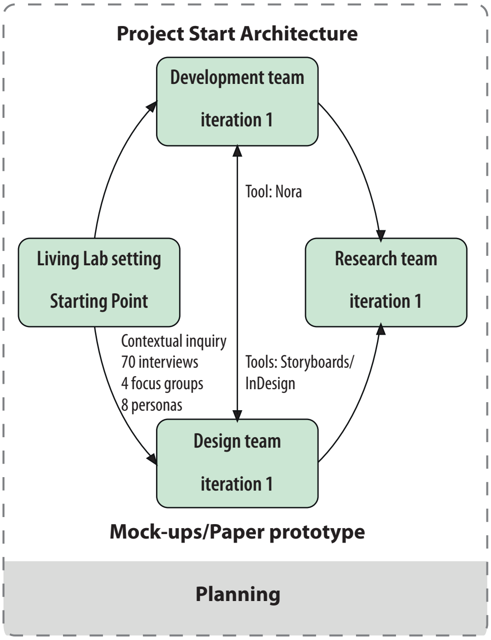
## 7.3 Summary

For our social innovation, which focused on end-user needs, we investigated user-centered methods that matched our design approach. A Living Lab approach helps internalize tacit knowledge from different stakeholders, which can be incorporated into the design of an IT artifact and validated in a real-world environment. Because our Living Lab setting is a co-operation between the university, large and small-medium enterprises, public organizations and end-users we had access to a great deal of expertise to guide the design process of the social innovation. In addition, the Living Lab gave us a unique opportunity to enrich our academic setting during the project and discuss practical insights from business partners, government as well as potential end-users with regard to a possible platform solution.

As explained in section 7.2 two efforts to involve a municipality failed, and only the third effort led to the municipality of Rotterdam coming on board (see table 23). In the first two efforts, the idea for the platform and social innovation were introduced to municipality stakeholders and pitched to the board of Mayor and Aldermen. The first municipality declined to participate, because they failed to the urge for social innovation or the use of a platform to empower their elderly citizens. The second municipality agreed to participate but was unable to initiate the project because of budgetary problems resulting from city infrastructural projects. The third municipality, one of the four largest cities in the country, agreed to participate and initiated our project and, in January 2015, we could officially start the Living Lab project.

To guide the Building, Intervention and Evaluation phase within the Living Lab setting, we used the five stages proposed by Ståhlbröst and Holst (2012), which will be described in the next chapters: 1) Planning (Chapter 8), 2) Conceptual design (Chapter 9), 3) Prototype design (Chapter 10), 4) Innovation design (Chapter 11), and 5) Commercialization of the innovation (future work).

# 8. First design iteration: Planning




In this chapter[1] we describe the Planning stage within the Living Lab setting as part of Research Phase 3: the Building, Intervention and Evaluation phase, which uses the problem framing and theoretical premises identified in stage one as an iterative process in our Living Lab setting. This phase interweaves the Building of the IT artifact, the Intervention in a real-life setting and the Evaluation of the IT artifact, which will be denoted as BIE.

In the remainder of this chapter, we describe how we executed the planning phase, while in Chapters 9 through 11, the other de sign iterations are discussed (i.e., concept design, prototype design, innovation design and commercialization).

## 8.1 First workshop: Kick-off meeting

To execute the planning phase we set up a kick-off meeting to introduce the Living Lab partners to each other and at the same time learn as much as we could about their expectations, values, skills and possible contributions within a relatively short time frame.

*1. Parts of this chapter are published in Keijzer-Broers, W., Florez Atehortua, L., & De Reuver, M. (2015). Prototyping a Multi-sided Health and Wellbeing Platform. Paper presented at the 24th International Conference On Information Systems Development, Harbin.*

In January 2015, eleven stakeholders came together at the Municipality of Rotterdam for the kick-off meeting (see table 24). To encourage knowledge sharing during the session, the ADR researcher, as the workshop moderator, asked the participants to have 'an open mind', with regard to their vision and highlighted the importance of the mixed competencies the different stakeholders brought to the table.

**Table 24. Living Lab partners Kick-off meeting (Q 1 2015)**

| No. | Partner | Occupation | Representative |
|---|---|---|---|
| 1 | **Municipality of Rotterdam** | Innovation manager | ICT and innovation department |
| 2 | **Municipality of Rotterdam** | Policy-maker Health and Wellbeing | WMO helpdesk |
| 3 | **Ziggo (multinational)** | Manager vertical sales | Sales department triple play |
| 4 | **Ziggo (multinational)** | Manager healthcare market | Triple play for healthcare market |
| 5 | **IBM (multinational)** | Innovation manager | Platform integration |
| 6 | **Medvision360 (SME)** | CEO | Service providers (healthcare) |
| 7 | **Neobis (SME)** | CEO | Platform development |
| 8 | **ICTU (governmental foundation)** | ICT Architect | Architecture development |
| 9 | **End-user 1** | Sales manager | Representative of informal caretakers |
| 10 | **End-user 2** | Financial manager and board member of Foundation Zo-Dichtbij | Representative of Young elderly (i.e., age group 55- 75) and of the Foundation Zo-Dichtbij |
| 11 | **University of Delft** | PhD researcher | ADR research |

A survey, that the participants had filled in in advance, was used as a starting point for the session, which focused on the expectations and possible allocation of participants' roles. Based on the survey, the workshop participants agreed about 1) the pre-defined partner selection within the Living Lab setting, 2) the role allocations in relation to the 'think tank' function (i.e., a sanity check for the ADR researcher), 3) the development and the implementation process and 4) end-user involvement. In addition, the suggestion was made that the participants could also focus on playing the role of soundboard for the ADR researcher. Possible additional Living Lab partners, including patient and elderly associations, (healthcare) insurance companies and pension funds, were also discussed. To moderate the complexity of the collaboration, we decided to take these potential partners into account in a next phase of the Living Lab.

The workshop participants discussed and listed the main matchmaking features of the platform (see table 25), which had already been identified during previous research iterations (see Chapter 6), to narrow down the focus of the platform and formulate a starting point for the development phase, while sticking to the essential matchmaking objects.

**Table 25. Objects of matchmaking for the platform**

| | Domestic | Health | Wellbeing |
|---|---|---|---|
| **Products** | Security<br>Home automation | Nursing aids | Entertainment<br>Comfort products |
| **Services** | Renovation (i.e., installer)<br>Maintenance (i.e., gardener) | Personal care<br>Healthcare | Comfort services (i.e., grocery, cooking, housekeeping) |
| **Local activities** | Every day activities<br>Education | Daycare<br>Care related activities | Sports and entertainment<br>Cultural<br>In/outdoor activities |
| **Contacts** | Family<br>Friends | Patient association<br>Healthcare organizations | Elderly association<br>Municipality |
| **Information about aging-in-place** | Advisors<br>Renovators | Municipality | Advisors<br>Caretakers |
| **Integration existing platforms** | Radio and broadcasting<br>Restaurants and takeaway | Governmental | Caregivers<br>Volunteers |

Table 25 illustrates the multiplicity of the objects of matchmaking ranging from basic information exchange to active recommendations for services and matchmaking, and from a pure focus on transactions to inter-active communication with end-users. The workshop participants confirmed our expectation from Chapters 1 – 5, that the platform could be a first mover in the Netherlands to combine and offer 1) matchmaking between smart living products and services, 2) finding local activities, 3) connecting with others (e.g., family, caretakers), 4) information about aging-in-place and 5) integrating successful, existing platforms in the Health and Wellbeing domain.

To align the expectations about the platform the Living Lab partners discussed and approved the functional and non-functional requirements from section 6.2. Additional requirements that were raised, but not mentioned earlier (i.e., 70 interviews and focus groups), are listed below (table 26):

**Table 26. Additional requirements**

| Id | Functional User Requirements |
|---|---|
| $R_{fu}8$ | The platform should channel information from the government and Health and Wellbeing providers |

| Id | Non-functional User Requirements |
|---|---|
| $R_{nfu}11$ | The platform should be monitored and governed by a trusted party |

| Id | Contextual Requirements |
|---|---|
| $R_c7$ | The platform should inform citizens about aging-in-place |
| $R_c8$ | The platform should encourage citizens to take action with regard to aging-in-place |
| $R_c9$ | The platform should have a certified check provided by a trusted party |

The additional requirements in table 26 were discussed by the Living Lab partners and added to the wish list to be taking into account during the development phase of the platform. As additional products and services for the matchmaking functionality (see section 6.1.3), the participants mentioned: t*axi-services and related transportation, Alzheimer cafes* (i.e., for people with partners who have dementia), *Repair cafes* (i.e., for people who like to repair devices etc.), but also *churches, and gatherings in the neighborhood*. Because all these matched the initial platform idea, they were added to the platform wish list as well.

Next, the name of the platform was considered. After careful considerations the Dutch platform is called: Zo-Dichtbij (free translation: As Close As Possible - ACAP).

After the plenary part of the kick-off meeting we created three groups and divided the different tasks among those groups. During the brainstorm session the groups discussed the follow-up strategy, with regard to 1) a high-level architecture of the platform (#5, #6 en #8), 2) possible revenue models (#1, #4, #9) and 3) the organization of the Living Lab setting (#2, #3, #7 en #10). We also decided to enrich the personas with user stories and scenarios (section 8.1.1) to gain a deeper insight into their customer journeys and list requirements without having to do excessive paperwork.

## 8.2 User stories and scenarios

As a result of the kick-off meeting, we appointed three teams for the project (table 24, p. 138) 1) the Research team (led by #11, who supervised eight research assistants), 2) the Development team (#5, #6, #7 and #8) and 3) the Design team (#9, #10). All teams could rely on the research-assistants that worked on the project between Q1 2015 to Q2 2016), while the Living Lab partners from the municipality (#1, #2) were regularly consulted. The same goes for partners who joined the project later on, like Dare to Difr (user experience), Oracle (architecture), UL (privacy and security) and elderly associations (intermediary elderly people).

The following tasks were appointed to the Research team 1) refinement of the personas and 2) development of user stories and scenarios. At the same time, the Design team worked on the paper prototype (section 8.3), while the Development team refined the high level architecture of the platform (section 8.4). Based on the input from the Living Lab partners and the focus group participants, the Research team elaborated the eight personas and used them as an input for user stories and scenario descriptions. The purpose of the personas and their associated task scenarios is to describe what the current customer journey looks like from different perspectives and, in addition, *if and how a platform could help improve the customer journey to age-in-place*.

With a user story, a system requirement is documented as a short, simple description told from the perspective of the person who wants the system, usually a user or customer of the system (Cohn, 2004). As a <*type of user*>, *I want* <*some goal*> so that <*some reason*>. With user stories requirements are derived from the perspective of the user: *what do they want from the tools or platform?* The format of the user stories actually forces designers to think from a user perspective. A user story is only meant to describe the behavior or flow from a user's perspective and can be sliced horizontally following the INVEST acronym (Wake, 2003): 1) **I**ndependent - can the story stand on its own, 2) **N**egotiable – can the story be changed or removed without effecting something else, 3) **V**aluable – does the story value the end-user, 4) **E**stimable – can you estimate the size of the story, 5) **S**mall – is the story small enough, and 6) **T**estable – can the story be tested and verified. To summarize, the user stories answered the questions: 1) for whom are we building the platform, 2) what are we building (i.e., intention) and 3) why are we building it (i.e., value).

The persona, who was regarded as the most challenging customer, was that of Annie (i.e., persona 2). She represents frail elderly people, who have no kids and are not tech-

## Persona 2 : Annie  Ammerlaan

*put in scene*

| | |
|---|---|
| **Age** | 79 years |
| **Place** | Schipluiden |
| **Home environment** | rural |
| **Marital status** | single, no children |
| **Profession** | housewife |
| **Social class** | below average |
| **Internet** | has no internet |

Annie has a small pension and she is quite lonely. She lives in a rented house. She has travelled a lot, but because of health problems, traveling is complicated. Annie is illiterate and has no experience with the Internet. She simply hates the phone and prefers to talk to people face to face.

**Family members**
Single, no children. She has reasonable contact with her neighbours.

**Health**
Annie is a fragile woman and has undergone several surgeries over the years. She is not that mobile and uses a walker. Mentally speaking she is still well. Despite her limitations, she remains happy and cheerful.

**Hobbies**
Reading, knitting, playing cards and watching TV. She loves socializing.

**Special needs**
Annie wants to live as long as possible in her own home environment, though lately that has become more and more difficult. She is in need of domestic help and contacts. She does not have a large social network and also lacks the money. Ideally, she would like to meet people for regular companionship, who can accompany her with outdoor activities as well.

Fig. 24. Persona Annie, who is 79, living alone and is not tech-savvy.

savvy, and therefore need an intermediary to guide them through the complexities of the Dutch health and social care system (see figure 24).

Annie is one of the eight personas and, based on several interviews with elderly people who are like Annie, the following user stories have been created for her, categorized as either functional, user interaction or contextual requirements (Verschuren & Hartog, 2005). See table 27.

| **Table 27. User stories for Persona Annie** | |
|---|---|
| **Requirements** | **As Annie an elderly person (79), who is single and does not use Internet ….** |
| **Functional** | … I need someone who can support me with my household tasks, so that I can stay independently at my place for a longer period of time |
| | … I need to find the right help at the right time to support me with home-related problems, like repairs, domestic help, transportation etc. |
| **User interaction** | … I don't need a system, I need real people |
| | … I need someone to talk to and to keep me company every now and then |
| | … I want people as back-up, but no meddling |
| | … I want to avoid noisy people in my house, because I want to stay in control myself |
| **Social context** | …. I need someone who can arrange help for me if needed |
| | … I need people who I can reach quickly in case of an emergency |
| | … I need activities in my neighborhood that I can join and that match my interests |

To create a more vivid understanding of what user stories might mean in practice, we expanded Annie's user story with scenario descriptions. A scenario is an analytical tool, based on evidence gathered during interviews, that provides a *'concise description of a persona using a software-based product to achieve a goal'* (Cooper, 1999, p. 180) and that can be used as an example of 1) a trigger event that may occur to Annie and 2) an understanding of the steps that Annie takes according to the setting of a user story.

One of the scenarios discussed for Annie was: *What if Annie, a single and elderly lady (79), had a small surgery? Who makes the practical arrangements to ensure Annie can return home instead of having to recover in a rehabilitation center?*

Because persona Annie has no children who can take care of her, we introduced a nephew as her intermediary, not only to pick her up from the hospital after her surgery,


Fig. 25 One of the scenarios, according to Persona 2: elderly person called Annie. (The WMO helpdesk is the Dutch Social Support Act).

but also to guide her through the Dutch healthcare system: from the arrangements with the WMO helpdesk, to the 'kitchen table conversation' (i.e., indication of which help is needed for people with impairments), and arranging additional help for Annie at her place. See figure 25 for the visualization of Annie's scenario, which is used as a reminder for the Living Lab partners during the project.

Although Annie is the subject of our social innovation *'How to age-in-place'*, due to her age and her aversion to technology, it is unlikely that she will use a kind of online system. On the other side, because Annie probably is in need of *some sort of help* within a *certain amount of time*, she needs an intermediary to help look for local products, services, contacts and activities. To verify our assumptions about 'Annie' and to validate the suggested requirements (section 6.1.4) we decided to include end-user expectations and related questions in two end-user surveys (see section 9.2). To do so, we developed the initial sketches (i.e., a paper prototype) that reflect Annie's situation, which at the same time takes an intermediary role of an informal caretaker into account. The Research team expanded all eight personas (see appendix) with user stories and scenarios, but to safe space we excluded them from the dissertation.

## 8.3 Paper prototype

After the Living Lab partners agreed to use the user stories and Annie's possible scenario as one of the core foci, the Development team translated the main platform features (i.e., marketplace products and services, contacts, local activities, information exchange and integrating existing platforms) into a simple navigation map from an end-user perspective (i.e., elderly person and informal caretaker). See figure 26.

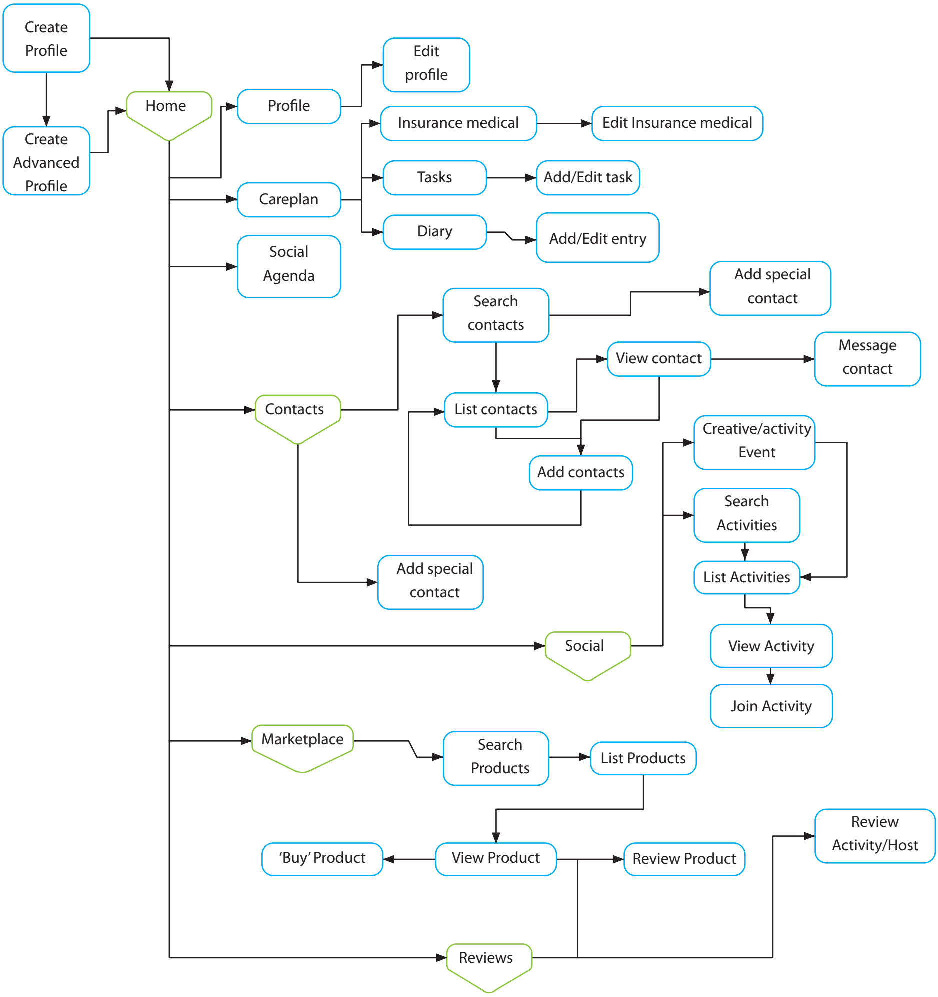



Fig. 26. Navigation plan from an end-user perspective (i.e., elderly person/informal caretaker).

Based on the refined requirements (section 6.2) the navigation plan basically captures basically three core functionalities: 1) a social environment for local activities and contacts, 2) a marketplace for smart living products and services with reviews, and 3) a personal


Fig. 27. First sketch of the Care Plan.

Health and Wellbeing profile, which can be displayed as a Care Plan. The rationale behind the Care Plan ($\mathbf{R}_{fu}7$ – see section 6.2) is that people themselves can decide what is done in relation to their own health and wellbeing, such as measuring, tracking, experimenting and engaging in interventions, treatments and activities. A Care Plan can contribute to an increased level of information flow, transparency, customization, collaboration and responsibility-taking aspects from an end-user perspective.

### 8.3.1 Care plan

As a second step, the ADR Research team translated the Care plan into a simple dashboard sketch, to present to potential end-users.

Figure 27 is the sketch that represents the perspective of an informal caretaker (for instance Annie's nephew) responsible for an older person (e.g. persona Annie). This is illustrated in the top bar of the sketch, where it is shown on whose profile the user is acting, self (My home) or some else's (Annie's home).

The Care Plan has five key elements:

(1) The menu to the left provides access to the three main features identified earlier as requirements, such as contacts, activities and smart living products and services.

(2) The agenda contains the tasks assigned to the user (i.e., Annie) by a doctor, caretaker or relative (or any other user with the required permission) related to Annie's health and wellbeing. In addition, the agenda contains activities/events, which are occasions that Annie (or someone else on her behalf) has voluntarily joined (through the Activities option on the menu to the left) as part of her social agenda.

(3) The diary keeps a record of events, observations and experiences of Annie giving others a traceable log of Annie's health and wellbeing, which can be shared with family and informal caretakers.

(4) Insurance and medical info contains the insurance policy file of Annie and other medical information that is important for Annie and those surrounding her.

(5) The notification section at the bottom reminds the user to complete the profile (so that relevant social activities can be suggested for Annie) and to review products and services that have been acquired (to present the feedback to other users and reduce the customer's risk perception in relation to the platform when purchasing products and services).

The Care Plan can be used by the end-user or shared with relatives, a district nurse, or even a care broker, but only with the profile owner's (e.g. Annie) permission. In addition, the Care Plan is key in our design for user engagement and adoption; it is a differentiator in terms of meeting the needs of potential users within the context of Health and Wellbeing. In other words, this functionality allows for an efficient handling of information for people involved in the care of others.

### 8.3.2 *First user test*

As a direct check involving potential end-users in Q1 2015, we included four face-to-face interviews as a lightweight user test to review the paper prototype outside the Living Lab (i.e., an elderly couple of 80+, an informal caretaker and a district nurse). The goal of the intended health and wellbeing platform was clear to all the interviewees and the platform was perceived as being beneficial for their own sake or to support others. In their opinion, the platform could especially be useful for elderly people (with digital skills), informal and formal caretakers, and people with chronic conditions or impairments. All the interviewees were able to describe the different elements and their purpose without any help from the researchers. Although they knew it was an initial sketch (i.e., a paper prototype) they gave helpful comments about font sizes, colors, missing elements and word choices.

Based on their input, a User Experience designer transformed the initial sketch of the care plan after a couple of revisions into a more appropriate paper prototype version, which could be included in two end-user surveys for a broader evaluation (see figure 28). The end-user surveys are described in Chapter 9.

## 8.4 Second workshop: Project Start Architecture

In a second workshop (February 2015), the overall architecture of the platform was further specified, by designing a reference architecture that provides a template solution for the service platform. The workshop was moderated by one of the Living Lab partners (i.e., an architect from the governmental Foundation ICTU). The nine Living Lab partners (see table 26: #3, #5, #6, #7, #8, #9, #10 en #11) who attended the Project Start Architecture workshop knew each other from the kick-off meeting.

During the workshop, the participants were provided with a particular reference architecture (i.e., Project Start Architecture) based on NORA, which is an acronym for the Dutch government reference architecture (NORA, 2010). Adopting a reference architecture within the Living Lab was expected to accelerate the delivery of the platform through the re-use of building blocks and existing solutions, by providing a common vocabulary to discuss the platform development within the Living Lab and create the structure of the artifact-to-be. The reason for adopting the Project Start Architecture (PSA) from ICTU was because we 1) could connect to a governmental reference architecture, which is specifically developed for the healthcare domain, and 2) could prepare for the scalability of the platform. The PSA consists of 1) a functions list, 2) indications of the interface and different interactions, and 3) the scope of the platform used to guide the technological decisions within the Living Lab.

The Dutch governmental reference architecture (NORA) was established in 2009, as the


Fig. 28. Paper prototype of the Care Plan (Dutch version).

main architectural framework for the Dutch government, which should support service design. Using the NORA and its associated building blocks in the design should: 1) improve the interconnectivity between the Living Lab partners, 2) improve the quality of service and, 3) allow private companies to adhere to government standards. Although the framework appears to work within a government settings, it was unclear whether the NORA could also be used in a public/private setting like the one incorporated in our Living Lab, while developing a Health and Wellbeing platform.

Before entering the second workshop, the expected benefits for the application of the NORA for Zo-Dichtbij were made more explicit and used as a starting point for the verification of:

1) interoperability (technical, semantic and organizational wise)
2) service level and robustness of the platform
3) ability to scale up the platform to a national level
4) ability to collaborate with the Dutch government

During the workshop we agreed about the working definition of Zo-Dichtbij and described the intention of the platform as:

*Zo-Dichtbij is an iterative and incrementally developed portal aimed at living independently bundled together within the Health and Wellbeing domain (i.e., smart living). The platform will be designed in such a way that it is interactive and will target citizens, the industry and the government. The platform aims to function as a social intervention instrument that will purposefully affect the behavior and circumstances of citizens as a way to increase their quality of life and create a community in which society as a whole benefits. The platform does not in the first place generate new services (apart from the platform services itself), but will focus on bringing together supply and demand.*

The participants agreed that the first deliverable should be a small-scale platform focused on the area of smart living that collects data and provides services within the municipality of Rotterdam.

This so-called Minimal Viable Product should at least 1) deliver an easy way for citizens to find products and services, 2) generate insights into the ability to cope with independence of citizens, 3) generate insights into the needs of citizens within the health and wellbeing domain, and 4) generate insights into the transaction costs that are paired with products and services in the Health and Wellbeing domain.

To that end, we used ten main principles and 40 derivative principles of NORA (see www.noraonline.nl). Each principle is accompanied by an application, rule or action (see table 28) relating to the provision of public services, and includes all activities by or through which service-providers carry out public tasks.

| **Table 28. Ten basic principles (BP) from the NORA reference architecture** | | |
|---|---|---|
| **Proactive** | BP01 | Service users will get the service they need |
| **Findable** | BP02 | Service users can easily find the service |
| **Accessibility** | BP03 | Service users can easily get access to the service |
| **Standard** | BP04 | Service users experience uniformity through the use of standard solutions. |
| **Coupling** | BP05 | Service users are offered services that are alike |
| **Transparent** | BP06 | Service users can access information that is relevant to them |
| **Necessity** | BP07 | Service users are not confronted with unnecessary questions |
| **Confidential** | BP08 | Service users should be able to trust that their information is not abused |
| **Reliable** | BP09 | Service users should be able to trust that the service provider keeps made agreements |
| **Constructive feedback** | BP10 | Service users can contribute to the service |

The PSA is meant to ensure an adequate and sustainable solution for services that comply with 40 architectural principles (see fragment in figure 29) with regard to technologies, service orientation, roles and responsibilities for providing digital services by the Dutch government.

| ID | Description | Application/effect | Relevance |
|---|---|---|---|
| AP01 | Services are reusable<br><br>(The service is designed so that other organizations can reuse them in private services) | What are potentially reusable services / facilities Zo-Dichtbij? Who could be interested in using it? https://www.logius.nl/diensten/samenwerkende-catalogi/<br><br>This AP is not applicable. Unless Zo-Dichtbij wants to openly share their information and systems this AP does not hold in terms of competition. If Zo-Dichtbij wants to share The use of the API store will enhance this principle and because the functionalities are designed as separate services.<br><br>The service should use open standards, but cannot be registered in a national service register. The services are designed in a general way and the Zo-Dichtbij specification is minimized. | 2 |
| AP02 | Uncoupling with services<br><br>(The steps in the service process are opened up as a service) | Zo-Dichtbij is not (yet) put down as a service process. There are as of now no definite process steps. That makes this principle irrelevant for the time being.<br><br>The main service is Zo-Dichtbij is the matchmaking between end-users and healthcare providers. | 0 |
| AP03 | Services complement each other<br><br>(The service complements other services to and does not overlap) | What role Zo-Dichtbij therein (compete, connect, ...) and how Zo-Dichtbij fills that role than (in terms of architecture, but also in terms of communication). Are the target groups of the various initiatives under or not?<br><br>The internal process steps are meant to be unique in this system. Between external systems this is logical for marketing concepts. The smart living area is underpopulated and therefore Zo-Dichtbij seems to fit. The combination of the | 0 |

Fig. 29. Fragment of the NORA design principles for Zo-Dichtbij (Project Start Architecture is written in red and the Solution Architecture in blue).

How the Project Start Architecture evolved in a Solution Architecture for Zo-Dichtbij, is described by research-assistant Greve (2016). Greve's report[2], contains the final architecture as well as the 40 principles, and can be used as a guideline to scale up the service platform.

## 8.5 Conclusion of the Planning phase

The Planning phase is used mainly to gain a common perspective and understanding about the research project 1) decisions regarding the project teams, 2) the purpose of the project, 3) important constraints (i.e., non-monetized and limited time) and 4) the pains and gains for the partners. The kick-off meeting was considered helpful in introducing everyone to each other and setting boundaries for the platform solution.

In the first part of the planning phase we arranged the practical and 'gentleman's agreements' with the Living lab partners. In addition, we agreed about: 1) the pre-defined partner selection within the Living Lab setting, 2) role allocations with regard to the 'think tank' function, the development and the implementation process, 3) end-user involvement, 4) the follow-up strategy, and 5) the prioritization of requirements.

To focus attention on problems and opportunities of a specific target audience, we used different design tools (i.e., personas, user stories and scenarios), which are considered to be helpful in fleshing out the platform users and in simplifying the understanding of and communication about these users involving the Living Lab partners.

As a follow-up the Research team (together with the Expert Team) elaborated on the refinement of persona 'Annie' and the development of her user story and scenario. In the meantime, the Design Team focused on the navigation map of the platform, the initial platform sketch and a lightweight user test.

In the second part of the Planning phase, we considered the development of the reference architecture for Zo-Dichtbij, which is used as a starting point for the Concept Design phase (See Chapter 9). The timing of the workshop Project Start Architecture is considered 'just-in-time'. As such, it resulted in a Project Start Architecture (PSA) document, which offered the Living Lab setting a first base from which steps could be taken in the iterative and incremental development towards a stable and durable

*2. The report on how the 40 NORA principles evolved from a Project Start Architecture into a Solution Architecture is available on request.*

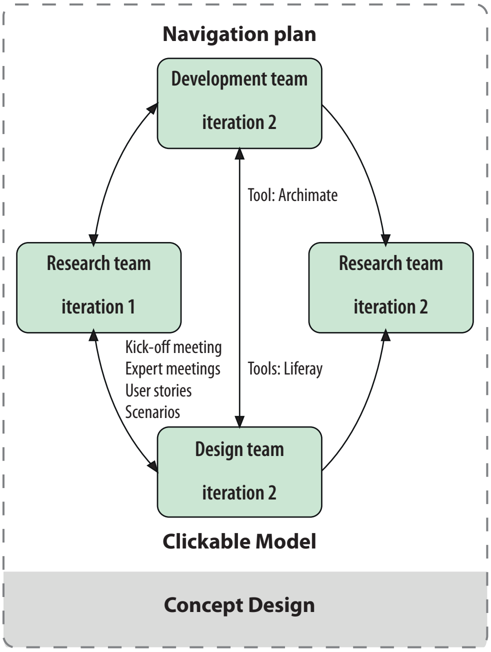
platform. The PSA formed the basis for the more detailed Solution Architecture and is used mainly to inform the decision-making process before and during the start of the project. As such, the document could be used as a guideline. Another purpose of the PSA is to develop a framework for architects and developers during the execution of the project. Ultimately, the PSA enhanced the development speed and efficiency of the project and made sure the solution fitted in the context set into the context set in this period of time. The PSA outlined the existing situation and showed where the project could possibly deviate from the initial context.

A summary of the different research steps in the BIE – Planning phase is presented in table 29.

**Table 29. Research phase 3: BIE – Planning**

| | |
|---|---|
| **Research input** | Pre-arrangements for the Living Lab setting (section 7.2) |
| **Research throughput** | Kick-off meeting Living Lab partner: 1) deciding about the project teams, 2) the purpose of the project, 3) important constraints (i.e., non-monetized and limited time) and 4) the pains and gains for the partners (section 8.1)<br>Refining personas, user stories and scenarios (section 8.2)<br>Developing navigation plan and paper prototype (section 8.3)<br>Technical workshop: structure and technical architecture of the platform based on the NORA Project Start Architecture (section 8.4) |
| **Research output** | Paper prototype of the platform (section 8.2)<br>Project Start Architecture: guideline to inform the decision making process (section 8.4) |

# 9. Second design iteration: Concept Design




In this chapter[1] we describe the Concept Design stage (i.e., second design iteration) within the Living Lab setting, as part of Research Phase 3: the Building, Intervention and Evaluation phase. Based on the input from the early testers (section 8.2.2), the ADR Development team worked on the refinement of the navigation plan, while the ADR Design team, according this navigation plan, developed mock-ups (section 8.1), which are translated in a clickable model of Zo-Dichtbij. Because programming is the heaviest component of developing a platform (i.e., the most expensive and hardest to change), we started by designing a clickable model. Based on the main features, we developed the screens, to ensure that we had the interface right before risking getting the software wrong and losing a great deal of time and money. In the design of the clickable model, several principles were incorporated in this effort, including visual hierarchy, simplicity and the use of familiar patterns from successful IT artifacts (e.g., Facebook, Google calendar).

1. *Parts of this chapter are published in Keijzer-Broers, W., Florez Atehortua, L., & De Reuver, M. (2016). Prototyping a Health and Wellbeing Platform: an Action Design Research Approach. Paper presented at the 49th Hawaii International Conference on System Sciences (HICSS), Kauai.*

## 9.1 Second round of user tests

After the clickable model was developed, we conducted a second user test with six participants (i.e., two elderly persons, two informal caretakers and two professional caretakers). Using familiar patterns when designing a prototype helps potential users feel more acquainted with the IT artifact. Although preparing a clickable model for a user test is a minor effort compared to developing a fully functional IT artifact, in our view the effects of testing could be comparable. Although the participants were not provided with a full experience, the user test was designed in a way that highlighted critical elements of the IT artifact, based on specific tasks and goals given to the participants as a controlled setting, creating the *feeling* of a finalized IT artifact.

In the test, which took approximately 1.5 hour per person, data was collected on the time that the participants took to complete the given tasks, as well as the overall experience with the prototype.

Leavitt and Shneiderman (2006) argue that usability testing should be performed early on in the design process with a small number of users (approximately six) in order to identify problems with the navigation and overall design. Once the navigation, basic content and display features are in place, quantitative performance testing (e.g., measuring time, erroneous pathways, failure to find content) can be conducted to ensure that usability objectives are met. In addition to provide valuable input on how the IT artifact could evolve towards a usable tool, the role of the usability test is to measure acceptance of the IT artifact in the early design stages. The user test was intended to

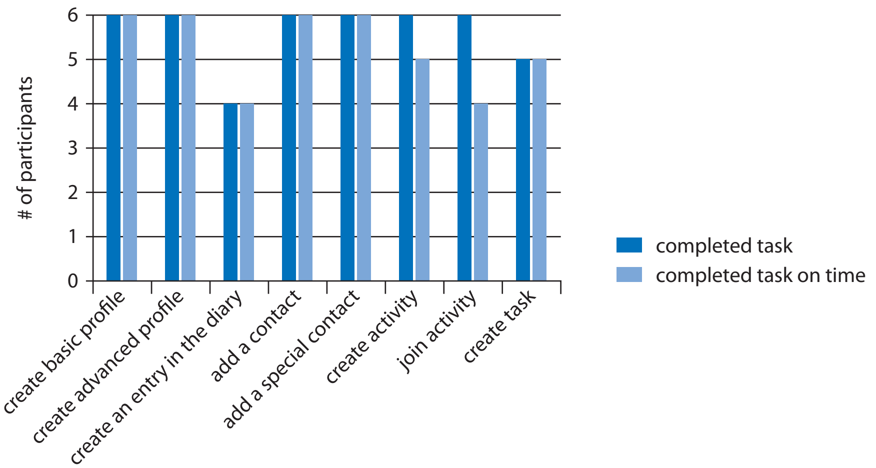



Fig. 30. Tasks as part of the user test with six participants (i.e., two elderly persons, two informal caretakers and two professional caretakers).

determine the extent to which the interface facilitates the user's ability to complete eight key tasks: 1) create a basic profile, 2) create an advanced profile, 3) create an entry in the diary, 4) add a contact, 5) add a special contact, 6) create an activity, 7) join an activity and 8) create a task (see figure 30). Sessions were recorded and minutes were taken to identify critical areas for improvement of the IT artifact.

Although, compared to the elderly people (i.e., 70+) the caretakers in some cases were able to perform the tasks more easily, except for entering the diary, the elderly people had no major issues using the clickable model. This second user test was helpful to execute the next iteration of improve the prototype (Keijzer-Broers, Florez Atehortua, & De Reuver, 2015). The quantitative data (based on a questionnaire) and qualitative data (based on face to face interviews) collected in the user tests are incorporated in a report (Florez, 2015), which is used by the Design team to make changes before retesting the IT artifact with the Living Lab partners, followed by a test with district nurses and WMO advisors from the municipality. Although no major issues emerged during this third user test with regard to improving the clickable model, the interviews with the district nurses revealed that independent living has a broad interpretation, which leads to mixed preferences among elderly people. While some of them prefer to age-in-place, others choose to live in elderly care settings to avoid living alone and to maintain interaction with other people. Health condition, housing arrangements, gender, and support from society are factors that affect the preferences of elderly people with regard to independent living. Different preferences about independent living make it clear that, despite the availability of a platform like Zo-Dichtbij, there is no guarantee that elderly will indeed use the platform. They have a choice whether or not to use Zo-Dichtbij, a choice that depends on what they value in their lives. Those who do not value independent living and prefer to live in a nursing home will probably not use Zo-Dichtbij, while others who do value the importance of independent living are maybe more likely to use the platform.

## 9.2 End-user surveys

Based on the recommendations from the testers, we revised the paper prototype and included the sketch of the Care Plan (figure 28, p. 153) in two broad end-user surveys to collect further data. The rationale behind the surveys was to validate the requirements gathered during the earlier research phases and to conduct an initial validation using the Capability Approach (section 9.2.1). We used surveys to try and reveal why people might want to use the platform, but also what is the potential impact on people when using the platform and to that end we focused on the needs of (elderly) people to expand their capabilities to achieve independent living (Yeung & Breheny, 2016) and how such a platform could help them in that respect (Oosterlaken, 2009). To show how the Capability Approach (CA) informed our design and how the platform can support capabilities and functionings of young elderly people and informal caretakers, we first describe how we operationalized our conceptual CA model (see figure 31 and description of the Capability Approach in section 4.2) in the two end-user surveys (see table 31). Based on the conceptual CA model we operationalized the construct into survey questions. See table 30.

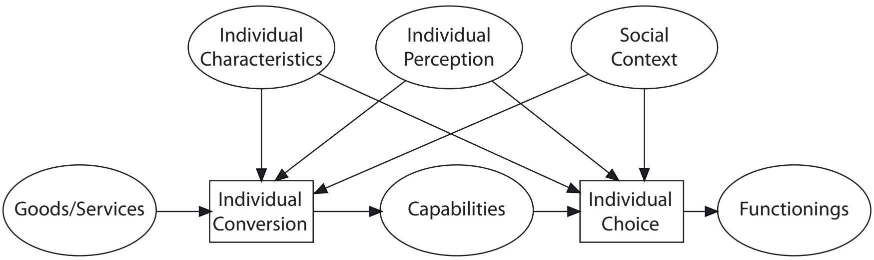



Fig. 31. Conceptual model of the Capability Approach.

**Table 30. Operationalization of the CA construct.**

| Construct | Variable | Description | Survey Items |
|---|---|---|---|
| **Individual characteristics** | Age | Elderly people will face more age-related challenges that can affect their ability to use ICT in their daily lives (Kapadia et al., 2015). | What is your year of birth? |
| | Gender | The use of ICT is never gender-neutral, and gender plays a role in determining the ICT needs of individuals (Alampay, 2006). | What is your gender? |
| | (Health) condition | To adopt new technologies, elderly people need to be in a good functional condition (Talaei-Khoei et al., 2015) or cognitively competent (Czaja et al., 2006). | Which aspects in daily life are difficult for the person you are taking care of? |
| | Technological knowledge | Older people need to be technically experienced to use ICT (Talaei-Khoei et al., 2015). People with a higher technological proficiency tend to use ICT more compared to those who are technophobic (Kapadia et al., 2015). | Are you able to use this platform without any difficulties? |
| | Daily activities | The use of ICT highly to a large extent depends on the occupation of individuals, with professionals expected to use ICT more (Alampay, 2006). | What are you doing in daily life? |
| | | | Who will benefit from a Health and Wellbeing platform? |

| | | | |
|---|---|---|---|
| **Goods / Services** | Platform features | ICT can be interpreted as a commodity that is valuable to individuals and can help them do or be (Heeks & Molla, 2009) . In particular, it is the feature that enables individuals to achieve something that they value (Hatakka & De, 2011). | Which elements would be important on the platform? |
| | | | How important are the following possibilities on the platform? |
| **Social context** | Recommendation from others | The decision making process of the elderly people to use ICT could be influenced by the people closest to them, such as family, friends and professional care providers (Alampay, 2006; Kapadia et al., 2015; Talaei-Khoei et al., 2015). | Who would you ask for advice about Health and Wellbeing? |
| | | | Where would you look for products and services for Health and Wellbeing? |
| | Satisfaction level | If elderly people are satisfied with using the platform, they will use it more often (Baroudi et al., 1986). | What is your satisfaction level in finding products and services for Health and Wellbeing? |
| | Expected benefits | The perception of elderly people regarding the expected benefits of using ICT plays an important role as a driver for them for using ICT (Melenhorst et al., 2006; Mitzner et al., 2010). The benefits include features that are useful to support their activities and improve their convenience (Chen & Chan, 2011). | What do you expect from this platform? |
| **Individual conversion** | Functional & non-functional abilities | Elderly people will use ICT if they believe that it will provide support for their functional and non-functional abilities. This abilities will empower their capabilities to perform daily activities (Talaei-Khoei et al., 2015). | In your opinion, how will this platform provide support for you? |
| **Capabilities** | Platform capabilities | Capabilities is what people are effectively able to do and be (I. Robeyns, 2005). Elderly people have a freedom to utilize the platform according to what they value (Hatakka & De, 2011). | I assume the platform will help me (or the one I take care of) to … |
| **Freedom to choose** | Intention to use | Elderly people will have the intention to use ICT / choose to use the features of the platform as a means to achieve independent living (Chen & Chan, 2011; Talaei-Khoei et al., 2015). | Which functionalities would you like to use (now or in the future)? |
| **Achieved functionings** | Independent living | It is important for elderly people to maintain their independence, for instance by staying in their own home (Mynatt & Rogers, 2001). They value independent living because it can improve their competence and own the way they live (Talaei-Khoei et al., 2015). | Which aspects in daily life that are difficult for you / the one you are taking care of? |

The first group of end-users, who received the online survey in February 2015, covered the LinkedIn network from the ADR researcher with approximately 1100 members. Within two weeks, 474 people responded (i.e., a 43% response rate). Although the target group can be regarded as a convenience sample, with the intention of obtaining a first impression about the interest in a Health and Wellbeing platform from the perspective of a large, heterogeneous group of people (i.e., different age group, gender and profession), we learned that almost 30% of the respondents was already an informal caretaker (at least 1 – 3 hours a week) and that 43% of the respondents belonged to the young elderly group (age > 55).

After a first analysis of the convenience sample, which looked promising, we decided to repeat the survey with a group of people, who were selected intentionally as young elderly/informal caretakers, to take a closer look at this specific target group. In April 2015, a panel of 400 informal caretakers from the Tympaan institute also received the survey. The Tympaan research institute focuses on quality of life in the social domain, ranging from youth and culture to care and informal participation. Within two weeks we received 150 responses (38% response rate), 82 female (57%) and 68 male (43%). The average age of the respondents is 71 years with a standard deviation of 8.78 years; 75% of our respondents are above 66. Both their age and the fact that they are informal caretakers (25% for even more than 9 hours a week), matches the platform's main target group. For an overview of the main characteristics of the survey samples see table 31.

**Table 31. Main characteristics of the survey respondents N = 150 Tympaan panel**

| | | |
|---|---|---|
| **Gender** | Male | 43% |
| | Female | 57% |
| **Age** | < 55 years old | 5% |
| | ≥ 55 years old | 95% |
| | Average | 71.25 years old |
| | Max | 88 years old |
| | Min | 46 years old |
| | Std. Deviation | 8.61 |
| **Nationality** | Dutch | 100% |
| | Others | 0% |
| **Informal caretakers (> 3 hours a week)** | Yes | 58% |
| | No | 42% |

The survey, which was used as an early evaluation of the platform, consisted of 28 questions. Because not all survey items were relevant examining the causality between the health and wellbeing platform and independent living, we selected the key questions that are relevant to the operationalization result of our CA model (see figure 31, p. 162). Our measurement selection is presented in table 32.

**Table 32. Selection of survey questions related to the Capability Approach**

| Construct | Dimension | Survey question |
|---|---|---|
| **Individual characteristics** | (Health) condition | 24. Who will benefit from a Health and Wellbeing platform? |
| | | 18. Which aspects in daily life are difficult for the person you are taking care of? |
| **Goods/Services** | Features of Zo-Dichtbij | 25. Which elements would be important on the platform? (8 items) |
| | | 26. How important are following possibilities on the platform? (8 items) |
| **Capabilities** | Capabilities enabled by Zo-Dichtbij | 28. I assume the platform will help me (or the person I am taking care of) to … (14 items) |
| **Individual perceptions** | Satisfaction level | 17. What is your level of satisfaction in finding products and services for Health and Wellbeing? (4 items) |
| **Social context** | Recommendation from others | 15. Who would you ask for advice about Health and Wellbeing? (8 items) |
| | | 16. Where would you look for products and services for Health and Wellbeing? (4 items) |

Each question in table 32 consists of several survey items based on the 7- points Likert scale (strongly disagree – strongly agree).

### *9.2.1 Analysis of the survey sample*

We describe the answers of participants using a frequency analysis, showing the mean and standard deviation. We consider 4 as a neutral value on the scale of 1 to 7, and assumed that a mean value above 4 represents a positive perception of the survey item in question. For every question, we also performed a one sample T-test with test value = 4, to test whether the average of each survey item is significantly higher than 4. The descriptive statistics results are discussed on page 166.

*Who will benefit from using the platform Zo-Dichtbij?*

We first analyzed the perception regarding important stakeholders, who could possibly benefit from a service platform (see table 33).

**Table 33. Descriptive statistics and one sample t-test for question 24**

| | N | Mean | Std. deviation | Sig. (2-tailed) |
|---|---|---|---|---|
| **Citizens in general** | 122 | 4.7 | 1.9 | .000 |
| **Young elderly (55-75 year old)** | 122 | 5.2 | 1.5 | .000 |
| **Elderly (75+)** | 119 | 5.2 | 1.9 | .000 |
| **People with physical disabilities** | 119 | 5.5 | 1.7 | .000 |
| **People with mental disabilities** | 119 | 4.9 | 1.9 | .000 |
| **Product providers** | 117 | 4.6 | 1.8 | .001 |
| **Service providers** | 117 | 4.9 | 1.8 | .000 |
| **Informal caretakers (relatives included)** | 125 | 6.0 | 1.3 | .000 |
| **Volunteers** | 121 | 5.8 | 1.4 | .000 |
| **Municipality (Social Care Act)** | 118 | 5.4 | 1.9 | .000 |

The statistics show that all the stakeholder groups have scores significantly higher than 4 ($p = .05$), which means that they would all benefit from using Zo-Dichtbij. Informal caretakers and volunteers will benefit the most, followed by people with physical disabilities and the municipality. It is not surprising that informal caretakers and volunteers would benefit the most from the platform, since the participants are part of an informal caretakers panel. Their perspective leads to the perception that Zo-Dichtbij will make their lives easier in terms of taking care of other people, especially elderly people.

*Individual characteristics: difficult aspects to handle*

We also examined which aspects of daily life in general are difficult to handle by elderly people to determine which capabilities require enhancement through a platform like Zo-Dichtbij. The descriptive statistics indicate that all items have an average score above 4, except 'enjoy food and drinks'. However, two other items were not significantly higher than 4, namely 'safety in and around the house' and 'memory' ($p = .05$). Consequently, these three aspects were perceived to be the least difficult to handle by elderly people.

**Table 34. Descriptive statistics and one sample t-test for question 18**

| | N | Mean | Std. Deviation | Sig. (2-tailed) |
|---|---|---|---|---|
| **Enjoy food and drinks** | 112 | 3.2 | 1.8 | .000 |
| **Go outside** | 112 | 5.0 | 1.9 | .000 |
| **Social life (contacts)** | 112 | 4.9 | 1.9 | .000 |
| **Safety in and around the house** | 111 | 4.1 | 1.9 | .551 |
| **Mobility in and around the house** | 110 | 4.6 | 1.9 | .003 |
| **Leisure (hobbies, sports)** | 109 | 5.6 | 1.9 | .000 |
| **Traveling** | 113 | 5.7 | 1.8 | .000 |
| **Memory** | 111 | 4.2 | 2.1 | .443 |
| **Cooking** | 109 | 5.1 | 2.2 | .000 |
| **Washing and getting dressed** | 110 | 5.0 | 2.1 | .000 |
| **Household** | 108 | 5.6 | 1.9 | .000 |
| **Gardening and maintenance tasks** | 110 | 5.9 | 1.8 | .000 |

Table 34 shows that the most difficult aspect to handle by elderly people is related to *gardening* and *maintenance tasks*, followed by activities related to *traveling*, *leisure* and *household*. *Cooking activities* and *going outside*, such as buying groceries, are also difficult to handle by elderly people, although they would appear to be less difficult as activities mentioned previously. These findings were subsequently used as input to ensure that Zo-Dichtbij would be able to provide relevant solutions to deal with these difficulties.

***Important features of Zo-Dichtbij***

Next, we analyzed the perceived importance of the platform features from the participants' perspective. Although the average score is higher than 4 for all features, one feature (marketplace products and services) is not significantly higher than 4 ($p = .05$), which indicates that the participants believed that all the other features are important.

| Table 35. Descriptive statistics and one sample t-test for question 25 | | | | |
|---|---|---|---|---|
| | **N** | **Mean** | **Std. Deviation** | **Sig. (2-tailed)** |
| **Marketplace products and services** | 113 | 4.3 | 2.0 | .078 |
| **Care plan (medical information and insurances)** | 120 | 5.5 | 1.6 | .000 |
| **Agenda for social and medical activities** | 119 | 5.3 | 1.5 | .000 |
| **Personal profile** | 117 | 4.6 | 1.9 | .000 |
| **Review possibilities product and services** | 113 | 4.7 | 1.8 | .000 |
| **Finding local activities** | 118 | 5.4 | 1.5 | .000 |
| **News about Health and Wellbeing** | 119 | 5.6 | 1.4 | .000 |
| **Diary (to share with relatives and caretakers)** | 121 | 4.8 | 1.9 | .000 |

Table 35 indicates that *news about Health and Wellbeing* is the most important feature, followed by the *Care plan, finding local activities,* and agenda. It is interesting that the news feature was given the highest average score, which shows that elderly people wanting to stay independent as long as possible in their own home, need to keep informed about health-related news that may be important to them, that allows them to increase their knowledge and help them make independent decisions on their own, especially in relation to their health condition.

***Non-functional requirements of Zo-Dichtbij***

In addition to analyzing the participants' perception of important features, we also analyzed the non-functional requirements of Zo-Dichtbij that could be important to them. During the data collection process, the purpose of this question is to derive new requirements for further development of Zo-Dichtbij. In our study, we used this question together with the previous question, to analyze important features as a means to enable capabilities to achieve independent living. We present our descriptive statistics for this question in table 36.

**Table 36. Descriptive statistics and one sample t-test for question 26**

| | N | Mean | Std. Deviation | Sig. (2-tailed) |
|---|---|---|---|---|
| **Anonymous use** | 121 | 5.3 | 2.0 | .000 |
| **Available for different devices (mobile, tablets)** | 122 | 5.3 | 1.9 | .000 |
| **Private and secured** | 122 | 6.4 | 1.3 | .000 |
| **Search based on keywords** | 120 | 6.0 | 1.3 | .000 |
| **Local search (postal codes)** | 121 | 5.3 | 1.7 | .000 |
| **Multilingual** | 119 | 4.3 | 2.1 | .076 |
| **Online helpdesk** | 119 | 5.5 | 1.7 | .000 |
| **Telephone helpline** | 119 | 5.7 | 1.7 | .000 |

Although all items scored higher than 4, the 'multilingual' feature is not significantly higher than 4 ($p = .05$), which means that it is the least important to further development, most likely because the participants have the Dutch nationality. In general, the platform should be safe in terms of privacy and security. It is also important to have a keyword-based search feature. Furthermore, a helpdesk feature (i.e., online and telephone) is believed to be important and should also be included in the platform. While a keyword search can help elderly people find what they need by themselves, a helpdesk can provide them with guidance without having to rely on informal caretakers. Moreover, it is also understandable that elderly people require guarantees regarding the privacy and security aspects of Zo-Dichtbij, especially because they are expected to provide some personal information.

*Capabilities enabled by Zo-Dichtbij*

In addition we asked respondents which of the capabilities of elderly people are expected to be enhanced by Zo-Dichtbij. The survey data show that the average scores of all items are significantly higher than 4 ($p = .05$), which indicates that the participants have positive expectations regarding all the capabilities listed in table 37 being enabled by Zo-Dichtbij.

| Table 37. Descriptive statistics and one sample t-test for question 18 | | | | |
|---|---|---|---|---|
| | N | Mean | Std. Deviation | Sig. (2-tailed) |
| Be socially involved | 124 | 5.1 | 1.7 | .000 |
| Add extra comfort at home | 123 | 4.8 | 1.8 | .000 |
| Improve interaction with others | 121 | 4.8 | 1.8 | .000 |
| Unburden myself or others | 121 | 5.0 | 1.7 | .000 |
| Arrange daily schedule | 123 | 4.4 | 1.8 | .023 |
| Find information about Health and Wellbeing | 122 | 5.5 | 1.6 | .000 |
| Filter local supply and demand | 119 | 4.8 | 1.8 | .000 |
| Help others in an easy way | 121 | 4.7 | 1.7 | .000 |
| Share a care plan with others | 122 | 4.8 | 1.9 | .000 |
| Live in a comfortable way | 123 | 5.2 | 1.8 | .000 |
| Avoid moving to another place | 125 | 5.3 | 1.9 | .000 |
| Age-in-place | 123 | 5.5 | 1.8 | .000 |
| Stay independent as long as possible | 124 | 5.7 | 1.7 | .000 |
| Monitor my relatives | 124 | 5.0 | 1.9 | .000 |

Based on the answers provided by the participants, we see that the platform can help elderly people to stay independent as long as possible. In line with this, Zo-Dichtbij can also be important to elderly people as a means of avoiding to move to another place, such as a nursing home. In addition, Zo-Dichtbij can help elderly people find information related to health and wellbeing, which indicates that there is a consistency between the main purpose of Zo-Dichtbij and the capabilities that the platform can generate in terms of independent living.

***Individual perceptions: satisfaction level***

We explored the participants' satisfaction level with regard to finding health and wellbeing products and services (see table 38). The idea is that elderly people are likely to use Zo-Dichtbij because of their disappointment with previous experiences related to finding products and services that they need (Chapter 1). Although all the items have an average score above 4, one item (*find help for family and friends*) is not significantly higher than 4 ($p = .05$).

| Table 38. Descriptive statistics and one sample t-test for question 17 | | | | |
|---|---|---|---|---|
| | **N** | **Mean** | **Std. Deviation** | **Sig. (2-tailed)** |
| **Finding information** | 127 | 4.7 | 1.5 | .000 |
| **Getting advice** | 126 | 4.6 | 1.6 | .000 |
| **Knowing who to turn to** | 126 | 4.5 | 1.9 | .008 |
| **Finding help for family and friends** | 127 | 4.2 | 1.8 | .197 |

Based on the analysis, participants expressed their satisfaction about *finding information, getting advice and knowing whom to turn to*. However, they are less satisfied when it comes to *finding help for family and friends*, possibly because there are too many products and services available in the market, and the information overload makes it difficult for participants, such as informal caretakers, to find the right solution for the people closest to them. As such, this can be an opportunity for Zo-Dichtbij.

*Social context: ask for advice*

Our analysis focused on people that the participants would ask for advice with regard to health and wellbeing. The descriptive statistics for this question are shown in table 38. Four items have an average score above 4, while one sample T-test indicates that only the *healthcare professional, local health and wellbeing provider*, and *local care act desk* are significantly higher than 4 ($p = .05$). We see that elderly people prefer asking advice from a *healthcare professional*, followed by a *local health and wellbeing provider,* and the *local care act desk* (municipality).

| Table 39. Descriptive statistics and one sample t-test for question 15 | | | | |
|---|---|---|---|---|
| | **N** | **Mean** | **Std. Deviation** | **Sig. (2-tailed)** |
| **Family** | 109 | 3.9 | 2.2 | .797 |
| **Friends** | 108 | 3.9 | 1.9 | .441 |
| **Healthcare insurance** | 110 | 3.9 | 2.1 | .649 |
| **Healthcare professional (GP, therapist, etc.)** | 125 | 5.7 | 1.6 | .000 |
| **Healthcare shop** | 110 | 3.8 | 2.0 | .255 |
| **Healthcare and wellbeing advisor** | 118 | 4.3 | 2.0 | .115 |
| **Local Health and Wellbeing provider** | 116 | 4.7 | 2.0 | .000 |
| **Local Care Act desk (municipality)** | 122 | 4.4 | 2.1 | .036 |

These findings suggest that elderly people prefer listening to people who are experienced and understand the context rather than people whom they are related. This may also be why family and friends scored very low compared to other groups. With regard to the context of Zo-Dichtbij, this would mean that elderly people may want to use Zo-Dichtbij if that is recommended by health and wellbeing-related stakeholders. However, this may not be the case if the advice came from family members or closest friends. The rationale behind these findings is that elderly people prefer to listen to professionals when it comes to deciding which products and services they need.

Social context: search for products and services

Finally, we analyzed which media the participants used to look for healthcare-related products and services, and found that '*print*' *and* '*online*' have an average score that is significantly higher than 4 (p = .05). The other two items (*television and meetings*) scored below 4, so we can say that elderly people do not prefer using those two sources to look for products and services.

**Table 40. Descriptive statistics and one sample t-test for question 16**

| | N | Mean | Std. Deviation | Sig. (2-tailed) |
|---|---|---|---|---|
| **Print (magazines, brochures)** | 118 | 4.7 | 2.0 | .000 |
| **Online (internet)** | 126 | 5.9 | 1.6 | .000 |
| **Television** | 112 | 3.7 | 2.0 | .082 |
| **Meetings (exhibitions and presentations)** | 117 | 3.7 | 2.1 | .167 |

We found that participants mostly use online and print sources to look for products and services for health and wellbeing. Again, this presents an opportunity for Zo-Dichtbij as an online platform, because elderly people may be interested in using Zo-Dichtbij, because it allows them to look for products and services online. Another way to interpret these findings has to do with how media (either online or offline) could play a role in influencing elderly people to use Zo-Dichtbij. Elderly people may be interested in using the platform if they were exposed to promotions and commercials about this platform, especially on online and offline media.

### *9.2.2 Conclusion of the Tympaan survey*

Our findings show that independent living is a notion that is perceived to be important by both elderly people and informal caretakers. From the survey analysis related to the Tympaan panel we learned that:

1) Although the average age of the respondents is above 71, they are capable to see the benefits of integrating platform technology as one of the instruments for supporting aging-in-place.
2) People between 55 and 75 can be seen as intermediaries for people who need help aging-in-place.

The CA, as a theoretical framework, can be used to study the contribution of a Health and Wellbeing platform in achieving independent living, but the evaluation should not focus on the availability of resources (goods/services) but rather on the impact of using those resources (capability expansion) to achieve individual goals (achieved functionings). Moreover, the CA values the importance of agency freedom, which means that we have to take people's individual preferences into account. A review of earlier studies suggests that that are three types of conversion factors that influence the capabilities of people: 1) individual characteristics, 2) individual perception and 3) social context.

We have shown that both elderly people and informal caretakers could benefit from this platform. On the one hand, informal caretakers will use features to enhance coordination with other caretakers and help others remain autonomous. On the other hand, elderly people will user several features that enable them to organize their lives and look for appropriate solutions to meet their needs, including a plan board, a diary and the marketplace for products, services and local activities.

To summarize, there are seven features in the platform that can contribute to enable six capabilities to achieve independent living. The features are 1) plan board, 2) activities, 3) diary, 4) Care plan, 5) contacts, 6) products and services and 7) help chat, while the six capabilities are 1) finding activities, 2 finding products and services, 3) manage daily activities, 4) monitor conditions, 5) stay connected with others and 6) arrange help for others. The extent to which the features are used depends very much on the users. Ultimately, the platform will contribute to enabling certain capabilities that can help elderly people to age-in-place, as well as allowing informal caretakers to support elderly people achieve independent living.

## 9.3 Third workshop: Architecture design

To discuss the initial design and architecture of the platform in March 2015, we arranged a third workshop with nine Living Lab partners (i.e., IBM, Ziggo, Neobis, Medvision360, ICTU, Foundation Zo-Dichtbij, Municipality and representatives of the elderly and informal caretakers - see table 26). In the workshop, which was moderated by the ADR researcher with the help of a research-assistant, we elaborated on the Critical Design Issues (CDIs) (see section 5.2.4) and the architecture of the platform. In addition, two new CDIs were identified as the discussion moved towards ensuring the platform's adoption by end-users.

The first new **CDI** is trust, which aims to ensure that the users believe in the reliability of the online platform, the accuracy of the information displayed, and the delivery fulfillment and service between the consumers and providers of products. After further discussion, the participants translated this CDI into two requirements with regard to the platform. The first requirement is a *rating/review* mechanism for products and services offered on the platform; reviewers are end-users who provide a rating and/or review after a transaction (e.g., the act of consuming a product or service or attending an activity offered on the platform) to present the feedback to other users and reduce the perception of risk. The second requirement is a moderator who oversees the transactions and performs actions to enforce the rules set and quality of the products and services being offered; this requirement also increases confidence in the platform by supporting dispute resolution and mediation services between consumers and providers.

The second new CDI is **data privacy**. According to the participants, there should be a clear separation between 'social' data within the platform's context and the data (e.g., medical) that must remain accessible only by the user or other people who are authorized (i.e., care takers, relatives). In addition, the data privacy policy of the platform should be concise and transparent so as to create trust in relation to the platform. For more details about privacy and security, see Mohamed (2015).

As a next step, the workshop participants discussed that, on a multi-sided platform, one contract for all the different types of services offered by all the different service providers would not be enough. In fact, it makes sense to create a system based on approval for each individual transaction within a general overall contract. For instance, approval for the delivery of personal data for each transaction, between a service provider and an individual, requires special software that is comparable to banking software for financial transactions (which can be viewed as a subset of personal data). With regard to the CDIs, the workshop participants agreed on a first high-level template to get an initial idea of the platform architecture. Based on the navigation map, the high-level template and the Project Start Architecture the overview of the platform architecture is described in figure 32.

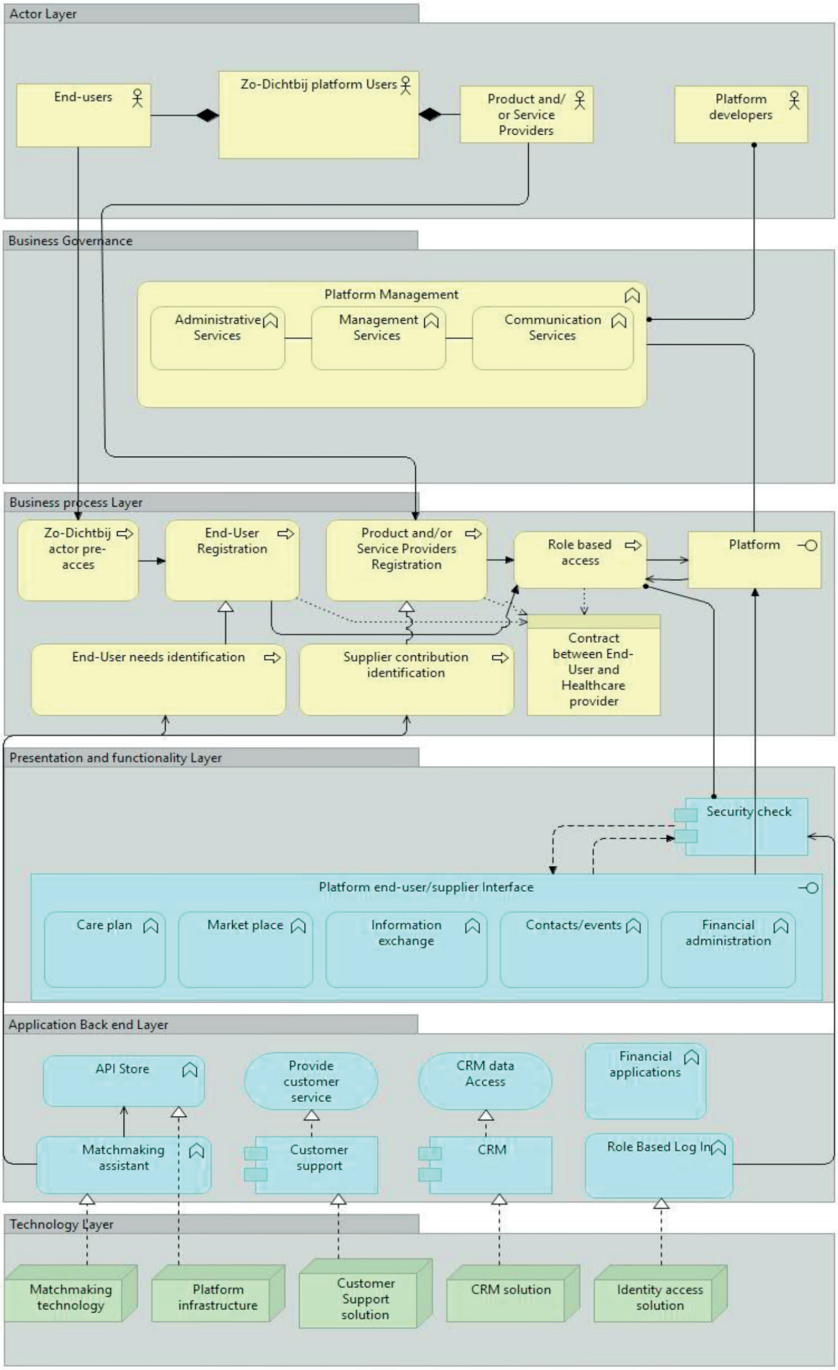



Fig. 32. Overview of the initial platform architecture as described in the Archimate language (The Open Group, 2016).

In addition, the Living Lab partners discussed that all authenticated pages must be accessed exclusively via secured HTTP (i.e., HTTPS), which means that all data throughout the platform that is sent via the Internet will have Transport Layer Protection through the Transport Layer Security (TLS). While the service platform will offer services to individuals and match them with service providers, this requires special attention to privacy issues, because each transaction within the platform is somehow related to personal data of the individual. As such, the platform will be compliant with privacy-by-design principles throughout all the development phases and the entire lifecycle. The appropriate use of existing Privacy Enhancing Technologies (PETs), as well as the EU Data Protection Directive (Directive 95/46/EC) will be implemented. Because compliance with rules on data protection and security is vital for healthcare applications, the platform has to be compliant with state-of-the-art Dutch standards for data security at a database level (i.e., NEN 7510) to allow medical information to be shared.

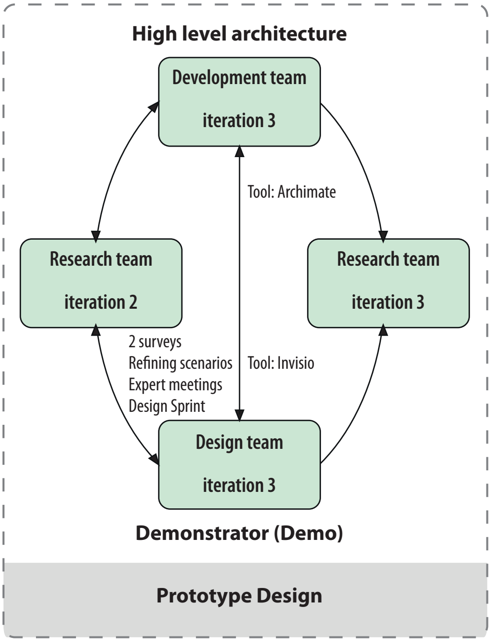
Figure 32 shows the different layers of Zo-Dichtbij (i.e., technology, back-end, presentation and functionality, business process, business governance and the actor layer) and how they are linked to the requirements, as discussed with the technology-oriented Living Lab partners. The look and feel of the final, extensive, architecture of Zo-Dichtbij looks is shown in appendix B.

## 9.4 Conclusion of the Concept design phase

UCD development relies heavily on end-user feedback. Our general motivation to include the end-user in the ADR process is to be able to adapt to new obstacles as they emerge. Accordingly, the ADR researcher adjusted the procedures based on end-user feedback to a simple platform solution (i.e. clickable model). Furthermore, communication with our target groups is crucial to understanding the abilities of the elderly people. Therefore, the ADR researcher included end-users (i.e., elderly, informal and professional caretakers) outside the Living Lab in every iteration, not only in interviews (Chapter 5) and focus groups (Chapter 6), but also in several user tests and two surveys, as described in this Chapter. By using multiple viewpoints to evaluate the IT artifact, we were able to improve the platform before moving on to the next design iteration: Prototype Design.
A summary of the different research steps in the BIE – Concept Design phase is described in table 41.

| **Table 41. Research phase III: BIE – Concept Design** | |
|---|---|
| Research input | Paper prototype as a guide to the high level template and to show the platform idea to the 'world' (i.e., inclusion in two end-user surveys) (section 8.2)<br><br>40 principles of the Project Start Architecture (section 8.3) |
| Research throughput | Second lightweight user test (section 9.1)<br><br>End-user surveys (N = 626) to flesh out the requirements (i.e., interviews and focus groups) and evaluate the Capability Approach (section 9.2)<br><br>Design workshop (refine Critical Design Issues and develop a high-level template of the architecture) (section 9.3) |
| Research output | Refined Critical Design Issues regarding Trust and Data Privacy and first platform architecture (section 9.3) |

# 10. Third design iteration: Prototype Design




In this chapter we describe the third design iteration of the platform with regard to the prototype design. In this phase, we reached a more tangible stage of the platform (i.e., clickable model), and the Living Lab partners encouraged the ADR researcher to define a vision on the business plan of Zo-Dichtbij and explore the platform's scalability.
In Q4 2014, a part of the Living Lab team already touched upon the Business Model propositions of a healthcare platform in a coaching's workshop (i.e., AAL2Business program from ZonMW), but this was relatively high-level, which meant we needed to explore how to prepare for a more sustainable Business Model future of our platform project. In this chapter[1], the prototyping phase and the exploration of the business model is described.

A thorough exploration of a business case and underlying business model for Zo-Dichtbij was complex due to the early stage of the platform development, as well as the involvement of multiple actors, with different views on the subject. Due to iterations during the design process and the new concepts that emerged in the course of the project, the complexity

*1. Parts of this chapter are published in Keijzer-Broers, W., & De Reuver, M. (2016). Applying Agile Design Sprint Methods in Action Design Research: Prototyping a Health and Wellbeing Platform. Paper presented at the DESRIST, St. Johns Canada.*

increased even more. However, the involvement of multiple stakeholders to explore the design of a business model and platform services, especially at the start of our project, could accelerate the exploration of the platform's potential and could also be beneficial to similar platforms. According to Van Limburg, Wentzel, Sanderman, and Van Gemert-Pijnen (2015), the involvement of stakeholders is essential in the business model design stages. Through stakeholder participation, the different value needs and a mutually determined fit for a business model can be identified. Although many difficulties and iterations have to be overcome before an innovation can reach the commercialization phase (Bergvall-Kåreborn et al., 2009), business modeling can be seen as a value-driven approach that can be incorporated into a business plan for further operationalization and deployment of Zo-Dichtbij. By determining the overall expected value before developing the platform, a better assessment can be mades as to whether or not it is worth investing in the platform.
In line with Ktata and Lévesque (2009) the Research team anticipated the benefit from combining our Zo-Dichtbij business view with agile development methods. Consequently, in line with our previous research efforts, our aim was to develop a business model in a practical, fast and flexible way.

Teece (2010), argues that, because the story around an innovation is written in the business model that it is critical to the success to an enterprise, the business model can be built before, for instance, the IT artifact emerges. Moreover, Heikkila, Heikkila, and Bouwman (2015) emphasize the importance of developing the technology, while iteratively validating this technology with the users, and at the same time building the business model. In that sense the business model exploration of Zo-Dichtbij can best be described as in figure 33, which means that business modeling, technology and customer validation are carried out in a cyclical manner (Q 3 2014 – Q 2 2016).

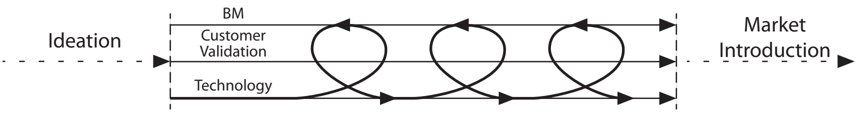



Fig. 33. Business Modeling from ideation to market introduction in a cyclical manner, adapted from Heikkila et al. (2015).

Bouwman, De Reuver, Hampe, Carlsson and Walden (2014) argue that business modeling needs to start during the early ideation phase of product or service development and that it is important to adopt an agile approach, with a focus on fast iterations, which is in line with our research strategy, which means that the conceptualization of the business model of Zo-Dichtbij includes iterative and parallel trajectories between the design of the business and of the platform.

However, in literature the exploration of business model design in an early stage has not yet been fully explored. In the health care domain, fore instance, the focus is mainly on business model analysis rather than on business model design (Mastelic, Sahakian, & Bonazzi, 2015). Although earlier studies have examined the business models of digital platforms, their importance with regard to services (Bouwman et al., 2008) is increasing, and it is associated with disruptive technologies (Chesbrough, 2010). In addition, a stakeholder analysis is required to identify the key stakeholders in the business model, along with their interests and possible business activities. As such, it is necessary to start with an actor analysis and define the strategic stakeholders (Bouwman et al., 2008; Solaimani & Bouwman, 2012) before involving the stakeholders in the BM design (Van Limburg et al., 2015). This part of the research has already been conducted (section 7.2).

Technological innovations that fail to create value are considered to be 'worthless', and figuring out how to deliver value to the customer is a challenge. The nature of the value can vary as well, and could relate to cost saving, (financial) benefits and/or the convenience level of individuals, which means that structuring the value network is part of the business model.

Although there are several existing Business Model ontologies, including CANVAS (Osterwalder & Pigneur, 2010), CSoft (Heikkilä et al., 2008), and VISOR (El Sawy & Pereira, 2013), we used the STOF model proposed by Bouwman et al. (2008) as our Business Model guide, which focuses on the Service, Technology, Organization and Finance domains in the business model process (section 4.1.2). The reason we decided to use STOF is that it emphasizes technological architectures and platforms in combination with value networks and eco-systems, and it takes the context of that organization into account as well. In addition, STOF is consistent with the method we used in the literature review on smart living (see section 3.1) and to structure the eleven in-depth interviews (see section 5.1)

## 10.1 Fourth workshop: Business modeling

As the acronym STOF indicates, business models are approached from four perspectives: Service, Technology, Organization and Finance. Bouwman et al. (2008, p. 71) argue that '*designing business models requires balancing the requirements and interests of the actors involved, within and between the various business model domains. Therefore the* *requirements in the service domain guide the design choices in the technology domain, which in turn affect network formation and the financial arrangements'.*

Therefore, in the BM exploration, we paid attention to Critical Design Issues (CDIs) in the Service domain, referring to *targeting, creating value elements, branding and customer retention*. In the Technology domain, the CDIs involved are *privacy, security, quality of service, system integration, accessibility for customers and management of user profiles*. In the Organization domain, the CDIs are *partner selection, network openness, network governance and network complexity*, and in the Finance domain the CDIs are related to *pricing, division of investments, valuation of contributions and benefits and the division of costs and revenues*.

The aim of the two Business Model workshops (June 2015) with the Living Lab partners was to design a first draft of the Business Model (BM) of Zo-Dichtbij[2]. From the workshop design, the ADR research team explored the different alternatives and collected information to design a first version of the business model taking the Critical Design Issues and Critical Success Factors in all four domains into account. As such, the goal of the workshop was to: 1) design a BM using the STOF quick scan, 2) perform a light-weighted BM stress test (Leopold, 2015), and 3) define a BM roadmap as a guide for the Living Lab setting.

Although we only used the STOF quick scan to define the business model (Bouwman et al 2008), the design workshops provided input to explore the initial BM for Zo-Dichtbij (see figure 33), including: value elements, value network, technical architecture, and possible revenues and cost sources (Bouwman et al, 2010).

The first BM workshop mainly involved representatives of the informal caretakers and user experience expertise (as well as a UCD designer) to shed light on the service domain, and on user needs, while the second BM workshop involved mainly representatives from companies to design the BM, and understand the complexities at an organizational level (i.e., Ziggo, ICTU, Medvision360, Neobis). See table 41 for an overview of the participants. The workshop facilitator was an authority in leading Business Model workshops as well as being one of the leading authors of the STOF framework.

*2. A full description of the BM of Zo-Dichtbij is available on request.*

| Table 42. List of Living Lab participants in two Business Model workshops | | |
|---|---|---|
| **Participant Workshop** | **Organization** | **Job Position** |
| **Session 1** | Informal Caretaker | Sales Manager |
| **Session 1** | Burst | CEO/User Experience Expert |
| **Session 1** | Foundation Zo-Dichtbij | Board member Zo-Dichtbij and Financial Expert |
| **Session 2** | Ziggo | Sales Manager |
| **Session 2** | Neobis | CEO |
| **Session 2** | MedVision360 | CEO |
| **Session 2** | ICTU | IT Architect |
| **Session 1 & 2** | Innovalor | Consultant - facilitator |
| **Session 1 & 2** | TU Delft | ADR researcher (TPM) |
| **Session 2** | Applied Science | Research assistant (Security) |
| **Session 1 & 2** | TU Delft | Research assistant (TPM) observer |
| **Session 1 & 2** | TU Delft | Research assistant (TPM) observer |

### *10.1.1 Revenue models*

During the two workshops several revenue models for Zo-Dichtbij were analyzed. See table 43 for a summary of suggestions.

| Table 43. Possible revenue model according workshop participants | | |
|---|---|---|
| **Revenue Model** | **Workshop 1** | **Workshop 2** |
| **Subscription Model** | Subscriptions should be low cost, or financed by a third party if elderly people lack the financial means (government, insurance)<br><br>From the provider side, a possible option is to buy a 'podium place' in the platform | The subscribers to the healthcare plan in the platform must pay. However, the foundation could start negotiations with insurance companies, and service providers to offer these services.<br><br>The service providers can pay for a 'podium place'. This can create limitations with regard to free access, and create doubts about joining the platform |
| **License Model** | All participants agreed with the platform being launched from the municipality, and receiving a fee in exchange of delivering information services. | The municipality is the first customer in the short term. They should pay for the platform services, because the platform would help them be more efficient, and reduce costs. |

| Revenue Model | Workshop 1 | Workshop 2 |
|---|---|---|
| **Freemium Service** | Information about healthcare plan, advisory services in the healthcare system, and personal information in the profile can be easily accessible at a very low cost, or even for free.<br><br>The premium features should generate constant revenues from the informal caretakers or the municipality | Although it is possible to use this revenue model, but it must ensure the adoption of the services |
| **Advertisements** | The platform owner should guarantee a large user base to the providers | The ranking system can be accompanied by advertisements |
| **Usage and Access Fee** | Mentioned, but implementing this revenue model is complicated from a technology and management perspective. | Not mentioned |
| **Transactions Fee** | Providers can work on demand, and the foundation can receive income based on transaction costs | The providers can be charged. Therefore prices for the customers increase |

Suggested revenue models ranged from a basic subscription for basic services, and a monthly fee for premium services, to a Freemium model where people have access to basic services for free and they pay for additional functionalities.

The strength and weaknesses of the various revenue models are pointed out (see table 44).

**Table 44. Strength and weaknesses revenue models according workshop participants.**

| | Strengths | Weaknesses |
|---|---|---|
| **Freemium Model**<br>**To elderly people and/or informal caretaker** | Free services enable and drive higher adoption levels.<br><br>Premium services can turn into potential revenues to the platform. | The success depends on the information and platform features (Care plan, diary, agenda, and information services) that will be provided. |
| **Advertisements to providers** | The firms understand the revenue model, and ads are aligned with promotion elements. | Location of ads can be distracting and therefore frustrate user base growth, |
| **Annual Fee to municipality** | Revenue stream to foundation. | Highly dependent on the municipality. |

Subsequently, there was a discussion among the participants about the potential role the insurance companies, and the platform's potential revenues in the future. For example, insurance companies can offer premium care, or the healthcare plan along with the subscriptions. However, the insurance companies can pay a license fee for a platform module customized to their user bases.

Next, the comparison of the two workshops was focused on how ideas could complement each other and which similarities were identified in the process. Finally, we validated and supported the results with the session's main participants in order to evaluate and hear their arguments in favor of (or against) the findings throughout the interviews.

### *10.1.2 Business Model refinements*

After the workshops, the BM is evaluated and refined with the Living Lab partners. For instance, the value propositions of Zo-Dichtbij must be in line with customer's needs (see table 45).

**Table 45. Value propositions different stakeholder groups.**

| | Value Proposition | Platform services |
|---|---|---|
| **Elderly People** | Stay and live at home independently as much as possible with support and better communication. | Light Version: Social contacts, Agenda, Diary and Profile information with local activities and lock-in features, feedback reviews.<br>Premium Service: Robust version to interact with providers and full access to information advisory services, and marketplace. |
| **Informal Caretakers (near relatives)** | Unburdening the informal caretakers and lightening the healthcare load with support, quality, and guidelines to be informed in one place at home. | |
| **Municipality** | Support your advisors and citizens guide, advice with comfort and quality to communicate more effectively, and contact us at home. | Information and Advisory services to communicate with their citizens.<br>Profiles to advisors, and direct involvement with their citizens via their profiles.<br>Data-collection (anonymized) from their citizens |
| **Providers** | Access to customers, and coordination to promote and deliver services in a marketplace. | Marketplace, advertisement, and interactions with their customers by the profile agenda, and/or diaries. |

Based on the discussion with the Living Lab partners we anticipated on BM changes throughout time. Therefore we developed a BM roadmap for Zo-Dichtbij (see appendix C) illustrating the changes to the BM with a layer of business activities (De

Reuver, Bouwman, & Haaker, 2013). The changes to the BM are assigned as intermediary steps in developing the service platform and be prepared for valorization.
In general, four stages are identified: 1) the design of the platform and its interface, 2) the rollout of the proof of concept, 3) the search of commercial partners and 4) potential adopters to establish a user base. However, these stages can be achieved by the alignment and balance of changes between the domains of the BM as well as the rollout of activities and constitute an ongoing process.

### 10.1.3 Discussion

With the business model sessions, we aggregated value-related needs from different perspectives (end-users, service providers and government agencies) and, through dialogues with the stakeholders, we co-created a fit with the values of Zo-Dichtbij. This can be seen as a focal point for the CDIs as well as the technical design, which is necessary for implementation (figure 34).
The recommendations from the BM workshops are mainly based on the discussion regarding the short- and long-term viability of the business model (Hidalgo, 2016).

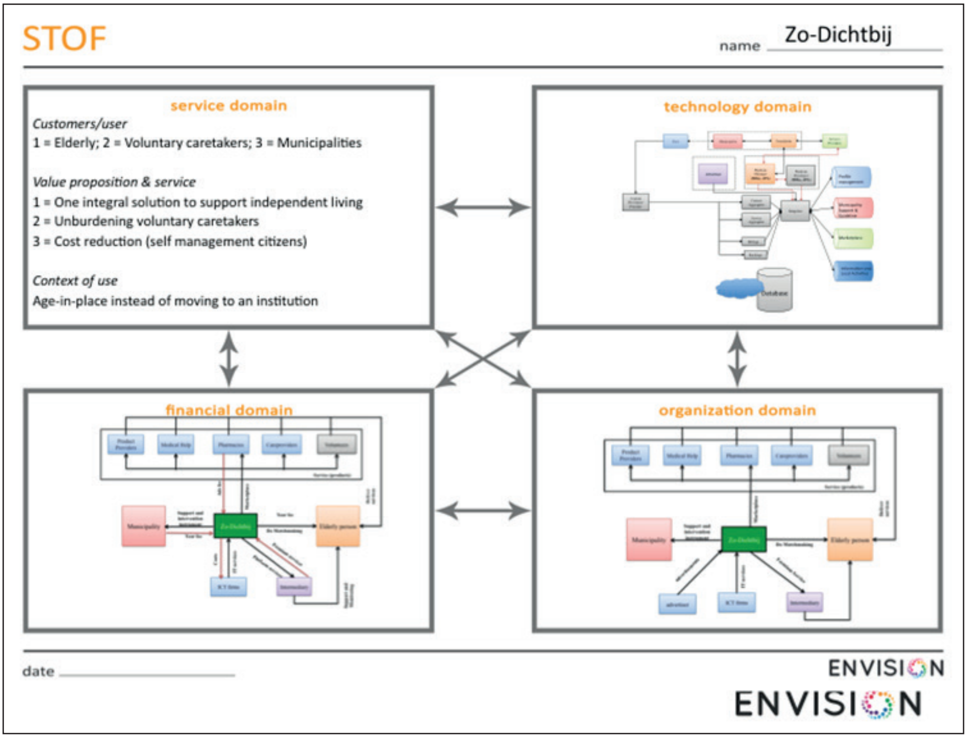



Fig. 34. Overview of the initial Business Model for Zo-Dichtbij.

The roadmap contains intermediary steps to ensure transitions to new platform development stages and potential partners who could be future customers. The aim of the roadmap was to describe these activities based on future changes to the business model.

In the end, the ADR researcher was able to use the proposed business model as a guideline for the Living Lab partners to communicate about the future business plans. The BM brought together all defined CDIs and, because the stakeholders in the Living Lab first decided about the BM before developing the business plan for Zo-Dichtbij, and the BM was created early on in the development process, the business plan could gradually take shape as well. Therefore the business plan, which contains, next to the BM, detailed information like resources, costs and concrete descriptions of activities is continuously updated during the development process of Zo-Dichtbij.

## 10.2 Fifth workshop: Google Design Sprint

After executing the first two design iterations (Chapter 8 and 9) and the initial business model exploration (section 10.1) the ADR researcher experienced a less energetic attitude within the Living Lab setting. At that point in time, the Living Lab partners were not satisfied enough with the output (i.e., a paper prototype and a clickable model), which means that more had to be done to keep them focused. Because there was no subsidy or financial compensation involved related to the stakeholders' effort, it was crucial to keep the participants motivated to stay on board of the project. After careful considerations about constraints (i.e., time, money and energy level) versus the research goal, we decided to use a Design Sprint method (Direkova, 2015; IBM, 2016c; Knapp, Zeratsky, & Kowitz, 2016) to speed up the prototype process, hoping that a design sprint workshop would provide the Living Lab partners with an energy boost, while at the same time resulting in a tangible artifact to 'show the world'. The Design Sprint was part of the third design iteration (i.e., prototype design)[3].

Although there is no shortage of models, frameworks and methodologies to guide design thinking, limited resources forced us to explore condensed design thinking methods like the ones provided by IBM (2016c) and Google Venture (Knapp et al., 2016) to shape our design sprint journey. Thanks to preliminary work in the first two

*3 An extensive analysis of the design sprint is published in Keijzer-Broers, W. J., & de Reuver, M. (2016). Applying Agile Design Sprint Methods in Action Design Research: Prototyping a Health and Wellbeing Platform. In DESRIST (pp. 68-80).*

design iterations, the actual Design Sprint session could be limited to a three day workshop instead of the recommended five.

### *10.2.1 Design sprint days*

Before the Design Sprint session the workshop moderator (an experienced UX designer) formulated the design tasks and prepared the six sprint stages (i.e., understanding, defining, diverging, deciding, prototyping and validating) as a guideline for the Design Sprint. In the meantime, the team members reviewed related background information stored on an online cloud tool.

The **first Design Sprint** day started with an in-depth interview with a representative of our launching customer (i.e., a policymaker of the Health and Wellbeing domain of the Metropolitan city), with the aim of verifying whether the assumptions about the platform were still valid and the platform continues to meet the local government's basic need to help people age-in-place.

Subsequently, the workshop participants compared these insights with the eight predefined personas. Although the focus in the first two design iterations was mainly on Persona 2 (i.e., Annie, the elderly woman who needs help to age-in-place), during the design process, the focus slowly shifted to a persona, who could represent the informal caretaker. The rationale was that, in line with the conclusion in section 8.4.2 and the results of the surveys (section 9.2.1) elderly people like Annie need an intermediary. Although 'Annie' is still the subject of our social innovation '*How to age-in-place*', due to her age and her aversion to technology, she is unlikely to use an online system. On the other hand, because Annie probably is in need of *some sort of help within a certain amount of time*, she needs an intermediary to help her look for local products, services, contacts and activities.

To that end, Persona 4 (Ria) was selected as the key-user of the platform, mainly because Ria (see figure 35) fits the user profile that emerged from preliminary research efforts: 1) she is an informal caretaker, 2) an intermediary for relatives, and 3) she belongs to the young elderly group (age between 55 – 75 year).
As described in figure 32, Ria (55) is married, has a part-time job as a caregiver, devotes her time to take care of her parents as well as her children, and belongs to the sandwich generation (Spillman & Pezzin, 2000). According to Roots (2014) adult children who are literally 'sandwiched' in between their aging parents and their own maturing children (or even grandchildren) are, because of this dual burden, subjected

**Persona 4 : Ria van Marrewijk**

put in scene

| | |
|---|---|
| **Age** | 55 year |
| **Place of birth** | Den Hoorn |
| **Home environment** | terraced house |
| **Marital status** | husband and 3 children at home |
| **Profession** | part time care giver at Buurtzorg |
| **Social class** | average income |
| **Internet use** | private |

Ria is a caring mother. Next to her job as a caregiver, she takes care of her family and her parents who also live in Den Hoorn. Ria is a social person. She is dedicated to her family and she wants to support her parents (both 80) to let them stay in their home environment independently as long as possible.

**Family members**
Married to Sjaak (57) whose profession is a greenhouse builder. Three young children living at home (17, 19 and 23 years old)

**Hobbies**
She has no time for hobbies, because of the dedication to her family.

**Special needs**
Ria is looking for nursing solutions for her parents. She has little computer skills, but with a little help from her children she will manage.

Fig. 35. Caregiver Ria (one of eight prepared personas).

to a great deal of stress. By defining what could lighten this burden for Ria, the Persona description is extended with initial user stories (See table 46).

As explained in section 7.1.1 user stories are written in the following format: As a <*type of user*> I want <*some goal*> so that <*some reason*>. This structure helps to really flesh out requirements and create a better understanding of the user. Although user stories for all the eight personas had already been developed at an earlier stage of the research (see section 8.4.1), within the Design Sprint workshop the user stories for Persona Ria are further refined and divided into 'must-have' and 'nice to have' requirements. Because of their 'assisting goal', the user stories from an informal caretaker (i.e., young elderly) differ from the user stories of the 'old' elderly people (see section 7.1.1).

| Table 46. User stories for Persona Ria | | |
|---|---|---|
| **Requirements** | **Must-haves** | **Nice to haves** |
| | As Ria, an informal caretaker… | As Ria, an informal caretaker… |
| **Functional** | … I need to be able to support my parents so they can live independently for as long as possible<br>… I need to find the right help at the right time to support my parents<br>… I need a monitor system to be notified when something is happening with my parents | … I want to post information in a diary and share this with my parents/relatives<br>… I want to stay in touch with my relatives about present and future tasks related to my parents<br>… I like to share a calendar with my relatives |
| **User interaction** | … I need a easy-to-use interface that helps me use an online system<br>…I need a online system that is reliable | … I want a helpline to support me with an online system<br>… I want to consult a review system for products and services |
| **Social context** | …. I need to have peace of mind in relation to the (health) condition of my parents<br>…. I need help from my kids as a backup related to the use of an online system | …. I want to find likeminded people, to share ideas and problems |

In addition, we approached the needs of both Ria and her parents (Bep and Jan) from a preventive, urgent and after-care perspective (see table 47).

| Table 47. Needs from an end-user perspective | | |
|---|---|---|
| **Perspective** | **Needs elderly people** | **Needs informal caretaker** |
| Preventive | What do we need to live in a comfortable way in our own home?<br>Where can we find additional help if needed?<br>Where can we find local activities, which suit our interests? | How can I support/monitor my parents in a seamless way?<br>How can I start a conversation with my parents about 'aging-in-place'?<br>Where can I find local activities to suggest to my parents that will match their interests and daily schedule? |
| Urgent | Who can help us in case of an emergency? | How can I arrange practical help to support my parents in case of an emergency? |
| After care | What kind of additional help is available to recover/stay at home after an incident | How can I find reliable products and services to support my parents so that they can stay at home? |

Based on the user stories and end-user needs, the workshop participants discussed various scenarios, one of which was selected to guide the platform design:

***What if Ria's mother Bep broke her hip? How can an online platform help Ria make practical arrangements to make sure Bep can come home to her husband Jan instead of having to recover in a rehabilitation center?***

The rationale behind this scenario is that fall incidents have a big impact on elderly, and the described fall scenario is a recognizable but complex situation to deal with for informal caretakers.

Fig. 36. Part of the design Sprint workshop participants with different backgrounds (i.e., development, UCD and academia).

In the **second Design Sprint day**, the scenario was extended with Ria's personal customer journey in relation to the arrangements she has to make in a certain timeframe after her mothers's fall incident. See table 48.

| Table 48. Arrangements Ria has to make, after her mothers' fall incident | |
|---|---|
| **Timeframe** | **Arrangements after the fall incident** |
| Directly | Collect insurance papers/medication/identification/their doctor etc.<br>Reassure Jan that everything will be all right with Bep<br>Follow the ambulance to the hospital |
| Within 1 - 4 hours | Inform close relatives<br>Pick up toiletries for Bep<br>Prepare questions for the surgeon<br>Organize practical arrangements for Jan: groceries, meals, walking the dog |
| Within 24 hours | Inform insurer/read insurance policy<br>Contact helpdesk local government: ask for assistance<br>Divide urgent tasks with close relatives: arrangements at home<br>Schedule hospital visits<br>Organize nursing aids: adjustable bed, walker/wheelchair etc. |
| Within one week | Find service provider for adjustments in the house: remove thresholds, renovate shower, install stair elevator etc.<br>Divide daily tasks with close relatives/informal caretakers<br>Think of a system to keep close relatives/informal caretakers informed about the situation (for instance a care plan).<br>Find suitable activities for both parents that match their interests and day schedule |

After defining the customer journey, the participants made a competitive overview of existing Health and Wellbeing platforms to make sure that *'the wheel has still not been invented elsewhere'*. See table 1 (section 1.2) for an overview of existing Health and Wellbeing platforms for elderly people. Subsequently, the participants outlined as many solutions as possible to help Ria in her customer journey, using different brainstorming techniques and methods like mind maps, storyboards and '*crazy eights*' (5 minutes to create 8 sketches). This idea-generation phase, without regards for constraints and criticism, resulted in dozens of plausible platform ideas, which were then categorized and extensively discussed with the team (see figure 37).

At the end of the second day, every participant selected what they thought were the three best ideas, and, at the start of the **Third Design Sprint day**, every participant had to pitch their favorite ideas. After the pitches the team discussed how to combine the most suitable ideas that could guide the platform design. Based on the input of the first two design sprint days the remainder of the third day was used to shape and reshape

Fig. 37. Overview (fragment) of used diverging techniques (e.g., mind maps and storyboards).

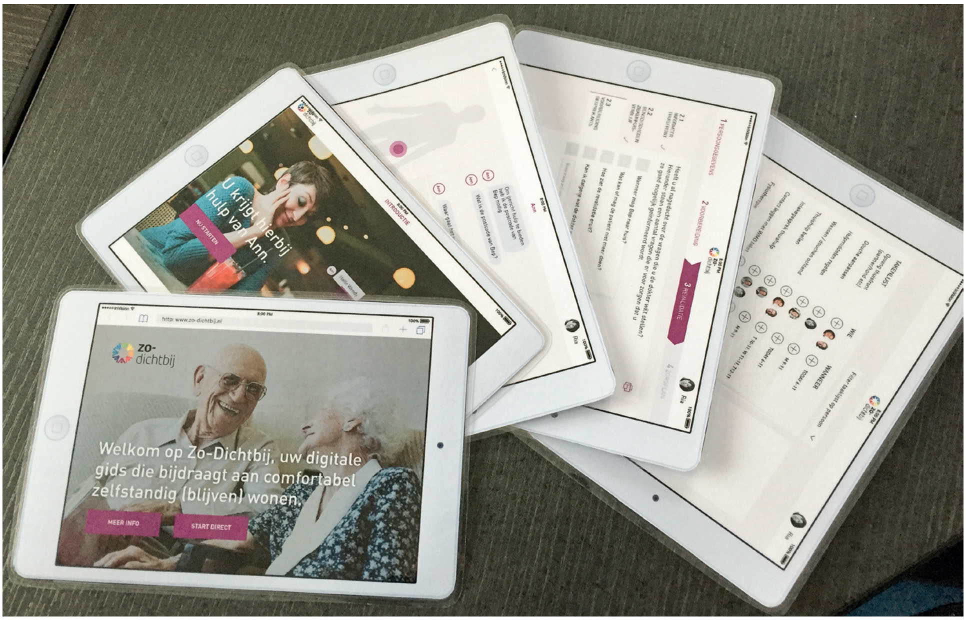



Fig. 38. First sketches of the platform demo Zo-Dichtbij (Dutch Market).

the demo of the platform according to Bep's fall scenario, taking into account Ria's pre-defined user-stories. See figure 38 for the first platform sketches.

### 10.2.2 Third user test: demonstration

After the workshop, to evaluate the third design iteration, the ADR Research team took a few weeks to discuss the demo with 30 end-users (i.e., elderly, caretakers, providers and representatives of the local government) to evaluate the demonstrator. Comments were gathered and the feedback summarized in a revision table. Overall, the demo was evaluated positively and highly appreciated by the test group. Minor details related to the use of colors, font sizes, spelling mistakes and question sequences. Interesting suggestions were made with regard to additional functionalities, like: '*anonymous use of the platform*', '*chat possibilities with relatives*', '*sharing diary with family*', '*simultaneous use of the care plan*', '*for profit use of the platform for clients of the district nurses*', '*connection with social media for arranging local activities*', '*frequent asked questions*' and '*checkboxes with medical information*'. *In addition, some reviewers had additional questions about: 'the security of the care plan', 'privacy issues' and 'if the guide in the platform was intended to be a real person or a chat bot'.*

After a few internal discussions with the Living Lab participants, core adjustments were made to the demo as input for the fourth iteration stage: developing the Minimal Viable Product.

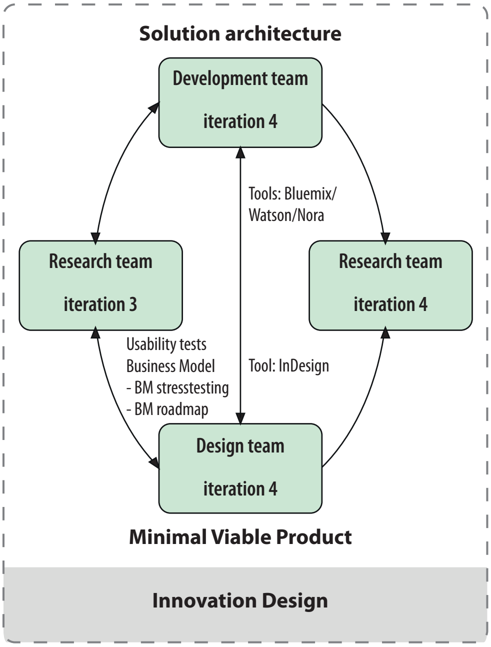
### 10.2.3 Conclusion of the Prototype design phase

In retrospect, combining UCD design and an agile-inspired way approach within the ADR Development team worked well in the Living Lab setting, but it relied heavily on the team members' ability to properly collaborate and to have an 'open mind' in the first place, which proved to be crucial in the Design Sprint session as well. Despite the different professional backgrounds of the participants (i.e., development, UCD and academia), within three workshop days, we managed to develop a platform demonstrator (i.e., demo) that justified previous research efforts (i.e., design requirements extracted from interviews, focus groups and surveys), which we would not have been able to do without the help of an experienced Design Sprint moderator.
As far as the workshop participants were concerned, the demonstrator was a concrete result of the Design Sprint, within a limited time-frame and budget. In addition, the sprint session also generated the expected energy boost within the Living Lab. Finally, with the demo, we had something more concrete to show and discuss with the 'world', which was perceived as a valuable intermediate step to inspire the fourth design iteration.

Based on the third design iteration we illustrated 1) how to combine agile and UCD inspired design approaches and, 2) how to incorporate a design thinking method within a design project. As such, the Design Sprint session turned out to be an enrichment of the third design iteration. It forced the teams to refine earlier research outcomes and make final decisions on how to visualize the platform in a demonstrator version, within a limited time-frame. Additional scenarios from different perspectives were under review as part of the fourth design iteration: developing the interface.
A summary of the various research steps in the BIE – prototype phase is provided in table 49.

| **Table 49. Research phase 3: BIE – Design Prototype** | |
|---|---|
| **Research input** | End-user survey analysis summarizing requirements and a first evaluation of how the IT artifact enhances capabilities of elderly people (section 9.2) |
| **Research throughput** | Business model workshops designed to determine value propositions, the BM and the roadmap (section 10.1)<br><br>Design Sprint: translating requirements into a low-fidelity prototype (section 10.2) |
| **Research output** | Business model, BM stress test and BM roadmap (section 10.1, and appendix C<br><br>Demonstrator (i.e., demo version) of the platform (section 10.2) |

# 11. Fourth design iteration: Innovation Design




In this chapter, we describe the Innovation Design stage within the Living Lab setting, as part of Research Phase 3: Building, Intervention and Evaluation. The output of the third design iteration is used for the fourth design iteration (the Innovation Design phase), which focuses on the development of a Minimal Viable Product (the interface) and set up an experimental design to test the interface with 36 young elderly/informal caretakers (i.e., fourth user test).

## 11.1 Interface design

To be prepared for a fourth user test of Zo-Dichtbij we translated the demo (Chapter 10) into a Minimal Viable Product (Van den Houdt, 2016), built on top of the IBM Bluemix cloud platform (i.e., infrastructure as a service), to provide testers with an operational web platform (IBM, 2016b). IBM is one of the Living Lab partners and their cloud platform solution allowed us to speed up the design process of Zo-Dichtbij, by deploying the application to a production environment, as well as adding a chat functionality (i.e., Watson), which is a possible solution for the 'guide feature' in the platform. Watson was the name given in the past to a 'super computer' developed by IBM that was able to understand natural language questions and return correct answers. Since 2015, IBM uses the name Watson to refer to a collection of web services designed to provide cognitive computation to their clients (IBM, 2016e). In particular a dialog service and a natural language classifier service were of interest to our project, and we used the dialog service to develop a chat bot, through which users can interact.

The demo application is designed as a 'three-tiered application architecture' (see figure 39) and the tiers are basically layers of the system that could be run on different systems (see Archimate architecture figure 32, p. 175).

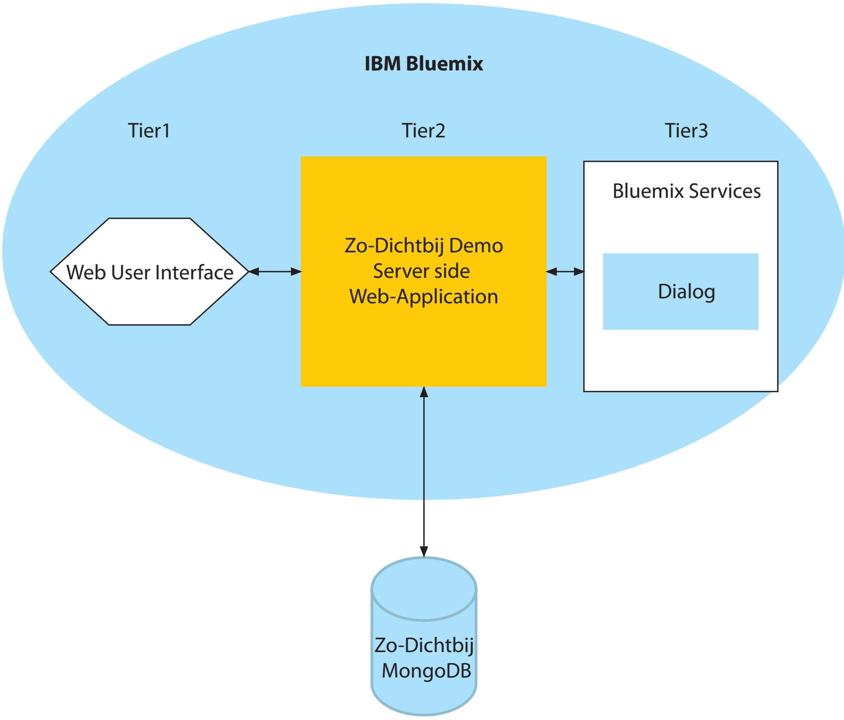



Fig. 39. Three-tiered application architecture Zo-Dichtbij interface.

Tier 1 represents the user interface, which is responsible for all user interaction from the web interface. Tier 2 is the actual application, which houses all business logic. Tier 3 contains the services and is responsible for handling the applications calls to the Dialog service on Bluemix. While each tier should be able to run on different systems, in this case both tiers 1 and 2 are run on the same server. However, one could imagine a mobile interface where tier 1 is run on a user's phone, while still using the same web-application to retrieve data. The demo web application is built using JavaScript on top of the Node.js runtime. The web framework of choice is Express, which is a minimalistic framework built for Node.js. Both Node.js and Express are open source projects and purposely built for the web, which make them suitable for developing web applications. The dialog service is used to respond properly to Q&A inputs from users. Additionally, the web application should be able to process data, which means a database is required, in this case Mongo DB, a non-relational and document-based database, which is 'easier' compared to a relational database like MySQL, simply because there are fewer restrictions adding data into the database, so the format of data can be adapted more quickly without breaking the application. Altogether, the flexibility of the database increases the development speed and robustness of the application, which was suitable for this phase of the design project.

Other important design choices were made for the user interface. To create a professional looking website in a short time-frame we used a front-end CSS, HTML and JS framework in combination with an open source CSS theme, which was adapted to match the Zo-Dichtbij color scheme. The front-end framework provides modules and styling options for building websites. The additional view templates are built using a templating system called Handlebars, which ensures a proper abstraction between view templates and the business logic. The maintainability of views is increased with the use of a templating system.

### *11.1.1 Visualization of the interface*

In the final implementation, users are able to create tasks, activities and diary entries. By storing user input it is possible to review what users have submitted during the experiment, which in turn enhance user experience, since users can browse the website and see their own input put in place, creating the perception of being on an active platform. Figure 40 shows the final version of the Care Plan homepage, based on the mockup presented in section 8.2 (figure 28, p. 153).

On this page, users are able to add tasks to the planning board and activities to the activity list, as well as adding diary entries. On the left side the distinct green sidebar provides an overview for the users while browsing the platform. In the top navigation users are switch between the Care plan and the help chat, with links to their personal messages and profile being provided. The ability to add tasks, activities and diary entries has been fully implemented, so users are actually able to use that functionality. The left menu on the home page provides a list of main features, like 1) planboard, 2) activities, 3) diary, 4) health, 5) contacts, and 6) products and services. As an additional feature the help chat (i.e., guide Ann) was developed. See section 11.1.2.

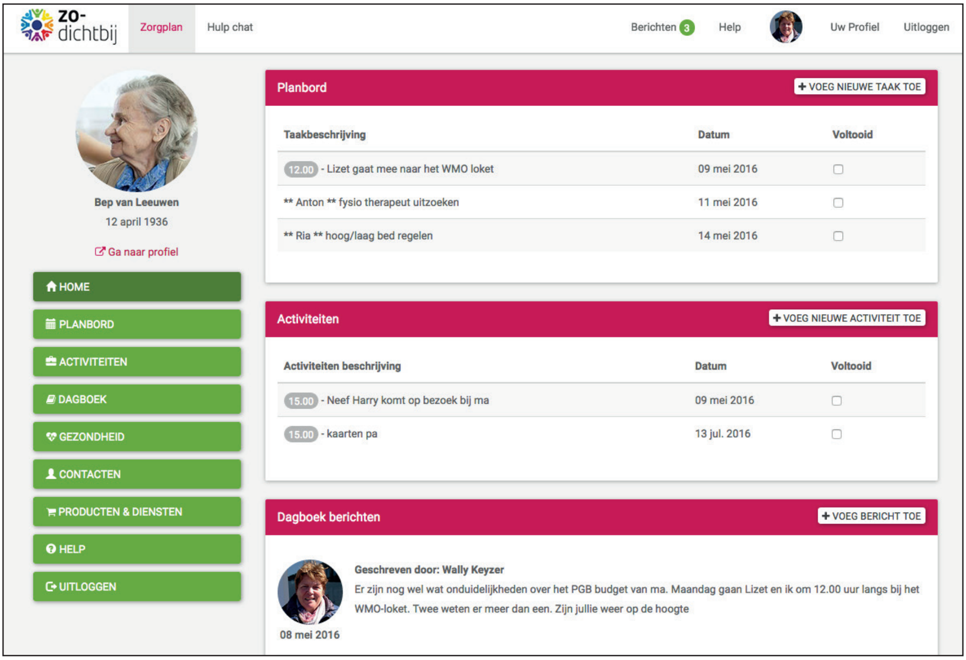



Fig. 40. Care plan homepage Zo-Dichtbij (in Dutch).

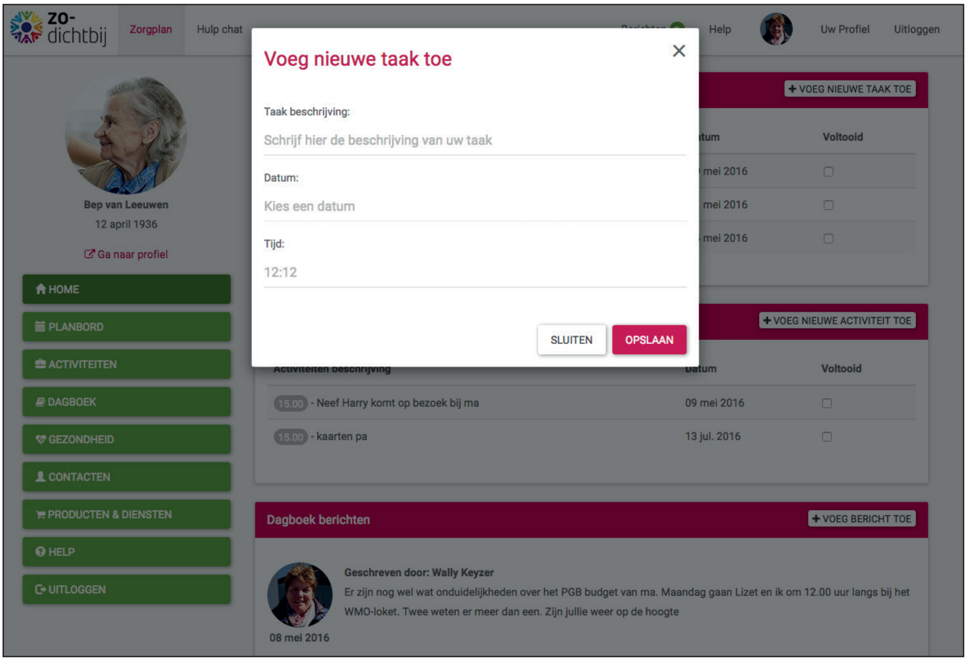



Fig. 41. Planning board: add new task (in Dutch).

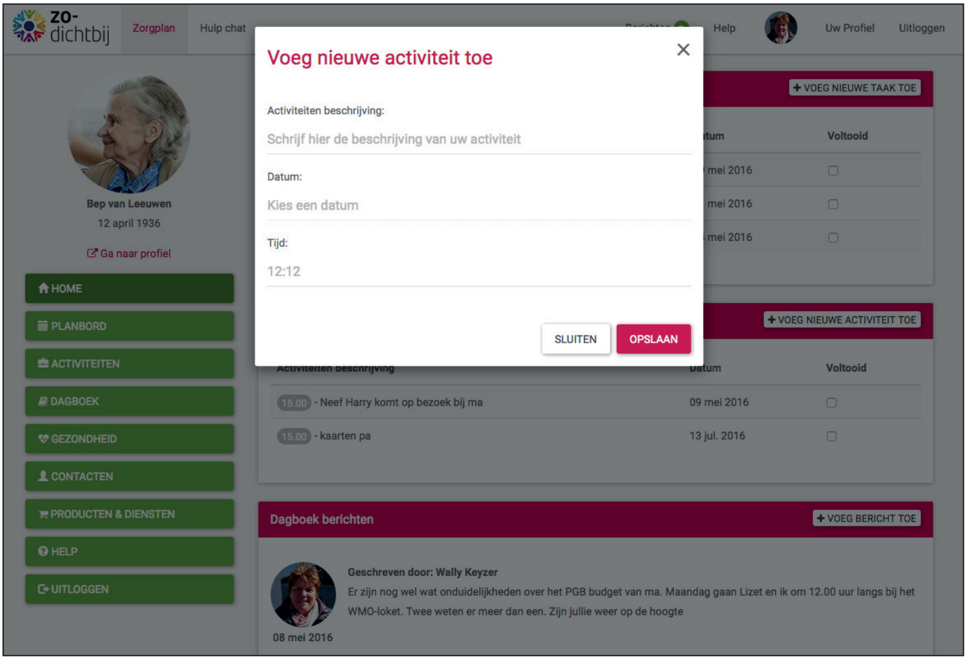



Fig. 42. Activities: add a new activity (in Dutch).

In addition, help features are included with general information about Zo-Dichtbij and Frequently Asked Questions (FAQ).

**1) Planning board**: This feature contains a to-do list and refers to things that need to be done in relation to the health of wellbeing of Bep. These tasks are assigned, for instance, by the doctor, relatives, or Bep's caregiver. In the experimental setting, Ria is in the lead, but it is also possible for other users to assign tasks for Bep as long as they have permission to do that. To add a new task, users click the '*add new task*' button and a new window will pop up (see figure 41), after which, they have to fill in the details, such as a task description, date and time. This example shows that Anton needs to find a physiotherapist on May 11, while Ria needs to make arrangements to order a special bed for Bep.

**2) Activities**: This feature contains a list of activities that Bep is involved in as part of her social agenda. To add activities to the list, Bep (or someone else on her behalf) can click on the '*add new activity*' button and a new window will pop up, where Bep or someone else can fill in the details (description, date, time). As an example, we can see that, in figure 42, Bep has a plan to play Bingo in the community center on the 21st of May, 14.30 hrs.

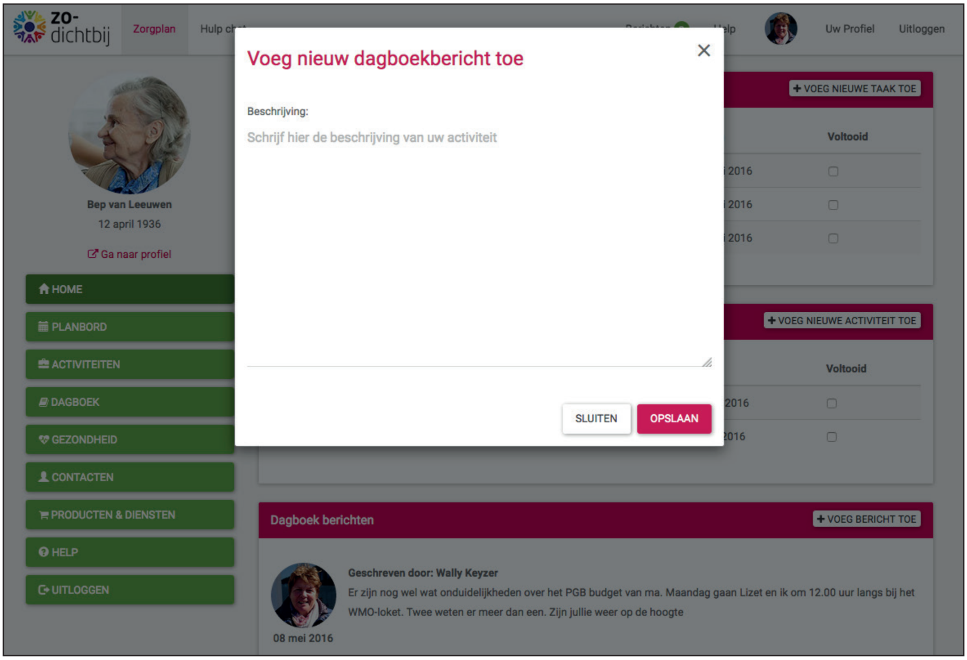



Fig. 43. Diary: write new message (in Dutch).

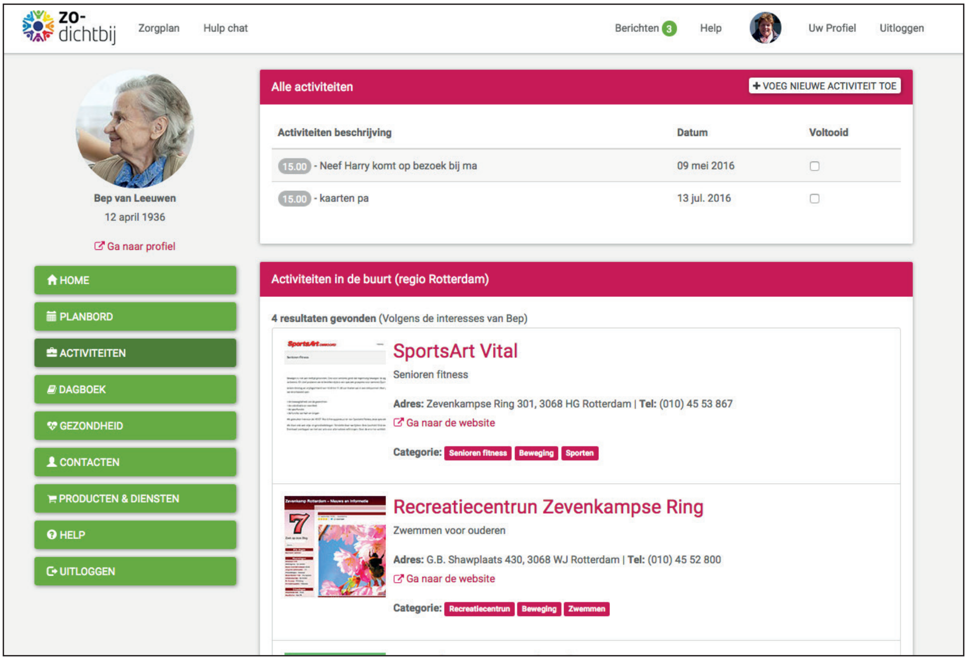



Fig. 44. Activities: list of activities in the neighborhood (in Dutch).

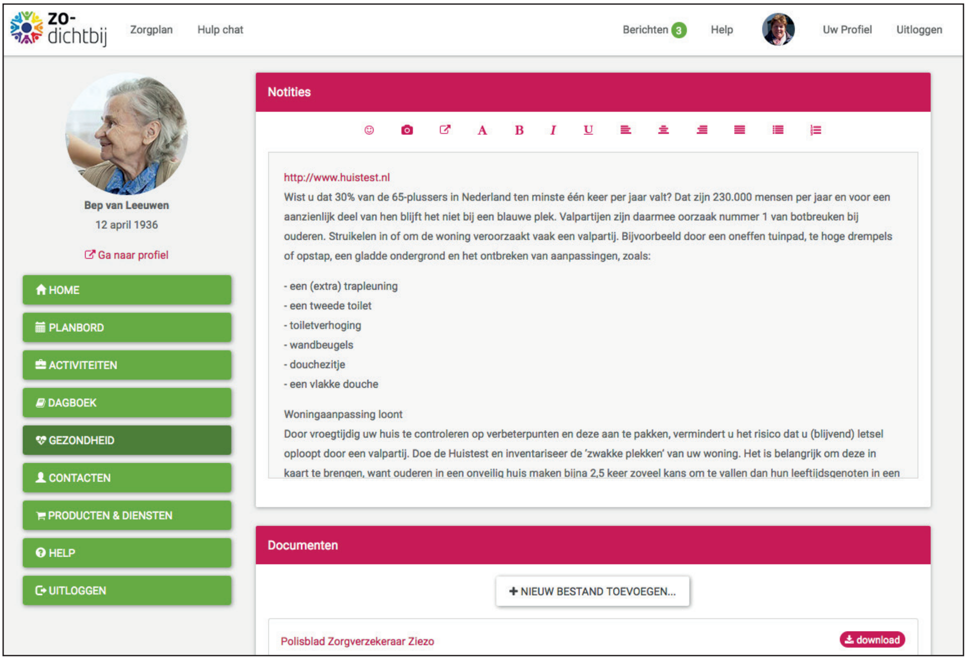



Fig. 45. Healhcare feature (in Dutch).

**3) Diary**: This feature contains a record of all activities, events, experiences, and observations related to Bep so that anyone with access to Bep's account can monitor Bep's updates, especially in relation to her health and wellbeing. All authorized users can post an update about Bep's condition using the '*add message*' button, after which the message is shown to everyone connected to Bep (see figure 43).

The plan board, activities and diary features in the menu on the left contain the same functionalities as the one on the home page. However, with regard to the activities feature, there is an additional functionality where users can search for suitable activities in the neighborhood (see figure 44). This feature provides information about each activity, such as address, phone number, a link to the website, and the activity's category.

**4) Health**: This feature contains Bep's insurance policy file, as well as other important medical information that is helpful to Bep and her caregivers. Users with authorization can add important notes here or upload and download relevant health files that may be needed in the future. We can see the example at the bottom of figure 45, of an insurance policy of Bep that can be downloaded for future reference.

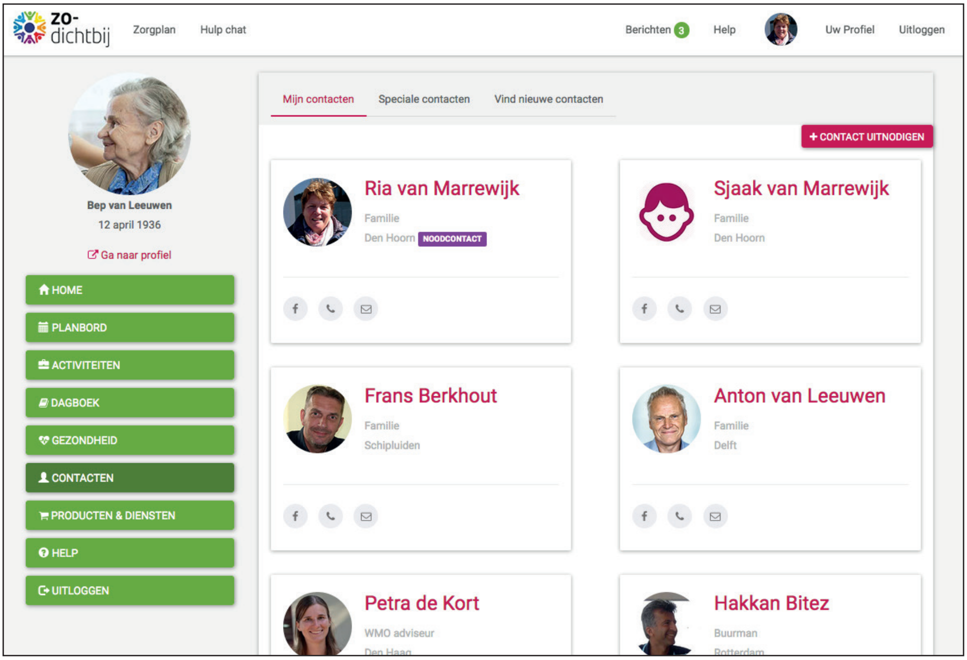



Fig. 46. Contact feature (in Dutch).

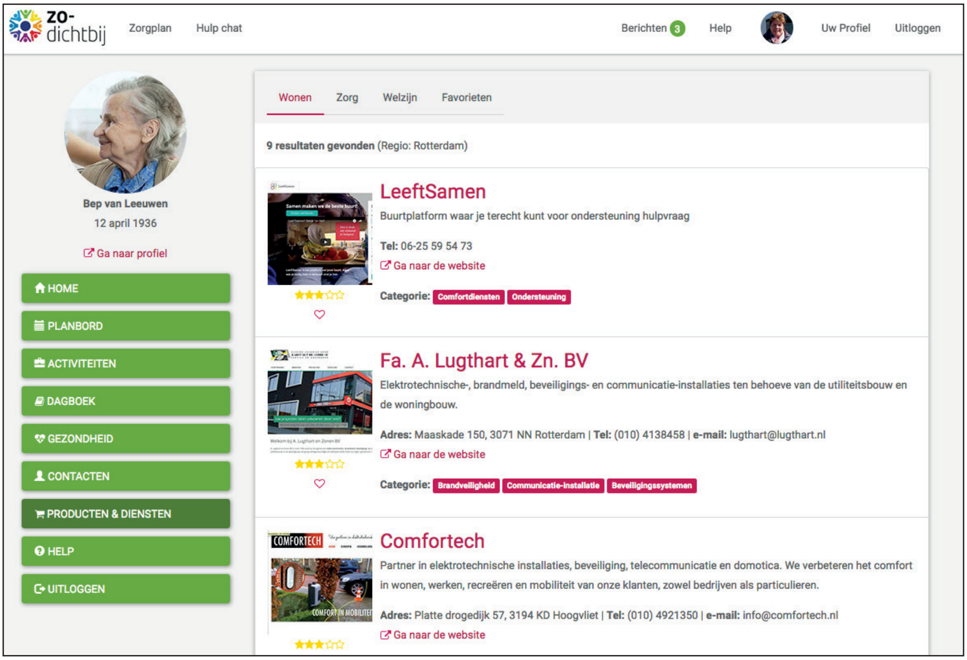



Fig. 47. Products and services page Zo-Dichtbij (in Dutch).

**5) Contacts**: This feature contains Bep's relevant contacts. In this feature, Bep (or someone else on her behalf) can easily add relevant contacts, such as other family members, neighbors, the district nurse, the municipality's contact (i.e., WMO desk). This feature also enables to assign someone to become an emergency contact, in this case Ria as the main caregiver of Bep. See figure 46.

**6) Products and Services**: This feature contains all health and wellbeing products and services that are offered in Bep's neighborhood, and is divided into three types of products and services: 1) domestic, 2) healthcare, and 3) wellbeing. Users can also save products and services as favorites, making them available in the favorites feature. The information provided in this feature includes address, phone number, a link to the website, and the products or services category. There is also a rating for every product or service so users can take the experiences of others into account. As seen in figure 47, the products and services page, provides an overview of products and services that have been filtered according to the user's location, in this case the Rotterdam area. Users can see at a glance how other users have rated certain services and products, and can save items to their favorites list.

### *11.1.2 Development chat bot*

For the help chat of Zo-Dichtbij IBM provided a service called Dialog for managing chats between users and a digital system. The chats are referred to by IBM as dialogs, hence the Dialog service (IBM, 2016d). The service itself is relatively basic. Developers are supposed to program an entire conversation in XML. This not only means that the systems response has to be programmed, but the developer also has to anticipate which types of input users may enter into the system, in order to couple the correct response.

**Help chat**: This feature, which is accessible from the top-left of the home page, allows users to have a conversation with a chat bot named Ann, which helps users find information they need. In our demo interface, Ann can only guide users with specific answers to find relevant products and services for Bep. However, it is expected that this feature will be more intelligent and can provide a broad range of solutions in the future.

Figure 48 shows a partial conversation between a user and the chat bot Ann. Users (colored magenta) are able to enter responses at the bottom of the screen and receive reactions from Ann (colored grey). Although, developing dialogs that can answer a

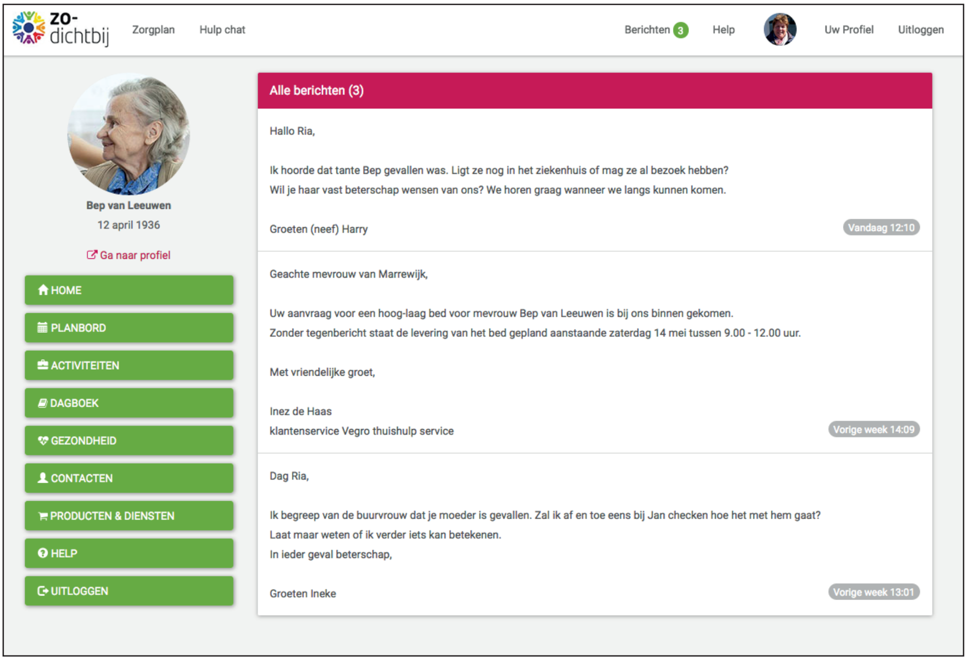



Fig. 48. Help chat called Ann. The chat bot on Zo-Dichtbij (in Dutch).

wide range of input is a laborious process, the XML files are arranged according to a natural conversation template, to enable designers to develop a natural language conversation.

### 11.1.3 Designing a natural language conversation

The default XML template provided by IBM is adapted according to general models that are provided in the field of conversation analysis, which are representative in both casual and professional conversations and hold in multiple languages and cultures. There are three general models, adjacency pairs, sequence expansion and repair (IBM, 2016a). Adjacency pairs are the most commonly used types of conversational sequences. Generally speaking, they can be seen as question-answer pairs, with the question and answer not produced by one and the same agent. Below an example of an inquiry-answer pair:

*Speaker A: 'Hello, how are you?'*
*Speaker B: 'I'm good thank you.'*

Sequence expansions occur when either participant in a conversation requires additional information before a final answer can be given. For example:

*Speaker A: Do you have information about hip fractures?*
*Speaker B: I have information about hip revalidation, would you like to see that?*
*Speaker A: Yes*
*Speaker B: *Provides information*

Finally, repairs occur when one of the speakers does not understand a response from the other speaker. In this case, the first speaker will ask for additional explanation or provide additional information in an attempt to clear up the misunderstanding. For example:
*Speaker A: 'Hello, what is your name?'*
*Speaker B: 'My name is Kim.'*
*Speaker A: 'Hello, Tim, nice to meet you.'*
*Speaker B: 'My name is not Tim, it is Kim.'*
*Speaker A: 'Excuse me, Hello Kim.'*

### 11.1.4 Implementing Ann's conversations

Although the natural language template provides structures to develop a natural language conversation, developing a conversation is complex, because every single expansion or interpretation of a user has to be pre-programmed. The easiest way to

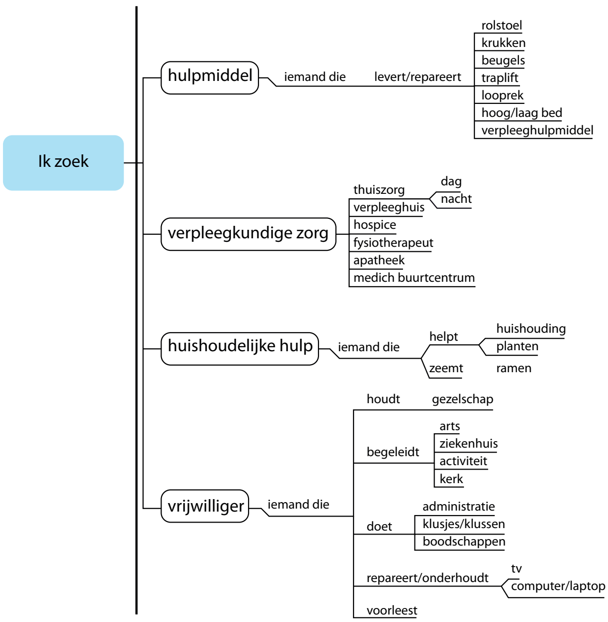



Fig. 49. Example of gathering information for the chat bot, preparing the answer pairs (in Dutch).

develop a chat bot was to start with base adjacency pairs (see figure 49 for an example of the answer pairs). Users are then able to retrieve answers when they ask simple questions. Because of the test groups of Zo-Dichtbij, the dialogues are prepared in Dutch.

However, this type of interaction with the chat bot is static and quite unnatural. To improve the chat experience, repair and expansion sequences have to be added. Repair sequences can be used to allow users to update faulty input. For instance, when users enter the wrong name, they have the option to correct their mistake. The conversation can then be improved by predicting certain expansion questions to guide users to the right answers. For example, as soon as a question of a user is not understood, the system can guide the user to a response that explains which types of questions can be understood. In doing so, users can learn how to interact with the chat bot.

To increase the cognitive capabilities of the Dialog service, developers can use the IBM's Natural Language Classifier service, which provides increased cognitive capabilities and is capable of 'understanding' user input and classifying it to the correct adjacency pairs. Unfortunately, this service is not yet available for the Dutch language (Q2 – 2016). IBM provides sample applications to demonstrate the functionality of their services. To speed up the development time, the dialog service sample application is used as a basis for the demo application, which in turn determines a majority of the software stack for the project.

## 11.2 Fourth user test: experimental design

To explore the effect of Zo-Dichtbij interface has on the capabilities of elderly people to support them to age-in-place, we set up an experimental design (Sekaran, 2006) with 36 participants (12 male and 24 female), which took between 1,5 - 2 hours. To avoid the informant bias (Winter, 2010) a heterogeneous group of 36 test candidates is selected in the age group of the young elderly (55 – 75) and/or familiar with the caretaker role. In addition, the participants had various backgrounds (health and wellbeing domain, local government and industry) and various levels of ICT skills. The average age of the participants was 61, with a standard deviation of 6.5. Although the test group was relatively small and heterogeneous, the experimental design was a test to see how elderly people/informal caretakers reacted on the Minimal Viable Product.
The setting of the experiment was arranged at a computer room at the university. Beforehand the participants were randomly assigned to a number, which accordingly correspond to a particular computer. The numbers 0 – 20 are assigned to experimental

condition R1 whereas numbers 21-40 are assigned to experimental condition R2, to minimize the effect of confounding factors (Sekaran, 2006). The only difference between the two groups is the order in which they receive the treatment, as shown in table 50.

**Table 50. Experimental design setup**

| Group | Pretest | Treatment | Posttest | Treatment | Posttest |
|---|---|---|---|---|---|
| **R1** | O1 | X1 | O2 | X2 | O3 |
| **R2** | O4 | X2 | O5 | X1 | O6 |

After the introduction the participants started with a pre-test, followed by the first set of scenario tasks related to Bep's fall-incident (see section 10.4.2). The experiment started with treatment (X1) or with treatment (X2) to prevent order effects. The experimental design was set up in such a way that the effect of disturbing factors was reduced. In addition to the questionnaires that the participants needed to fill out, other observations were made (i.e., two observers made notes during the experiment). Due to the short time between pretest and treatment there was a minimal risk of fatigue. After the first treatment a post-test was conducted. Observations in the form of a questionnaire were conducted before and after the treatment. In all, the users performed two different sets of scenario tasks and thus performed two post-tests. Figure 48 shows the experimental procedure.

The treatment consisted of thirteen tasks, as presented in table 51. Scenario tasks were devised with actionable steps, to ensure that the subjects experienced the platform in a similar way. A task list was provided that the subjects needed to accomplish while using

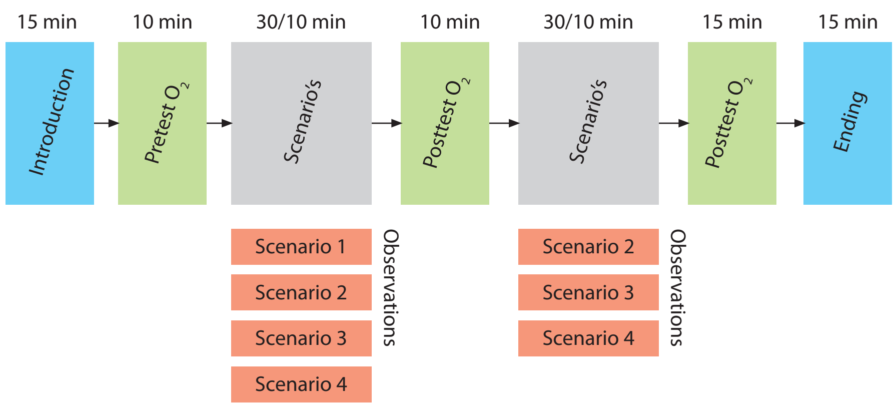



Fig. 50. Structure of the experimental design test setting.

the interface. Moreover, the order in which the different tasks had to be performed determined the different treatments of the groups.

| Table 51. Tasks within the scenario from Persona Ria and her parents Bep and Jan | |
|---|---|
| **Task 1**<br><br>Open Google Chrome on your desktop and type demo.zo-dichtbij.nl | **Task 8:**<br><br>Choose a service provider who can install and deliver a stair elevator |
| **Task 2:**<br><br>Login at Zo-Dichtbij with the delivered login information | **Task 9:**<br><br>Choose a service provider who can support with household tasks |
| **Task 3:**<br><br>Inform the family on the condition of Bep via the diary. | **Task 10:**<br><br>Bep likes to swim. Use help chat Ann. Find and write down where she can go swimming as soon as she has recovered. |
| **Task 4:**<br><br>Plan for today that Frans will do grocery shopping for Jan (Bep's husband). | **Task 11:**<br><br>Use help chat Ann. Find background information about 'fall prevention for elderly' and write down the website. |
| **Task 5:**<br><br>Ria received a message from her cousin. Add to the plan board that he will visit Bep oncoming weekend. | **Task 12:**<br><br>Find a telephone number of a community center to support Bep and Jan with local activities |
| **Task 6:**<br><br>Find the insurance policy of Bep and write down her policy number.<br><br>Policy number: ......... | **Task 13:**<br><br>Find the emergency number of Zo-Dichtbij<br><br>Number: ......... |
| **Task 7:**<br><br>Plan an activity for after two weeks where Bep and Jan can both participate | |

Note: Scenario 1: login (tasks 1 and 2). Scenario 2: make practical arrangements (tasks 3 through 7); Scenario 3: search for products and services (tasks 8 and 9) and Scenario 4: search for information (task 10 through 13)

Task 3 through 9, were used to familiarize people with the digital platform and show them the workflow of organizing care tasks. Additionally, each scenario was color coded, so the two observers in the room could see at a glance which scenarios are performed by the participant at what point in time. Tasks 10 through 12 had to be performed while using the chat bot Ann. The tasks were designed so users are more likely to interact with the chat bot in a way that will provide valuable answers. Although both groups performed the same tasks within the four different scenarios, by changing the order of the scenarios we were able to create a control group and use the different results to mitigate treatment effects. It was important that the treatment for each subject is generally speaking the same, to ensure a homogenous treatment effect. Therefore, the four scenarios that were developed, allowed users at least to experience the most important aspects of the platform in a similar way. Additionally, each subject was provided with the description of persona Ria and the fall-incident of mother Bep (section 10.2.1), which led the constructed tasks. Additionally, persona Ria determined which data was pre-loaded into the web application. Each participant was thus presented with the exact same data to start with. In addition, the participants were observed by two observers, who logged the time people needed to complete certain scenario tasks, and who observed the participant's behavior. After completing the experiment, seven participants were asked to take part in a short closing interview, to assess the experiment and provide feedback on their experiences[1].

### 11.2.1 Analysis of the experiment

During the experiment participants from both experimental groups took about five to ten minutes to familiarize themselves with the platform, mainly because, on purpose, no manual was provided on how to use the platform. The group that started with tasks that required the chat bot had to learn how to communicate with the chat bot before receiving the correct answers, while the other group that started immediately on the platform itself, needed to find their way through the system. At this stage, two researchers were available to answer simple questions. In a non-experimental setting, this type of feedback would be difficult to provide, so at the same time, it was a test to see whether the platform was self-explanatory. As soon as the participants familiarized themselves with the platform, there were no major challenges to complete the tasks.

### 11.2.2 Conclusion of the Innovation design phase

Thanks to the Minimal Viable Product of Zo-Dichtbij, the users were able to experience what the platform will be like when it is fully operational. As such, the interface provided a unique opportunity to conduct an experiment with a target user group and at the same time measure the effect of a platform for Health and Wellbeing on the capabilities of elderly people. First of all, the features of a platform for Health and Wellbeing are leading in determining whether a platform helps elderly people to age-in-place. In this case the platform mainly facilitates features that on the one hand, enable information sharing between the caretakers of a 'patient', and on the other hand, provide meaningful

*1. The full report, which shows the results and analysis of the experimental design is available on request* matches between local and national product and service providers. The combined features allow elderly people to increase comfort, affiliation and control in the form of independence. Thereby, due to the ease of communication among caregivers, social innovation can take place between relatives and acquaintances. The platform lowers barriers for people to become involved in the care of others, which in turn allows them to share the burden of taking care of elderly people more easily, which may also improve the quality of the care they provide.

The platform testers stated that Zo-Dichtbij seemed to be an effective tool enabling elderly people to live comfortably in their own homes. In addition, the platform can 1) inspire social innovation, simply by lowering the threshold to performing healthcare-related tasks for others, and 2) play a role in facilitating the informal caretakers of vulnerable (older) people without a network to rely on. Also the participants stated that, if (non) profit caretakers on the platform are properly screened, in terms of their reliability, the platform could create a safe and trusted network for elderly people and their informal caretakers, allowing also elderly people without a network to benefit from the platform and receive informal help more easily.

Furthermore, a chat bot is seen as an effective way to bring together product/service providers and consumers. However, developing a chat bot able to answer a complex and broad range of questions is a daunting task. Without a Natural Language Classifier service (i.e., Watson that supports the Dutch language), this Q&A task does not seem practically viable. Therefore, as a backup plan, the chat bot can be developed as a secondary service: an additional feature within the platform. While the Dutch language is on the IBM Roadmap for Q4 2016, the chat bot functionality is on the wish list of the Living Lab partners.

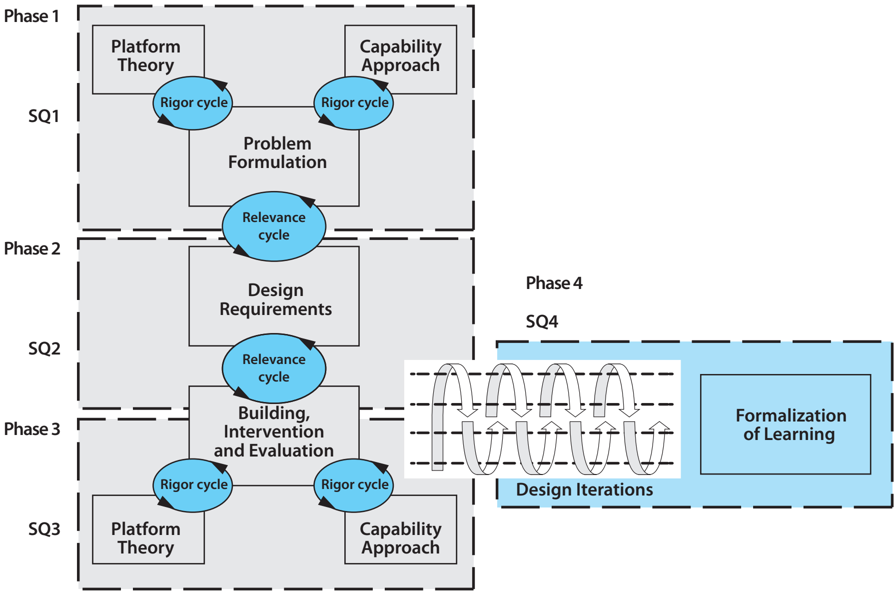
The test group served as a proxy to measure the effect of a platform for health and wellbeing on capabilities of young elderly (> 55) in general, and caretakers in particular, to determine the wellbeing of their people under care. However, it could be argued that specific knowledge with regard to healthcare and wellbeing can be beneficial in determining whether or not a platform for Health and Wellbeing can in fact increase the wellbeing of elderly people.

To familiarize themselves with Zo-Dichtbij, we suggest providing end-users with a simple tutorial that guides them through the platform, which should be easy and unobtrusive as well as complete. The tutorial should also take the different computer skill of users into account, which less skilled users requiring more assistance, while more skilled users should be able to skip the tutorial.

A summary of the different research steps in the BIE – innovation design phase is presented in table 52.

| **Table 52. Research phase III: BIE – Innovation Design** | |
|---|---|
| **Research input** | Demonstrator (i.e., demo version) of the platform (section 10.1) |
| **Research throughput** | Development of the interface using BlueMix and Watson (IBM) (section 11.1)<br><br>Experimental tests with 36 end-users (young elderly people and informal caretakers) (section 11.2) |
| **Research output** | Minimal Viable Product of Zo-Dichtbij (section 11.2) |

# 12. Research phase 4: Formalization of Learning




The central aim of this research phase is to discuss and reflect on the research process and to answer the fourth sub-question.

***SQ 4. What can we learn from the development process of a service platform for Health and Wellbeing related to aging-in-place within a real-life setting?***

This chapter is meant to formalize learnings for other ADR researchers, to which end we start by explaining how the seven ADR principles from Sein et al (2011) have been incorporated in our research. Next, we suggest which new and refined principles should be added to the ADR method when developing a platform for social innovation.

## 12.1 How to put the ADR principles in practice

Although the four stages of the typical design cycle from Sein et al. (2011) have been included in our design (i.e., the *how*) - 1) Problem Formulation, 2) Building, Intervention and Evaluation (BIE), 3) Reflection and Learning, and 4) Formalization of Learning - we needed more guidance for our process (i.e., the what). Therefore, for a more detailed view of the different stages, we expanded this design cycle with insights from Hevner (2007) and (Verschuren & Hartog, 2005) and came up with a refined

ADR research framework. As such, we describe how the seven ADR design principles, as part of the ADR framework, informed our design process.

In the first research phase (i.e., Problem Formulation) the problem is formulated as is it perceived by the researchers.

***ADR principle 1: Practice-inspired research***

In our case, the practical problem is not so much an organizational problem but the societal challenge of an aging population, and the associated health costs. Growing social needs, together with budgetary constraints, require innovative solutions. In the light of limited resources available, in particular social innovations offer potential solutions to pressing social demands, while making better use of the available resources. By encouraging social innovations, policy- makers in the healthcare domain strive to pursue a triple win (Hubert, 2010): 1) providing products and services that are beneficial, of high quality, affordable to citizens and that add value to their daily lives, 2) providing services that are sustainable in the long term, and 3) creating new business opportunities for (social) entrepreneurs. To identify and conceptualize the research opportunity, we conducted two interview rounds with stakeholders in the smart living domain, more specifically, in the area of Health and Wellbeing.

The first round of interviews (section 5.1) focused on identifying the practical problem, i.e., finding out why smart living and Health and Wellbeing services have not taken off. We conducted open-ended interviews on issues regarding fragmented smart living service offerings, consumer adoption, technology issues, business models, inter-organizational collaboration and knowledge sharing. The interviewees included installer companies, opinion leaders and manufacturers with a track record in the smart living domain. The main finding of this first set of interviews was that end-users are unaware of which smart living solutions are available and how they can meet their needs (Keijzer-Broers & De Reuver, 2016). Meanwhile, we discovered that service providers had problems reaching end-users and promoting their products and services. According to the interviewees a solution was required to address this mismatch between supply and demand.

In the second round of semi-structured interviews (section 5.2), we focused on identifying potential solutions into the practical problem with potential user groups and various stakeholders. The interviewees were selected from three stakeholder groups: strategic level stakeholders (i.e., knowledge institutes, government and funding partners), affiliate level stakeholders (i.e., service and technology providers) and potential end-users (i.e., care providers and citizens in different age groups). Based on the interviews, we identified three main features of an online platform for Health and Wellbeing: 1) an online community for contact, social wellbeing and interaction with the neighborhood (consumer-to- consumer) driven by the need for social cohesion, 2) a portal for bundled smart living services and solutions (business-to-consumer), driven by the need to centralize all information about aging-in-place and 3) an intervention instrument for the municipality (government-to-consumer), driven by the need on the part of municipalities to interact with citizens their needs for services and questions about the different healthcare arrangements. As far as a main goal for the IT artifact was concerned, we found that it should enable end-users to enhance self-management (i.e., independency) by providing relevant information and by bringing together (i.e., matchmaking) different stakeholder groups (i.e., end-users, providers and government).

To evaluate our first ideas about a Health and Wellbeing platform and to develop requirements for the IT artifact, we conducted two rounds of focus group meetings (section 6.1), to 1) validate the basic platform features (i.e., online community, portal and intervention instrument), 2) identify the first functional and non-functional requirements of the platform, and 3) shape the outline of the tentative design of the platform. During the focus group meetings with researchers, end-users and practitioners, we developed the basic requirements for the digital platform. The requirements were evaluated through a questionnaire involving the focus group participants, after which the requirements were clustered into categories through exploratory factor analysis.

Thus, we gave rise to the practice-inspired research principle by using different methods, like interviews and focus groups, to get to the heart of the social problem and at the same time analyze suggested IT artifact solutions.

***ADR principle 2: Theory-ingrained IT artifact***

We used two main kernel theories to be ingrained in the IT artifact. As we identified in the problem exploration phase, the main goal of the IT artifact should be to connect people (i.e., elderly people and informal caretakers) with product and service providers. We therefore adopted Platform theory to inform our design and focused on multi-sided platforms, which are discussed in studies involving strategic management (e.g. Gawer, 2009) and information systems (e.g. Tilson, Lyytinen, & Sørensen, 2010; Yoo et al., 2010). We used concepts from multi-sided platform literature to identify design issues for our IT artifact, like accessibility, value propositions, targeting and user profile management (Chapter 6)

The aim of the platform is to improve the ability of elderly people to live longer at home. Such a conceptualization of people's wellbeing in terms of their capabilities to function independently how they want is core to the Capability Approach, which focuses on what people are actually capable of doing with the resources they have at their disposal at a certain point in time.

The Capability Approach has recently been adapted to measure the impact of Health and Wellbeing initiatives on a societal level (Stephens, Breheny, & Mansvelt, 2015; Talaei-Khoei et al., 2015; Vichitvanichphong et al., 2014). As Robeyns (2005) explains, the Capability Approach assumes that the end of wellbeing should be conceptualized in terms of people's capabilities to function; in other words it is people's actual opportunities to take on, meaning the actions and activities that they want to engage in, and be whom they want to be. We used the concepts of the Capability Approach to operationalize evaluation criteria for the IT artifact (Chapter 9), but also to steer the discussion during the design iterations and look beyond usefulness and usability of the IT artifact.

To address the theory-ingrained artifact principle, we emphasized Platform theory and Capability Approach to inform our IT artifact, not only to structure the problem and identify a possible solution, but also to guide the design, before moving on to the next research phase.

***ADR principle 3: Reciprocal shaping***

This principle links the building of the platform (i.e., prototyping) and the constant evaluation of the prototypes in recursive design cycles (i.e., design iterations). In this phase, practices from researchers as well as practitioners and end-users have been taken into account. In all, we used four design iterations (see figure 50), in which the platform evolved from a paper prototype and mock-ups to a clickable model and a demo, and finally a Minimal Viable Product. As such, by iterating the prototypes and by consulting the multidisciplinary ADR teams and stakeholders inside and outside the Living Lab, reciprocal shaping occurred.

***ADR principle 4: Mutually influential roles***

To conduct the BIE cycle, with several design iterations, we set up a so-called Living Lab of public and private partners, including end-users (i.e., elderly people and informal caretakers). The partners were identified in the problem framing stage and committed themselves to developing, implementing and testing the IT artifact in practice. The most important stakeholder in our setting was a municipality, which, being regarded as the launching customer, provided access to citizens, the WMO desk and district nurses.

In addition to the municipality, other Living Lab participants were two small businesses (SMEs) that develop software for healthcare, one large IT firm (that develops big data analytics systems including in the healthcare domain), and one triple-play provider who has a relationship with end-users (i.e., both multinational companies). Our Living Lab partners were not compensated for their efforts in the BIE cycle, nor was any external funding provided. Consequently, throughout the project, there were time and money constraints within the Living Lab, so we focused on using efficient tools that could guide our design strategy, without losing sight of our intended research goals.

To track real-time problems during the design process and to allow rapid iterations, we used an agile approach based on flexibility, adaptability and productivity and combined it with UCD. Although agile and UCD design traditionally use different approaches for resource allocation (Fox, Sillito, & Maurer, 2008) agile and UCD methods are increasingly combined in practice, as this appears to result in better designed products compared to versions designed using waterfall approaches (Da Silva et al., 2011; Sy, 2007). Agile methods aim to deliver small sets of features with minimal design effort in short iterations, while UCD takes more time and considerable research effort. We adapted insights from the two design methods and incorporated them in a design framework that matched our project. See figure 51.

To shape the design iteration steps, we formed three Action Design Research teams from the Living Lab setting, which worked in parallel: 1) a Development team, which specified the Critical Design Issues of the platform, established a project plan and developed the initial template of the platform architecture and took care of the refinement, 2) a Design team, which designed mock-ups as basic input for the low-fidelity platform prototype and translated a clickable model into an Minimal Viable Product, and 3) a Research team, which identified problems through interviews, facilitated workshops and evaluated the product through (four rounds) of user tests. Having the end-user on-site made it possible to facilitate user tests and allowed the teams to incorporate the test results into subsequent design iterations. Meanwhile, input from potential end-users within the Living Lab (e.g., local government, service providers, informal caretakers and elderly people) informed the research process.

How the design iterations were executed during the design process is extensively described in Chapters 8 through 11. Although we made preparations for the fifth design iteration (i.e., commercialization phase), which included business modeling (section 10.1) and discussions with the government and industry, the execution of this

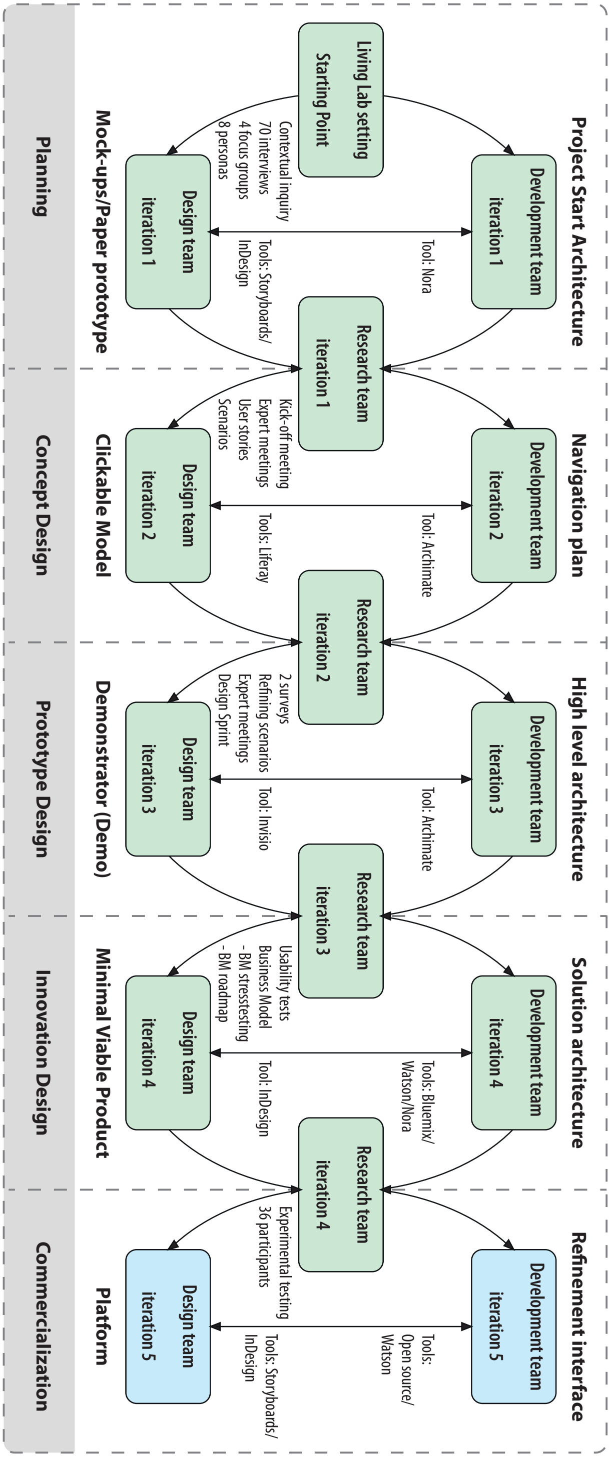



Fig. 51. Overview design iterations executed by three ADR teams.

phase is part of the future research agenda within the Living Lab setting and therefore falls outside of the scope of this dissertation.

We demonstrated principle 4 with regard to mutually influential roles, by involving the Living Lab partners in the entire design process. In five workshops with the Living Lab partners, ranging from design and architecture to business modeling the 'open mind' of the participants supported the process of mutual learning. All partners were in some way (sometimes in different settings) involved in the workshops, which emphasized their interest in learning from each other.

***ADR principle 5: authentic and concurrent evaluation***

In ADR, evaluation is not a separate stage of the research process that follows after building the IT artifact, but it is interwoven with ongoing evaluation steps. Since evaluation steps had already been executed in the Formulation phase (i.e., focus groups – section 6.1) we followed this path in the BIE phase as well. In addition to formative evaluation such as interviews and user tests among elderly people and informal caretakers, we also used summative evaluations like surveys to evaluate the paper prototype (Chapter 9) and the Minimal Viable Product (Chapter 11).

Although Sein et al. (2011), as mentioned earlier, proposed a design phase called Reflection and Learning in our view this phase is incorporated into the entire research process, in which the results are evaluated sequentially and consequently looped back in *rigor, relevance and design cycles*. Our early and recurring evaluation steps are in line with Verschuren and Hartog (2005), who define evaluation as the process of comparing separate parts with selected criteria and draw a conclusion on whether this phase is satisfactory or not. As such, we moved from building a solution for a particular case to applying what we had learned to a broader class of problems. Conscious and constant reflection, on the problem, the kernel theories and the evolving IT artifact, is necessary to generate knowledge. Principle 6 (i.e., guided emergence) combines analysis of intervention results with an ongoing evaluation, and is a combination of principles 1 to 5.

***ADR principle 6: Guided emergence***

Based on a logbook with over 1100 memos (see table 54), which incorporates the decision steps related to the ADR process, the ADR researcher did constantly reflect on the process. Subsequently, regular discussions with an Expert Team outside of the Living Lab could mirror these reflections. See appendix D for a summary of the most important decision steps and their outcomes.

In the fourth design phase (i.e., Formalization of Learning) we aim to formalize the learning by developing general solution concepts for a class of field problems. Principle 7 - generalized outcomes- focuses on the transferability of the results and the communication of the outcomes. In this phase the outcomes of the third design iteration are being used for the fourth design iteration (See figure 50), which focuses on the development of the Minimal Viable Product.

*ADR principle 7: Generalized outcomes*

Due to the situated nature of the ADR outcomes generalization is a challenge. We aimed to produce generalized outcomes on three levels: 1) generalization of the problem instance, 2) generalization of the solution instance and 3) derivation of design principles from the design research outcomes.

The fully-fledged application of the ADR design principles, in accordance with the framework proposed by Sein et al. (2011) is summarized in table 53[1].

**Table 53. Fully-fledged application of the ADR design principles according to the framework from Sein et al. (2011).**

| Stages and principles | IT Artifact | |
|---|---|---|
| **Stage 1: Problem Formulation** | | |
| Principle 1: Practice Inspired Research | Research was driven by the need to support citizens in relation to aging-in-place<br>Exploration of whether an innovation that addresses social demand (aging-in-place and taking care of the elderly people) contributes to addressing a societal challenge (i.e., aging society) | *Recognition*: Shortcomings of available digital service platforms to help people age-in-place |
| Principle 2: Theory Ingrained IT artifact | The kernel theories used were Platform Theory and Capability Approach, embedded in a Social Innovation context | |

1. *An extensive analysis of the ADR design principles will be presented at ICIS 2016, paper: 'Action Design Research for Social Innovation: Lessons from Designing a Health and Wellbeing Platform' (Keijzer-Broers, W., De Reuver,M.).*

| | | |
|---|---|---|
| **Stage 2: Building, Intervention and Evaluation** | | |
| Principle 3: Reciprocal Shaping | Recursive cycles (i.e., design iterations) to shape the Living Lab environment | *Alpha Version*:<br>The service platform (i.e., Zo-Dichtbij) conceived as a design idea evolved from a paper prototype via mock-ups into a clickable model. |
| Principle 4: Mutually Influential Roles | The Action Design Researcher who was in the lead (social entrepreneur and PhD researcher) included end-users, practitioners and researchers in the Living Lab to include technical, theoretical and practical perspectives. | |
| Principle 5: Authentic and Concurrent Evaluation | The prototypes of the platform (i.e., paper, mock-ups, clickable model and demo) were evaluated internally (i.e., within the Living Lab) as well externally (i.e., elderly end-users and (in)formal caretakers). | *Beta Version:*<br>The clickable model evolved from a demo into a Minimal Viable Product, which is implemented and evaluated in a real-life setting. |
| **Stage 3: Reflection and Learning (entered throughout the whole research process)** | | |
| Principle 6: Guided Emergence | The ensemble nature of Zo-Dichtbij was recognized. Furthermore, design elements for the platform were derived and mirrored with an Expert Team.<br>Logbook of the Action Design Researcher is used to reflect on the process. | *Emerging Version and Realization*: New design elements for Zo-Dichtbij based on results emerging from the Formulation and the BIE stage. |
| **Stage 4: Formalization of Learning** | | |
| Principle 7: Generalized Outcomes | A set of design principles for ADR was articulated positioning Zo-Dichtbij as an instance for similar settings (i.e., Living Lab) See section 12.7 | *Ensemble Version*: An ensemble embodying the design principles and a guideline for researchers to apply ADR in practice. |

## 12.2 New and refined ADR design principles

Our case of ADR for social innovation has several traits that differ from ADR in other settings, which gave rise to new or at least refined design principles. Principles are derived from analyzing the logbook data collected throughout the project. See Table 54 for an illustration.

**Table 54. Fragments from logbook related to new and refined design principles.**

| Date | Researcher's activity | Main findings | Formalization of learning |
|---|---|---|---|
| Feb 2013 | Conduct exploratory interviews with elderly people and informal caretakers | End-users are skeptical: they fear yet another technology will be developed without consulting the target group | *Principle:* Translate a societal problem into a practical problem on a stakeholder-level |
| Apr 2013 | Desk research on societal problems of an aging population; Follow-up interviews with stakeholders in healthcare and potential end-users | Artifact should enable social intervention for participation in healthcare, `bringing back users in the driver seat' | Start with a social problem with a potentially large impact, i.e. the transition in care provisioning from national to local government and the idea of harnessing healthcare expenditures by having people live longer independently at home longer. |
| May 2013 | Establish an Expert Team composed of four people who represent end-users familiar with healthcare domain. Expert Team will mirror the ADR researcher and translate the decision steps that were made in a logbook | Expert Team minimized research bias from ADR researcher | *Principle*: Involve citizens early and continuously in the ADR project<br><br>Social innovations often affect the social practices of citizens in profound ways. The ADR researcher should elicit and continuously consider how the IT artifact affects the social practices of citizens. Therefore the involvement of end-users from day one of the project is recommended, even before any alpha or beta versions are produced.<br><br>To involve end-users from start to finish helps to get the study objectives and methods right |
| Jul 2013 | Develop a stakeholder map that visualizes the multiple user groups of the health and wellbeing platform | End-users should not be treated as homogeneous group but fulfill different and partly overlapping roles: elderly people and informal caretakers | |
| Jul 2014 | Conduct focus groups with stakeholders and end-users (i.e., elderly people and informal caretakers) | Insight into what should be core functionalities of a health and wellbeing platform to support people age-in-place from an end-user/stakeholder perspective | |
| Sep 2014 | Involve elderly associations (Unie-KBO, ANBO, PCOB) and the patient association (NPCF) in ideation of the artifact | Insight into the wish-list of branch associations with regard to a social innovation to help people age-in-place | |

| | | | |
|---|---|---|---|
| Nov 2013 | Desk research on project cooperation involving stakeholders from different disciplines | Insight into how to secure long-term commitment from stakeholders to become involved in practice-oriented research | *Principle:* Reciprocal shaping between social practice and IT artifact<br><br>Design cycles iterated between shaping the IT artifact and the affected social practices. New features of the IT artifact led to ideas on how to improve social practices of the stakeholders involved, and vice versa. |
| Jul 2014 | Set up a Living Lab for the Building, Intervention and Evaluation phase of the ADR framework. Give participants an equal vote in the decision-making process. Involve enterprises, university, public organizations and end-users. | The designed artifact emerges from interaction in the Living Lab, and results from trial and error: from having the idea, to testing, learning, failing, re-envisioning and realizing a (minimal) viable product | |
| Sep 2014 | Use different design tools to support the decision-making process of the platform: personas, user stories, vision documents, task scenarios. | In-depth understanding and refinement of for whom the platform is and consequently not is being designed for | |
| Sep 2013 | Quantitative research (end-user surveys) and qualitative research (interviews, focus groups, workshops) for formative evaluations of the artifact | Formative evaluation of the artifact. Identification of knowledge gaps | |
| Apr 2013 | Use participatory observation and keep a logbook (>1100 notes) and involve research assistants, to build a chain of evidence and reduce the researcher's bias | ADR researcher is part of the study but at the same time an outside observer<br><br>The ADR researcher should be well aware of the different political, economic and social values that play a role in the social innovation. Evaluation criteria for the IT artifact are thus value-laden and ADR researchers aiming for social innovation should make this explicit and balance these different values. | *Principle:* Balance political, economic and social values to evaluate ADR results |
| Dec 2014 | Use the Capability Approach to evaluate how the platform contributes to the ability of elderly people to age-in-place | Empirical basis for the Capability Approach to evaluate the impact of IT artifacts as an alternative framework in adoption research | |
| May 2015 | Use Iivari's (2015) second design science research strategy to frame the research | Solve a societal problem by building a concrete artifact in a specific context and generate prescriptive knowledge to be packaged into a general solution concept to address a class of problems | |

***Translate a societal problem into a practical problem on a stakeholder level***

Taking social innovation as a starting point appears to imply that more effort is required in the problem formulation phase. We did not start from a specific business problem or IT opportunity, but from a social problem with a potentially large impact, i.e. the transition in care provisioning from national to local government and the idea of controlling healthcare expenditures by having people live independently at home longer. Consequently, in the problem exploration phase, we had to understand the social problem and the social practice that underlies the current situation. In our case we started from a rough idea about the societal problems in question, i.e. growing expenditures in elderly care, decentralization of elderly care to municipalities, and the trend of having elderly people live longer independently at home. Before initiating the design iterations, we had to translate the societal problem into a practical problem of one or more specific stakeholders. We did so by conducting two extensive rounds of interviews with potential stakeholders. These interviews were not only instrumental to understanding the societal problem and solutions, but also to identifying and motivating stakeholders to become involved in our design iterations. Identifying and obtaining commitment from the stakeholders took a great deal of effort, especially since two municipalities declined to participate in advanced stages of preparation. Moreover, since the practical problem for stakeholders at the start of the ADR project had not been clearly identified, the researcher had to drive the process of identifying stakeholders and persuading them to become and stay involved. In addition to research skills, this also required engaging more entrepreneurial activities, like safeguarding the interests of the stakeholders, setting up gentlemen agreements and setting up a Foundation with a non-profit status to ensure the project's long-term sustainability.

Our case shows the challenges of moving from a societal problem towards a specific stakeholder-level problem that can be addressed in design iterations. The ADR researcher needs to understand the societal problem, the stakeholders involved and their social practices, while also having to identify, involve and motivate stakeholders. Therefore, we suggest as a refined design principle (i.e., related to Sein's design principle 1): Translate a societal problem into a practical problem on a stakeholder level.

***Reciprocal shaping between social practice and the IT artifact***

Furthermore, our different design iterations led to an increased understanding of how the IT artifact and social changes affected each other. After several discussions within the municipality (section 5.2 and appendix D), our conceptualization of a matchmaking platform between elderly people and service providers (i.e., IT artifact) made policy-makers aware that their front-office should provide more comprehensive and tailored advice to their elderly citizens on which care products and services to adopt for their specific situation (i.e., a new social practice). While discussing the IT artifact, the municipality also became aware that they might save costs if the platform would be able to answer easy-to-solve questions from citizens and if the platform allowed elderly people to discuss with each other which care solutions are available. The municipality thus realized they should not only provide advice but also facilitate interaction between elderly people (i.e., a new social practice), which meant that we decided to add peer-to-peer communication features (i.e., IT artifact) to our matchmaking platform. The platform log data functionality (i.e., IT artifact) also raised ideas on how to use segmentation in delivering care services and advice by the municipality (i.e., a planned new social practice).

While developing our IT artifact, we found that a matchmaking platform would also affect family members of elderly people, who often provide informal care. We found that a main challenge for informal caretakers is to stay up-to-date on the care being provided to their relatives. Therefore, we added a Care plan feature to our matchmaking platform (i.e., IT artifact), which provides a single point where informal caretakers can find and exchange information on the status and care received by their relatives. Discussions with informal caretakers (for instance in sections 5.2, 6.1 and 11.2) showed that they especially value how these remote communication opportunities help them remain at a distance but still take care of their family members, and share information with other informal caretakers and medical professionals (i.e., new social practice).

These examples show how our design cycles iterated between shaping the IT artifact and reshaping social practices. New features of the IT artifact led to ideas on how to improve social practices of the stakeholders involved, and vice versa. We found there is no one-way relationship from social practice to the IT artifact, but that they reciprocally influence each other. Therefore, we suggest as a refined design principle (i.e., related to Sein's design principle 3): Reciprocal shaping between social practice and the IT artifact.

***Involve citizens early on and continuously in the ADR project***

In our case, the new social practices and IT artifact affect citizens in various ways. Elderly people are affected, as they shift from a passive role in which they receive advice on care products and services, towards an active role of finding the information themselves.

Family members who provide informal care are also affected, as they will, in practice, often use the matchmaking platform on behalf of their elderly relative. Especially the sandwich generation of young elderly between 55 and 75 are affected, as they will use the platform to find care for themselves as well as for their parents. We involved citizens as early as the Problem Formulation phase to make sure we would come up with acceptable solutions. Therefore, we involved elderly end-users to inform our design choices but also to gain credibility among prospective users. We used tools like personas, user stories and user scenarios to remind the designers continuously of how their choices would affect the social practices of citizens. We used methods of focus groups, surveys, interviews and usability tests to inform and evaluate our IT artifact development.

While involving end-users in design processes is certainly not a new idea, the examples we gave from our case illustrate how citizen involvement from day one is helpful even before any alpha or beta versions are produced. Social innovations often affect the social practices of citizens in profound ways. The ADR researcher should elicit and continuously consider how the IT artifact affects the social practices of citizens. Therefore, we suggest as a new design principle: Involve citizens early on and continuously in the ADR project

***Balance political, economic and social values for evaluating ADR results***

In our case, we encountered different political, economic and social values to justify the social change created by our platform. Facilitating elderly people to age-in-place is often justified by claiming that it increases their quality of life and wellbeing. Transferring elderly care from professional providers to family members, as the care plan in our IT artifact facilitates, is often justified based on an idealistic vision of a `participatory society', where citizens take care of each other rather than relying on the state. Decentralization of care to municipalities, which our platform helps to organize, is justified by the idea that reduced overhead leads to more intimate relationships between care providers and elderly people. At the same time, all three of these social changes are also clearly policy strategies aimed at reducing healthcare expenditures. During the decentralization of care to municipalities, elderly care budgets were reduced with more than 50%. Critics have argued that independent living, as well as informal care and decentralization are not so much designed to benefit elderly people, but that their aim is to justify harsh budget cuts. Therefore, rather than sticking with the political justifications, we explicitly considered the citizen perspective in evaluating the consequences of our designed platform. We used the Capability Approach to evaluate how the platform contributes to the ability of elderly people to live their lives how they want to in ways that are meaningful to them. By doing so, we broadened our evaluation criteria beyond the economic and business criteria of municipalities and providers, to include the effects of the IT artifact on citizens.

We argue, that the ADR researcher should be well aware of the different political, economic and social values that play a role in social innovation. In our Health and Wellbeing case, we found that what is called a social innovation by one group of stakeholders may be considered harsh budget cuts by others. What is considered a beneficial social change by one political stream may be considered a regrettable step towards individualization and reduced solidarity between citizens. Evaluation criteria for the IT artifact are clearly value-laden and ADR researchers aiming for social innovation should make this explicit and balance different values. Therefore, we suggest a new design principle: Balance political, economic and social values for evaluating ADR results.
The refined and new design principles are summarized in table 55.

**Table 55. Refined and new design principles for ADR for social innovation**

| Design principles | Execution design principles within the social innovation case |
|---|---|
| **Translate a societal problem into a practical problem on a stakeholder level** | *Refined design principle (1)*<br>As the starting point is a social innovation, the ADR researcher first needs to identify a practical stakeholder problem. This is both a research issue (i.e. understanding the societal problem, affected stakeholders and their social practices) and an action issue (i.e. identify, involve and motivate stakeholders). |
| **Reciprocal shaping between social practice and the IT artifact** | *Refined design principle (3)*<br>Ideas on new IT artifacts and changed social practices do not evolve independently but influence each other. To solve social problems, the ADR researcher needs to allow for reciprocal shaping between social practices and the IT artifact. |
| **Involve citizens early on and continuously in the ADR project** | *New design principle*<br>Social innovations affect practices of citizens in profound ways. User involvement goes beyond ensuring adoption or fulfilling user needs. To understand the social problem and allow reciprocal shaping between social practice and IT artifact, the ADR researcher should involve citizens early and continuously, even before any alpha or beta versions are produced. |
| **Balance political, economic and social values for evaluating ADR results** | *New design principle*<br>Social innovations and desired social change are value-laden. Social innovations are often used to reframe political or economic agendas. ADR researchers should be aware and balance the different values at play. |

These new and refined ADR principles can guide scholars and researchers to execute the ADR method when facing a societal challenge.

# 13. Conclusion and reflection

This dissertation presents how to design, prototype, implement and evaluate a digital service platform for Health and Wellbeing with the aim of supporting people to age-in-place. The *societal driver* behind this research is rooted in a social problem related to aging populations, while the *theoretical driver* is derived from the aim to bridge the gap between the theoretical analysis of service platform development and the design process of platforms. At this point in time, empirical research on jointly developed platforms is still scarce, while the process, which incorporates how digital platforms arise, evolve and can be governed over time, can contribute to the emerging scientific debate in the IS community about the development of digital platforms.

The overall objective of this research was:

***To design, prototype, implement and evaluate a service platform for Health and Wellbeing in a real-life setting, that 1) enhances the capabilities of elderly people to age-in-place, 2) unburdens informal caretakers, 3) helps service providers promote their products and services, and 4) contributes to the specific tasks of local governments to support social intervention for citizens within the context of Health and Wellbeing, while keeping the costs under control.***

Based on the research objective, the overall question of our research was framed as follow:

***How can a digital service platform for Health and Wellbeing be designed, prototyped, implemented and evaluated within a real-life setting, which subsequently supports three different stakeholder groups (i.e., end-users, service providers, local government) in relation to aging-in-place?***

Within the scope of this study, we reached our research objective of designing, developing, implementing and evaluating a service platform for Health and Wellbeing to help people age-in-place.

Based on the Problem Formulation phase (Chapter 5), the three specific design goals were:

1. Create awareness among end-users on what products, services and technologies can help them age-in-place. Within that context the platform contributes to the

exchange of information and knowledge about smart living, to create awareness among end-users (elderly people and informal caretakers).

2. Satisfy the requirements of end-users, service-providers and local governments. Within that context, the platform contributes to developing and describing the process around the exchange of value, information and physical processes, as well as communicating about them.
3. Provide a match between (latent) needs and (as yet unknown) services. Within that context, the platform brings relevant players together, allowing for collective action within the smart living domain, with an emphasis on interconnection.

The IT artifact as designed provides two core features: the sharing of information between elderly people and caretakers, and matchmaking with service providers in the Health and Wellbeing domain. In combination, the evaluation of our experiment (see Chapter 11) shows that these features contribute to capabilities of people to increase comfort, affiliation and control in the form of independence. The combined features of information sharing and matchmaking also make it easier for elderly people and their family to find volunteers that may become involved in providing care. As such, these capabilities reduce the burden on informal caretakers and volunteers taking care of elderly people. In other words, the features of the platform enhance the capabilities of young elderly people (55 -75) and informal caretakers, which in turn allows for social innovation in the realm of informal care over elderly people.

In practical terms, the proposed online platform can be seen as a groundbreaking concept for the smart living domain in the Netherlands, where there are currently no platforms that offer 1) matchmaking between providers of smart living products and services and potential end-users, 2) help people find local activities 3) connect with other people (e.g., family, caretakers), 4) provide information about aging-in-place, and 5) integrate successful, existing platforms in the Health and Wellbeing domain.

Furthermore, we demonstrated in our research that a social innovation, which addresses a social demand (aging-in-place and taking care of elderly people) helps address a societal challenge (an aging society), and through its process dimension (the active engagement of the elderly people related to healthy aging) can help reshape our society from a welfare state into a participatory state.

At the moment, there are no service platforms, that bring together three different stakeholder groups within the Health and Wellbeing domain in the Netherlands, nor does similar IT artifacts exist elsewhere (see Chapter 1), which means that the potential of a service platform for Health and Wellbeing is also worth exploring outside of the Netherlands.

## 13.1 Contribution to literature

Our study contributes to design theories in two ways. Firstly, we contribute to existing knowledge on how to adapt ADR methods to the specific situation of platform design for social innovation. Secondly, we increase our understanding of how the features of a multi-sided service platform affect capabilities of elderly people to age-in-place.

### *13.1.1 Contribution to ADR method*

***Demonstration of how to use ADR in practice with limited resources***

While ADR provides guidance to the process, it gives the researcher a great deal of freedom in how to execute the research process. Since the method was established relatively recently (2011), there are as yet few practical examples being described in literature (Rogerson & Scott, 2014; Smith, 2015), which means that our study is one of the first fully-fledged applications of the ADR method.

There is a gap in existing IS literature with regard to practical design studies that illustrate how one can apply empirical research methods in developing and testing design theory and kernel theories. We aimed to bridge this gap by using a DSR approach, which provides a lens to design, prototype, implement, and evaluate a digital service platform for Health and Wellbeing in a real-life setting (i.e., a Living Lab).

To track real-time problems during the design process, and to allow for rapid iterations, we adopted an agile approach based on flexibility, adaptability and productivity, and combined it with UCD. The two methods traditionally use different approaches to resource allocation, but they are increasingly being integrated in practice, because they would appear to deliver better-designed products compared to other approaches. Although agile methods strive to deliver small sets of features in short iterations, while UCD takes more time and considerable research effort, we showed how the principles underlying both methods could be combined, within an ADR project, with limited resources.

***Adaption of ADR to social innovation context***

Our research contributes to Design Science Research by applying the Action Design Research method to unravel the phenomenon of social innovation. Given societal challenges in areas like healthcare, sustainability and safety require ICT solutions, we expect that social innovations will become increasingly important for IS design researchers.

Our study revealed that applying Action Design Research (ADR) to address a societal challenge (aging-in-place and care for the elderly) requires a Societal-Demand Dominant inspired research, which can be added as a principle to the problem formulation stage of ADR. As mentioned in Chapter 2, rather than involving end-users after '*the arrow has left the bow*', we included potential end-users (e.g., local government, service providers, informal caretakers and elderly people) in the Living Lab. This informed the research process, allowing us to implement and test all the required aspects of the platform, both inside and outside the Living Lab setting. Having the end-user on-sight, made it possible to conduct several user tests and allowed the various ADR teams to incorporate the test results in subsequent design iterations.

Because aging-in-place is related to a societal demand, which encompasses an entire population rather than a single organization a Societal-Demand Dominant approach was chosen for the Building, Intervention and Evaluation phase. To that end, we adapted the model proposed by Sein et al. (2011), in a sense taking a hybrid approach in which all prototype versions of the platform are evaluated not only internally but also externally. During the first design iteration, the ADR researcher challenged the participants' existing ideas and assumptions about the platform's specific use context, to create different versions of the prototype in follow-up design iterations, ranging from low-fidelity prototypes, like a paper prototype, clickable model and a demo, to a Minimal Viable Product (see figure 52).

Our study can be regarded as a validation of the ADR method, based on primary data. However, we posit that the ADR method is relatively abstract and the specific characteristics of social innovation require adaptations to the existing approach of ADR. In particular, as described in Chapter 12, social-innovation inspired ADR should: 1) be based on an in-depth understanding of the social problem and underlying practices, 2) allow for reciprocal shaping between the changes to social practices and the IT artifact, 3) from the very start of the ADR process, involve citizens who are affected by the social innovation, and 4) be led by change agents that can identify and motivate stakeholders, balance political, economic and social values, and bring about change. Therefore we suggest that these four refined design principles should be added to the ADR framework, to guide researchers who face societal challenges.

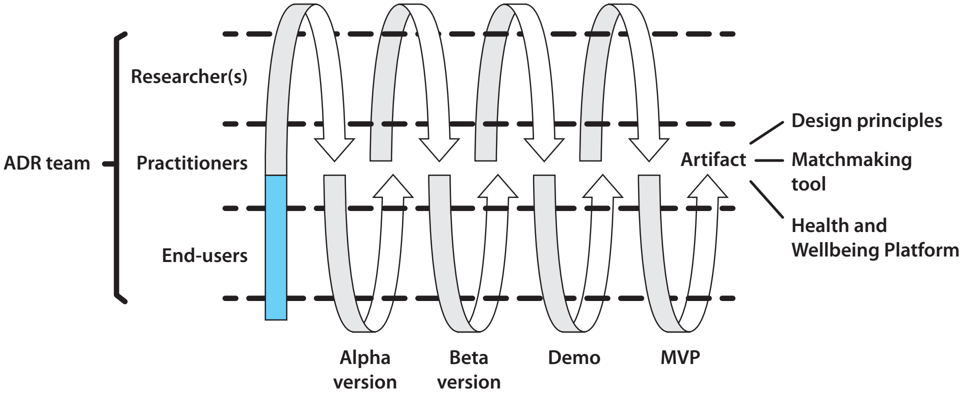



Fig. 52. BIE iterations from a Societal-Demand Dominant perspective, extension based on Sein et al. (2011).

***<u>Demonstration of situated ADR in practice</u>***

Based on the results of our research, we contributed to Action Design Research by refining the ADR research framework (see Chapter 2), as such 1) add an extra research phase, which focused on design requirements based on Verschuren and Hartog (2005), 2) incorporate insights from Hevner (2007) regarding relevance and rigor cycles, 3) use a Living Lab setting to shape the various design iterations in the BIE phase, in accordance with Ståhlbröst and Holst (2012), and 4) focus on the Second Design Science Research Strategy (Iivari, 2015) to 'flesh out' the ADR design process.

In addition, we showed how to implement the *Second Design Science Research Strategy* (i.e., Strategy 2) in practice to solve a specific problem of Dutch municipalities, by building a concrete IT artifact within the smart living domain. Strategy 2 is different from the *First Design Science Research Strategy* where researchers construct or build a Meta-IT artifact as a general solution concept to address a class of problems. Iivari (2015) contrasted 16 dimensions on a detailed level, which are important to understanding the essential differences between the two Design Science Research strategies. For our social innovation we used the second DSR strategy, which follows the context-process-outcome framework proposed by Iivari (2015), as shown in table 56.

| Table 56. Outcomes Second Design Science Research Strategy, based on Iivari (2015) | | |
|---|---|---|
| **Dimension** | | **Outcomes Second Design Science Research Strategy** |
| **1.** | **Researcher – client relationship** | Municipality of Rotterdam, one of the four Metropolitan areas in the Netherlands |
| **2.** | **Major problem to be addressed** | Help citizens age-in-place and unburden the WMO desk |
| **3.** | **Typical uncertainty of the DSR project** | Second best alternative – WMO desk without the use of a digital tool to help citizens age-in-place |
| **4.** | **IT artifact built** | System implementation in a Living Lab setting using four design iterations |
| **5.** | **Primary role of the real system implementation** | Instantiation as a proof of concept (i.e., a Minimal Viable Product) tested among young elderly/voluntary caretakers in the age group between 55 – 75 |
| **6.** | **Nature of the target IT artifact** | Emergent system – envelop platform which embraces national and local platforms for Health and Wellbeing |
| **7.** | **Typical nature of the IT meta-IT artifact** | Expanded design principles of Sein et al. 2011 |
| **8.** | **Innovativeness** | Mixed tendencies: envelop platform in Health and Wellbeing domain related to aging-in-place |
| **9.** | **Practical relevance** | Address an immediate practical/social problem related to an aging population |
| **10.** | **Major process driver** | Experiences from the process as formalization of learning for researchers and practitioners |
| **11.** | **Research method: ADR** | Mixed method: interviews, focus groups, surveys, logbook |
| **12.** | **Generalization** | Lessons learned from the process and design guidelines |
| **13.** | **Access to the client** | Living Lab setting: municipality, end-users, providers and academia (quadruple helix) |
| **14.** | **Expertise needed** | Interdisciplinary |
| **15.** | **ADR Research team** | ADR researcher in the lead of the living lab setting, supervising research-assistants |
| **16.** | **Time and costs** | Time consuming and expensive. In addition, securing the commitment of multiple stakeholders for a longer period of time was crucial |

According to Strategy 2 the researcher has a relationship with an identifiable client (a municipality). Furthermore, a specific problem is encountered and although the researcher should keep an open mind, this does not imply that the researcher entered the DSR project with a blank mind. The ADR researcher already had an initial idea about the DSR contribution (i.e., aging-in-place). A typical uncertainty of this DSR project is the second best alternative for the municipality in helping the citizens of the Metropolitan area to age-in-place (i.e., WMO helpdesk function for Health and Wellbeing without using a digital tool).

Our research is one of the first, to apply the Second Design Science Research Strategy proposed by Iivari (2015), following all the 16 suggested dimensions, which helped us to flesh out the '*how*' in our ADR study. In our longitudinal study, we attempt to solve a societal problem by building a concrete IT artifact (a service platform for Health and Wellbeing) within a specific context (elderly people aging-in-place) and gather prescriptive knowledge (with regard to the application of ADR to a societal problem) to be packaged into a general solution concept (social innovation) and address a class of problems (a matchmaking platform for important social issues). The artifact in question is still undergoing continuous refinement (from low-fidelity prototypes to a Minimal Viable Product). As such, future research can examine how the Minimal Viable Product will emerge into an implemented service platform in practice.

### 13.1.2 Contribution to Capability Approach and Platform theory

Our starting point is the situated Living Lab context, rather than theoretical propositions on how to design the platform, thus resembling the type-2 strategy as proposed by Iivari (2015). See section 13.1.1. However, the empirical evaluation of our design goals, requirements and the IT artifact provides reusable knowledge on how to design service platforms, involving both reusable features in the artifact that can be generalized to other problem instances, and knowledge on how to manipulate the core constructs in the theory (Baskerville & Pries-Heje, 2010).

***Capability Approach***

The artifact in question combines features of information provisioning between elderly people and caretakers, and matchmaking between elderly people and care providers. Although these are not novel features for platforms, they have not been applied in the smart living domain so far. As such, our study represents a case of 'exaptation' (Gregor & Hevner, 2013, p. 347), which is explained as '*effective artifacts may exist in related problem areas that may be adapted in the new problem context*'. However, our study does show that these features, when combined, enhance the capabilities of elderly people to age-in-place. Therefore, to support the main capabilities of elderly people we added features to the service platform like 1) a Care plan, which combines a plan board, contacts and a diary function, 2) a marketplace for local products and services, and 3) an overview of local activities, arguing that these features have a positive impact in enabling capabilities that help elderly people to achieve independent living.

Additionally, our study provided an empirical basis for the Capability Approach as a way to evaluate the impact of IT artifacts. Although the Capability Approach has similarities with acceptance theories like TAM (i.e., Technology Acceptance Model) and UTAUT (i.e., Unified Theory of Acceptance and Use of Technology), the latter are usually related to an organizational context for technology adoption, and empowering elderly people using technology requires a different approach. We argue that elderly people will adopt a technology when they believe it improves or maintains their capability, which gives them the freedom to choose the 'functionings' they value. Hence, elderly people like to have the freedom to utilize the platform according to what they value. In section 9.2 we found that it is important to elderly people to maintain their independence and be able to age-in-place. Being independent also means that they can improve their capabilities and have the freedom to choose how they want live. In other words, if elderly people believe that independent living is a valuable goal that they want to achieve, they will look at how the platform can help improve their capabilities to achieve this goal (Chapter 11). Our study supports that at least young elderly people (i.e., 55 – 75 year) are likely to adopt a service platform for Health and Wellbeing, because they believe that it improves independent living in the long term. Our study also provides the potential of the Capability Approach as an approach to evaluate the consequences of IT artifacts to support elderly people in their daily lives.

As far as the utility of the applied kernel theory is concerned, we can conclude the following. The Capability Approach is useful for evaluating the functionalities of the service platform. However, the theory is relatively abstract and specifications to the domain were required to fit them into a construct, which guided our quantitative survey research, in particular because the platform was not yet available. However, our operationalization of the Capability Approach for platforms should pave the way for future researchers to apply the theory.

***Platform Theory***

In addition, our study provided the empirical basis for creating a design theory on digital multi-sided service platforms, which is currently still lacking in literature (Nikayin, 2014). While digital platform literature is often concerned with evaluating profitability for platform providers or the generative potential for app developers, our study examined how platform functionalities affect the capabilities of elderly people. As such, this dissertation provides a basis for developing design theory on how to design and implement a multi-sided service platform to improve the capabilities of elderly people.

For the applied platform theories in this study, we used Tiwana (2014) as a checklist during the design of the service platform, including 1) multi-sidedness: focusing on three stakeholder groups (end-users, providers, government), 2) network effect: how to reach out for a critical mass of potential users, 3) envelopment: combining functionalities in a multi-platform bundle, which leverage shared user relationships, for instance by including local/national web initiatives, and 4) how to shape the platform architecture (from a project start architecture to a solution architecture). We found that a checklist, like the one we extracted from the work by Tiwana (2014), 1) was helpful to steer discussion, retain focus within the Living Lab, 2) evaluate intermediate products and 3) to prepare the platform architecture. We were able to integrate the suggested functional and non-functional requirements within the Minimal Viable Product (section 6.3). However, as we discussed in section 5.3, the choices and prioritization of the requirements have to be reconsidered when developing the market version of the interface.

## 13.2 Contribution to the Smart Living domain

Despite the commercial efforts in various sectors (i.e., Health, ICT, Building and Energy) smart living products and services have yet to make it onto the mass market, because people are unable to find them in a fragmented marketplace. A platform for Health and Wellbeing could partly solve this problem by matching supply from reliable service providers with the demand of citizens who want to age-in-place. We argue that smart living products and services that are technologically feasible and acceptable can make it to the mass market if end-users are able to find them, and the information is provided in a more structured way. Creating awareness among end-users about existing solutions to help them age-in-place is challenging and the acceptance process of technology for aging-in-place is not always clear. Such awareness will increase by offering a digital service platform to find information on relevant applications within the smart living domain that can help elderly people age-in-place: from home modifications to providing assistive living technologies, which can be defined as adaptations to the environment, ranging from the elimination of slip and trip hazards like throw rugs, or grab bars and railings to complex remodeling of the house to accommodate daily living. However, our research reflects the need for collaboration among various stakeholders to boost the smart living market.

In addition, as explained in Chapter 5, installer companies in the Netherlands play a vital role in the smart living industry, as they already have a relationship with end-users for maintenance in households (electrical and mechanical maintenance, surveillance and domotics). Although other companies in the smart living industry (i.e., healthcare providers, energy providers and telecom operators) play a role as well, installers are among the few who are in contact with end-users on a regular basis about independent living. Especially in the new setting in the Netherlands (since January 2015), where municipalities are responsible for their citizens' health and wellbeing, installers are in a position to exploit their role as intermediaries

To support the aging population to live independently (i.e., age-in-place), policy-makers are looking for solutions that range from physical and economical support to smart homes supported by ICT solutions. What service providers in the smart living domain lack in general is a service platform to 1) address the mismatch between supply and demand of products and services, 2) share knowledge about the domain, and 3) acknowledge the expertise and advisory role of experienced service providers, which means that a platform designed to match supply and demand paves the way for local intermediaries (like installers), who offer smart living products and services, not only to get and stay in contact with end-users, but with policy-makers, who are responsible for the health and wellbeing of citizens as well.

A service platform that focuses on providing reliable information in the smart living domain allows stakeholders to make better informed decisions with regard to a social demand (an aging population). This is particularly crucial for elderly people and their informal caretakers, who need a reliable tool to support practical arrangements related to aging-in-place.

Despite the various stakeholders' diverse interests, we argue that a service platform for Health and Wellbeing can support three stakeholder groups (end-users, service providers and governments) at the same time. We have shown that a service platform is able to 1) help citizens look for smart living products and services to age-in-place, 2) unburden informal caretakers, 3) help service providers promote their products and services, and 4) contribute to the specific tasks of local governments to support social intervention for citizens in the context of Health and Wellbeing, while keeping the costs under control.

## *13.3 Reflection*

The choice in favor of a methodological approach not only affects which explanations we may find in our research, but also issues we end up neglecting. When we started our journey, Design Science Research (DSR) seemed tempting, not in the last place because DSR gives a high degree of freedom to formulate a design theory and draw conclusions. In addition, Action Design Research (ADR) allowed us to use a combination of research

instruments and collect both quantitative and qualitative data. Since DSR emphasizes the need for constructing solutions to complex socio-technical problems, we argue that DSR allows researchers to make a contribution to both science and society.
When trying to solve Health and Wellbeing-related problems, it is important to know whether the design solution is sustainable (i.e., viable and feasible) in the long run. Also, due to the fact that this research was conducted in a Living Lab setting instead of an organization, the solution has to be relevant to the entire group of stakeholders. As such, the design challenge for an aging society is tackled by creating a *specific solution* for the Dutch Health and Wellbeing market, from which both theoretical and practical lessons can be learned.

As suggested by Verschuren & Hartog (2005), to increase the reliability of our study we evaluated the design steps until we reached a saturation point. The same goes for the refinements of the platform's requirements. The outcomes from the Problem Formulation phase (Chapter 5) served as input for the development phase (the Building, Intervention and Evaluation phase) of the platform prototypes (Chapters 6 to 11). In addition, we improved the enrichment and evolution of the personas using storyboards, vision documents and task scenarios in such a way that the personas focused attention on a specific target audience to discover for whom the platform *is* and consequently *not is* being designed for.

Social innovation is a challenging phenomenon because it requires 1) a social entrepreneurial mindset, 2) a commitment to developing a creative idea within a complex domain, and 3) the skills to bring like-minded people together to mainstream the innovation. How to design for social innovation is also challenging. In our case, the ADR project started with the personal drive and observation of the researcher. ADR recognizes that the designed artifact emerges from interaction within the context, even when the initial idea was guided by the researcher's intention. A Living Lab was set up to conduct the interventions with partners from public, private, academic and user side. Although none of the participants received external funding for their participation and interventions, they were eager to shape and reshape the platform idea into the 'ready-to-market' phase. In addition, they were flexible during the time-consuming research process and supportive to the research-assistants. During the research the ADR researcher had to made numerous decisions, especially to avoid disturbing factors with regard to 1) the complexity of the setting (having too many partners on board), 2) the choice of partners (not having the right partners on board), 3) commitment (making sure everyone kept their promises), 4) balancing timeframe (time consuming operation), 5) balancing content control (ADR researcher actions versus social entrepreneurial actions). Thanks to the guidance of methods like ADR, STOF and FormIT we managed to keep the Living Lab up and running.

Because a social innovation rather than an organizational problem was the starting point, the only traction at the problem formulation phase came from the ADR researcher. As such, a limitation of any socially inspired ADR project is that personal traits and the network of 'the' social entrepreneur has an effect on the generalizability of findings. It is up to the ADR researcher to involve other stakeholders who are affected by or enable the social innovation, and to motivate them to stay involved. Therefore, realizing a social innovation from idea to valorization, in a complex multi-actor setting, depends very much on the abilities of the ADR researcher, who acts as a kind of change agent. In our case, in addition to possessing the necessary research skills, the change agent had to arrange activities like maintaining IPR, source codes, setting up gentlemen agreements and establishing a Foundation (with a non-profit status) to ensure long-term sustainability of the platform, but also design a business model that address the interests of all the participants, and a roadmap for implementation and scaling up the platform. However, from a research perspective, this makes it even more important to reflect on the generalizability of the results and the effect the researcher has when intervening in the process. To avoid some of the researcher's bias, a logbook was used which over 1.100 notes to build a chain of evidence. As such, every effort was made to make the decisions, taken within the research, as traceable as possible. In addition, an Expert Team outside the Living Lab was used to mirror the ADR researcher.

Although the platform development can not be regarded as *rocket science*, the process to prepare the social innovation was far from easy, as we constantly had to loop back within a multi-disciplinary setting. Generally speaking, the entire social innovation process was a process of trial and error: from having the idea, to testing, learning, failing, re-envisioning, to developing a (minimal) viable product. As is common in ongoing processes, most of the time, we did not know what we would encounter (and when) in the social innovation process, and this required resilience and perseverance from the Living Lab partners, and the ADR researcher in particular.

During the research process it was challenging to identify on which stage in the project we actually were (see figure 53). For instance, when we could not involve a municipality in our Living Lab setting, were we bracing to withstand the '*dark night*' of social

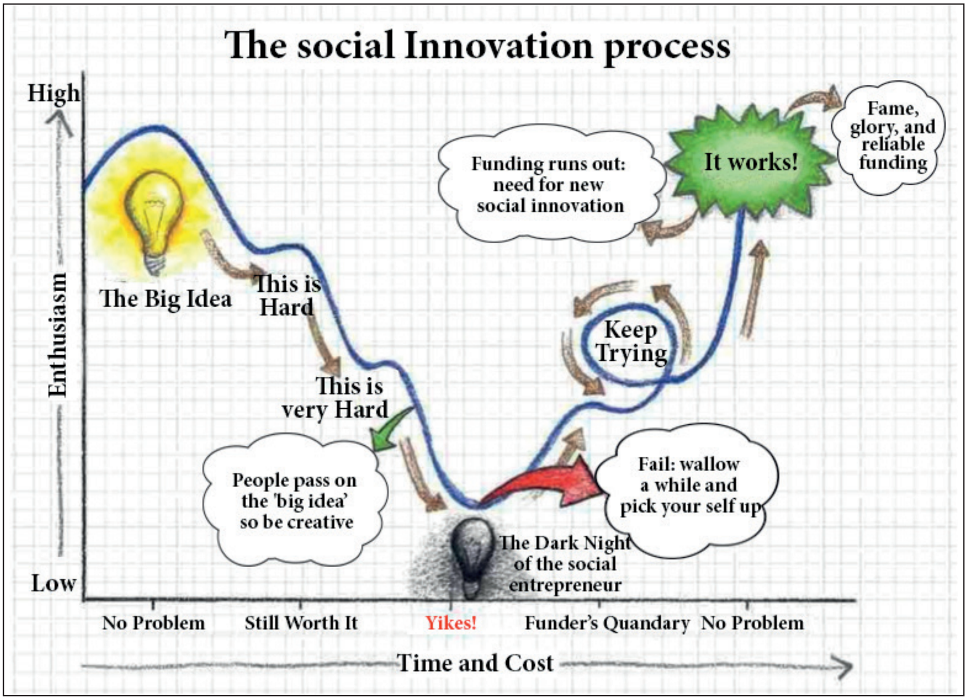



Fig. 53. Social Innovation Info graphic adapted from Brown, Pratt and McCambridge (2012) (illustrated by Atherton).

entrepreneurship, or was that phase still to come and had we just reached the '*it's very hard*' phase? Maybe we were in the '*keep trying*' phase and had to stay in the game just a little longer? As David Brown stated in the Nonprofit Quarterly: '*Perseverance and a great idea seem to make up the secret sauce here*'.

In the end Zo-Dichtbij should make a difference for three different stakeholder groups (end-users, service providers and government) in relation to an aging population. To benefit from the experience and immaterial assets within the Living Lab, the Zo-Dichtbij Foundation should concentrate on the valorization phase with a focus on the long-term viability and feasibility of the service platform. Although the idea behind digital service platforms is easy to copy, to copy the set-up of a platform like Zo-Dichtbij, without all the experience and immaterial assets provided by multi actors, is far from easy. During the research we discovered that the Internet no longer acts merely as a distribution channel, but as a creation infrastructure as well. Therefore, organizational boundaries can be redefined and allow Zo-Dichtbij to leverage an external ecosystem with different stakeholder groups, which creates new forms of value.

Although the service platform has not yet been fully implemented, the future for Zo-Dichtbij seems promising. The Foundation Zo-Dichtbij, with a non-profit status, already aligns with business partners as well as local governments to enroll the platform in the Netherlands, with the platform's market introduction expected by the end of 2016.

### 13.3.1 Recommendations for ADR researchers

Based on our findings we can recommend ADR researchers to explore the possibilities of multi-sided platforms to try and solve societal, IT or organizational problems. Not only because the potential of service platforms in IS is there, but because platforms deliver exiting design research challenges as well. ADR researchers have to consider the diversity of involved the stakeholders involved and identify the knowledge gaps (like implementation fidelity and impact) by applying a multi-disciplinary research strategy. In addition, they have to emphasize formative evaluations and recognize the importance of mixed methods (i.e., quantitative and qualitative research) for evaluation purposes.
ADR recognizes that the designed artifact emerges from interaction with a context even when the initial design was guided by the researcher's intention. As such, ADR researchers should not only focus on high-level goals, but also on the details within a project, and they need to take the ecosystem into account.

In our case this meant that the researcher had to go out into the world and observe the actual experiences of elderly people and how they improvise their way throughout their daily lives. Through participatory observation, the ADR researcher can become part of the study, but at the same time has to be an outside observer. Therefore, we used the snowball technique to spread the word about our platform idea and, starting with our own network, reached out to local intermediaries, which provided introductions to other people and helped build understanding and credibility in related communities. To involve end-users from start to finish helps get the study objectives and methods right.

Furthermore, integrating design thinking as part of Design Science Research helps the ADR researcher focus on creating products and services that are human-centered and rely on our ability to be intuitive construct ideas and recognize patterns. As such, we used different design tools like personas, user stories and scenarios, which supported decision-making during the design process of the platform. Especially design sprints (Chapter 10) are useful tools, when 1) there is a major challenge, 2) there is a tight deadline, 3) financial resources are limited, and 4) you are simply stuck and need to rejuvenate your project. The steps in design thinking are undertaken sequentially and loop back through the different stages (i.e., inspiration, ideation and implementation).

More than once, this can feel chaotic. In retrospect and as soon as you achieve the anticipated results, the entire process, like design, observe and develop (again), makes sense after all.

### *13.3.2 Recommendations for policy-makers*

It is up to policy-makers to commit to social innovations like Zo-Dichtbij and support citizens, not only to promote the idea, but also to incorporate similar ideas into their policies and give rise to effective and efficient interventions. Because an aging population leads to policy issues related to increasing healthcare costs, sustainability of retirement plans and a decelerating effect on potential growth due to an increased social burden, an aging population can serve as a 'wake-up call' for local governments. To support an aging population, policy-makers should, at the very least, facilitate their citizens to age-in-place.

The paradigm shift in the healthcare domain requires a different attitude and involvement not only from citizens, but also from public and private parties to improve the response to new social demands. In addition, social innovation encourages people to become an active part of the innovation process. Therefore, policy-makers should facilitate people who suffer from social exclusion and empower them to participate in society. Whenever participation and independent living is out of the question, these citizens should be able to rely on a kind of 'safety net', which is arranged by the local government.

Collaborative solutions can serve as catalysts for social change and innovation, just because 'collaboration is doing together, which you cannot do apart'. However, collaboration requires a clear vision to realize one's goals and this means people have to deal with conflicts rather than avoid them. Social entrepreneurs can serve as 'change agents' who are able to anticipate bottom-up movements (from bureaucracy to grassroots) and try to find new and better ways to respond to societal problems, which can make a difference in society. Because this in in principle a joint effort, policy-makers should challenge and empower both social entrepreneurs and citizens, while at the same time facilitating bottom-up initiatives to foster social innovations, without necessarily taking the lead themselves.

### *13.3.4 Limitations of the research*

Although we tried to observe both rigor and relevance in this study, several limitations influenced the interpretation of the findings.

Dilemmas within the research are related to light-weight versus heavy-weight user testing, the rigor of the Action Design Research methodology versus other research methods, as well as budget and time constraints.

To improve the validation of the platform we initially planned to test Zo-Dichtbij in three districts in the Metropolitan area of Rotterdam, using an experimental design setup, but were unfortunately unable to do so, within the available time frame. Therefore, the final validation step of the MVP was arranged in an experimental setting at Delft University of Technology with 36 end-users (i.e., young elderly people and informal caretakers), to test how the platform idea was perceived. This means that we did not incorporate authentic evaluation, as suggested by Sein et al., but replaced this by a more controlled evaluation setting, but still with the intended target group and with a low content control from the moderators. Although the effect in practice of this social innovation in practice has not been measured, yet, we tried to capture reality as good as possible within the experimental setting. Having said that, the authentic evaluation test within the three districts is still part of our future research agenda. With the aim to get a deeper understanding how the next version of the platform affects the capabilities of elderly people age-in-place and at the same time reveal the impact of the social innovation on citizens in general.

Although, as a participatory observer, the ADR researcher became part of the study, it is important one always to bear in mind that one acts and observes as an outsider. This was not an easy task, and therefore a researcher's bias could not always be prevented. As mentioned earlier, to avoid some of this, the ADR researcher kept a logbook, with over 1.100 notes, to build a chain of evidence. This reflective journal ensured transparency and the decision steps make it possible to follow the research flow. See appendix D for a summarized overview of the decision steps. To reduce participatory observation bias we also involved research assistants wherever possible, who conducted additional research under the supervision of the ADR researcher.

Finally, we did not examine how time and space affected the outcomes of the findings. Although Zo-Dichtbij is related to the specific healthcare and legislation structure of the Netherlands, and in particular to local governments, our ambition is much broader than that. Therefore our seed strategy encompasses Europe and US as well, not only via efforts made by the representatives of the Living Lab setting (i.e., SMEs and multinationals) but also via the ADR researcher's contacts with the industry and researchers from other universities.

## 13.4 Future research agenda

The limitations discussed in the previous section provide avenues for future research. This study can serve as a basis for several research studies. The overall question of our future research agenda could be: How to use Action Design Research to guide research initiatives in multidisciplinary settings and lead them from an initial idea, through design and development to the 'ready-to market' phase. This means multi-disciplinary collaboration and knowledge exchange between academia and industry, for instance to accelerate innovations, while BM and exploitation are discussed from the start.

Another future research area involves testing the applicability of ADR for the development of service platforms in other domains, like Finance, Energy or Institutional Healthcare, not only to execute cross-case comparisons, but also to test the generalizability of service platform concepts and the way design choices and market factors may influence the findings. It would be valuable to examine whether different studies, when conducting Action Design Research, identify the same effective alignment between practical relevance and academic rigor, which refers to high quality (i.e., rigorous) studies that are useful in particular (i.e., practical relevant) situations.

While we studied the start-up phase of a service platform (i.e., from idea to valorization), future studies can explore how to ensure the up-scaling and use of the platform in practice, and lead it through the valorization phase, which can be viewed as a separate project, in which the aim is to introduce the innovation to potential buyers and assess its market potential. In our study we already prepared for a possible up-scaling of the platform 1) considering the Business Model, Business case and Business Model roadmap for Zo-Dichtbij 2) encountering the development of a Minimal Viable Product, 3) pitching the idea to potential (funding) partners, and 4) elaborating on the Foundation to embed Zo-Dichtbij as a social innovation. These preparations can be the starting point of a new research project.

In addition, the revised ADR framework for social innovation (Chapter 12) should be tested using different methods in different settings. Although the proposed revised ADR framework is used to guide the design of our IT artifact, the framework is only used in one design case. To validate the framework more research efforts are recommended, where the framework accompanied and its design principles are tested in various settings.

## 13.5 Closing remarks

At this point in time (Q3 2016), the proposed online platform appears to have potential for the smart living domain in the Netherlands, because it would be a first mover to combine and offer: 1) matchmaking between providers of smart living products and services and potential end-users, 2) the ability to find local activities, 3) connect with others (e.g., family, caretakers), 4) information about aging-in-place, and 5) integration of existing successful platforms in the Health and Wellbeing domain. We were fortunate that we could rely on a Living Lab setting to place the values of the stakeholders in the healthcare domain within a real-life context and identify design guidelines. The context both stimulated and challenged research and development, with public/private authorities and end-users not only participating in the Living Lab, but also contributing to the entire innovation process. As such, we hope that our research efforts paved the way for similar research strategies.

In retrospect, the last two prototype versions of Zo-Dichtbij (i.e., demo and MVP) were perceived as 'just-in-time', which made it easier for the Living Lab partners to engage in thorough discussions about the platform idea in the market with customers (i.e., elderly people, informal caretakers, providers and local governments), as well as potential (funding) partners. Since the translation from the clickable model into a demo and a Minimal Viable Product, which can be consulted via https://www.zo-dichtbij, Zo-Dichtbij is used as a visual support during numerous 'pitches' with influential companies in the Netherlands, to explore up-scaling and valorization of the service platform. As such, new research and business opportunities for the service platform are opening up.

## *Closing remark to other scholars*

***Find a topic that really matters and try to make a real impact: 'Just go for it and enjoy the ride'.***

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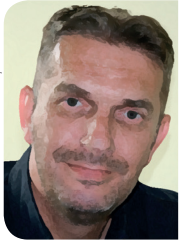
# A Personas

## Persona 1 : Frans Berkhout

*put in scene*



| | |
|---|---|
| **Age** | 49 years |
| **Place of birth** | Schipluiden |
| **Home environment** | residential area |
| **Marital status** | married, 2 children |
| **Profession** | home care products supplier |
| **Social class** | average income |
| **Internet use** | work and private |

Frans is a hardworking man who easily makes long working weeks. He is constantly looking for new customers and products.

**Family members**
His wife, Anne, is 50 years old, works part-time at a plumbing company in The Hague. His daughter is studying and his son works at a horticulture. Both still live at home.

**Health**
Frans is a healthy man, but the deteriorating economy is causing him stress.

**Hobbies**
Frans is a handball coach and he loves reading and music. If the weather is fine, he travels in the area with his motorcycle.

**Special needs**
Frans needs customers for his products. He notes that more can be added to the company's brand awareness and product sales. He is also seeking partnerships with companies / institutions to increase his customer base. He is looking for ways to approach consumers directly.

## Persona 2 : Annie Ammerlaan

*put in scene*

| | |
|---|---|
| **Age** | 79 years |
| **Place** | Schipluiden |
| **Home environment** | rural |
| **Marital status** | single, no children |
| **Profession** | housewife |
| **Social class** | below average |
| **Internet** | has no internet |

Annie has a small pension and she is quite lonely. She lives in a rented house. She has travelled a lot, but because of health problems, traveling is complicated. Annie is illiterate and has no experience with the Internet. She simply hates the phone and prefers to talk to people face to face.

**Family members**
Single, no children. She has reasonable contact with her neighbours.

**Health**
Annie is a fragile woman and has undergone several surgeries over the years. She is not that mobile and uses a walker. Mentally speaking she is still well. Despite her limitations, she remains happy and cheerful.

**Hobbies**
Reading, knitting, playing cards and watching TV. She loves socializing.

**Special needs**
Annie wants to live as long as possible in her own home environment, though lately that has become more and more difficult. She is in need of domestic help and contacts. She does not have a large social network and also lacks the money. Ideally, she would like to meet people for regular companionship, who can accompany her with outdoor activities as well.

## Persona 3 : Kees van de Ende

put in scene

| | |
|---|---|
| **Age** | 81 years |
| **Place of birth** | Maasland |
| **Home environment** | residential area |
| **Marital status** | married, no children |
| **Profession** | retired engineer |
| **Social class** | average income |
| **Internet use** | private |

Kees is an introvert but overprotective husband who takes care of his wife Toos (84) who suffers from dementia. He hopes to live independently with his wife as long as possible. Before Toos was sick, Kees never had to do much in the household. At the age of 80 he had to change his daily life a lot.

**Family members**
Married, no children and a limited social network.

**Health**
Kees is a moderate smoker, but a heavy drinker. He takes about 5 drinks a day. Physically he is still a strong person.

**Hobbies**
Until last year, every day he cycled a lot and enjoyed working in the garden. Nowadays, because of Toos, he stays most of the time at home.

**Special needs**
Kees needs social contacts and would like to take part in outdoor activities. However, he would prefer to be in control of his life and does not like nosy people.

## Persona 4 : Ria van Marrewijk

put in scene

| | |
|---|---|
| **Age** | 55 year |
| **Place of birth** | Den Hoorn |
| **Home environment** | terraced house |
| **Marital status** | husband and 3 children at home |
| **Profession** | part time care giver at Buurtzorg |
| **Social class** | average income |
| **Internet use** | private |

Ria is a caring mother. Next to her job as a caregiver, she takes care of her family and her parents who also live in Den Hoorn. Ria is a social person. She is dedicated to her family and she wants to support her parents (both 80) to let them stay in their home environment independently as long as possible.

**Family members**
Married to Sjaak (57) whose profession is a greenhouse builder. Three young children living at home (17, 19 and 23 years old)

**Hobbies**
She has no time for hobbies, because of the dedication to her family.

**Special needs**
Ria is looking for nursing solutions for her parents. She has little computer skills, but with a little help from her children she will manage.

## Persona 5 : Ellen van de Windt

put in scene

| | |
|---|---|
| **Age** | 47 years |
| **Place of birth** | Delft |
| **Home environment** | city center |
| **Marital status** | married, 3 children |
| **Profession** | coördinator Foundation Welfare Elderly |
| **Social class** | average income |
| **Internet use** | work and private |

Ellen is a highly motivated and energetic woman who is committed to the welfare of the elderly and specifically in the area of Midden Delfland. Next to her job, she is a volunteer at a social care organization. She is continuously gathering funding and seeks as many volunteers as possible.

**Family members**
Married to Jan (51), working as an accountant, three children (12, 16 and 21). The eldest daughter studies in Groningen.

**Health**
Good, but their daughter (16) is slightly mentally retarded and needs extra attention.

**Hobbies**
Walking and biking

**Special needs**
Someone who can give her feedback. She is also looking for opportunities for her daughter to prepare her for society.

## Persona 6 : Anton Gielissen

put in scene

| | |
|---|---|
| **Age** | 62 years |
| **Place of birth** | Delft |
| **Home environment** | terraced house |
| **Marital status** | single, 2 children living away |
| **Profession** | civil servant Social Affairs Delft |
| **Social class** | more than average |
| **Internet use** | work and private |

Anton is a middle-aged man, active in the Social Affairs Department of the municipality of Delft. He is particularly engaged with questions of the WMO (care regulations) and taxi fees for elderly and people with impairments. He is a social person.

**Family members**
Anton is a single (divorced) man. His two children moved out of the house recently and are studying more than 50 miles from their hometown.

**Health**
Anton has had a mild heart attack and is a patient of the cardiologist. Because he suffers from shortness of breath, he is under control at a long specialist.

**Hobbies**
Anton is an active man and that keeps him fit. His main hobbies are fishing and playing cards. In his spare time, Anton is a volunteer at the card club.

**Special needs**
Anton needs more volunteers and donors for "his" club and to do his work properly at the municipality he needs useful instruments and communication tools to advice his clients.

## Persona 7 : Petra de Kort

put in scene

| | |
|---|---|
| **Age** | 25 years |
| **Place of birth** | Den Haag |
| **Home environment** | city center |
| **Marital status** | living together with a boy-friend |
| **Profession** | advisor WMO office Midden Delfland |
| **Social class** | average income |
| **Internet use** | work and private |

Petra is a young woman who has recently started as a consultant at the WMO office at the municipality of Delft. Her challenge is to get the best out of her job and she wants to make career within the municipality or in politics. Her primary goal is to stay within the agreed WMO-budget, looking very critical look at all the incoming requests and allocations.

**Family members**
Living together with her friend Pascal (31), who is a welder by profession. They have no children. Mother Ria past away last year and father Eric (57) is lonely ever since.

**Health**
Good, but she is worried about her father.

**Hobbies**
Petra loves reading and playing music. She also plays netball and is a member of the CDA (political party).

**Special needs**
Petra is looking for a good tool that can help her reach her WMO goals. In addition, she is looking for opportunities for her father, like psychological help. Next to that she would like to help him finding contacts in his own environment.

## Persona 8 : Hakkan Bitez

put in scene

| | |
|---|---|
| **Age** | 55 years |
| **Place of birth** | Delft |
| **Home environment** | poor neighbourhood |
| **Marital status** | married, 6 children, 1 living away |
| **Profession** | unemployed |
| **Social class** | below average |
| **Internet use** | private (with help of the children) |

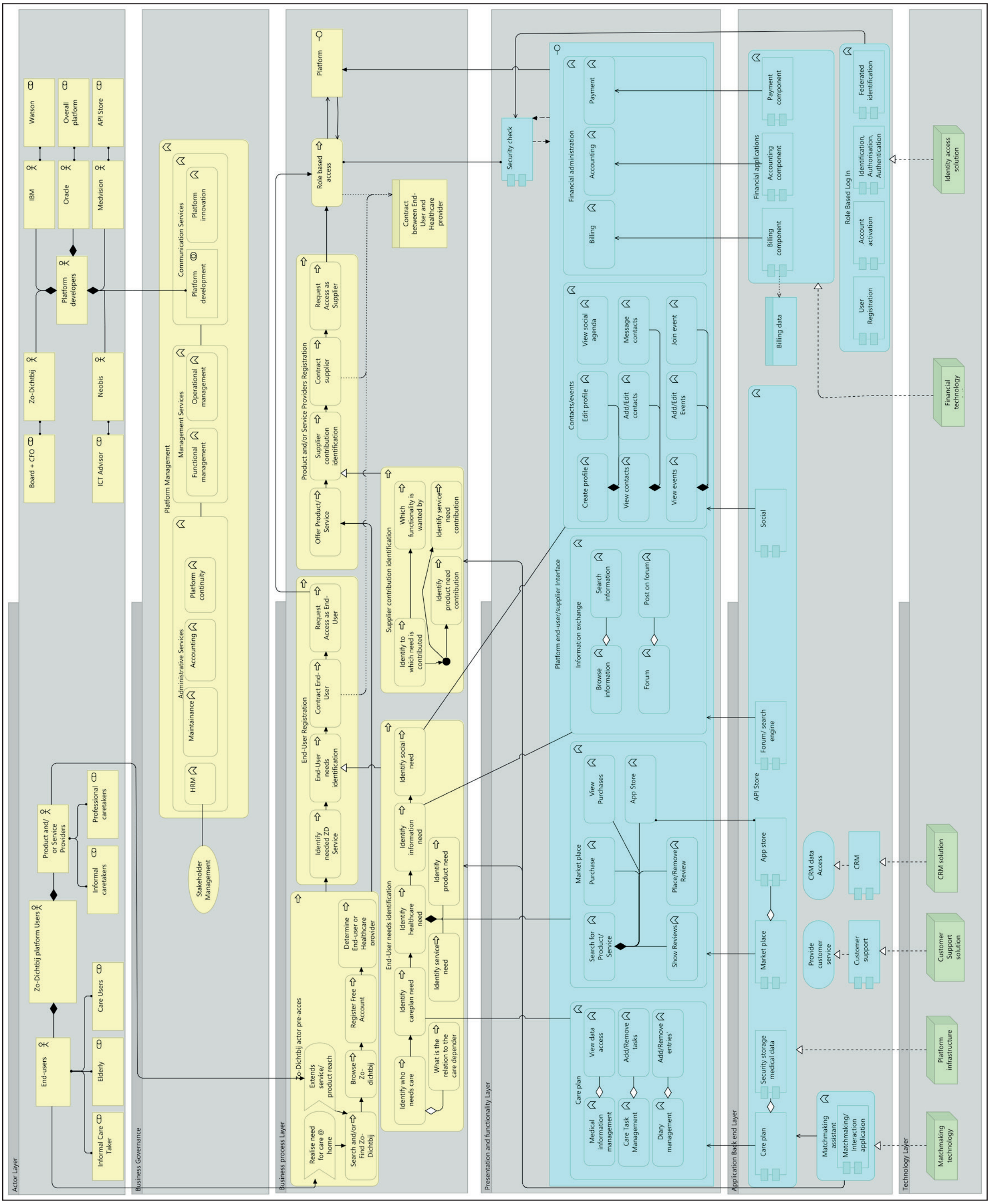
Hakkan is unemployed. He has worked for years in the garden, but due to the recession he got fired. For a year he receives a benefit from the government. Although he tries very hard, he can't find a job, also because of his poor Dutch skills.

**Family members**
Hakkan is married and has six children (aged 12 to 24 years). Five children still live at home. His wife takes care of the children. The eldest daughter has a job and lives in Den Haag. The two youngest children have mild behavioural problems, which is especially difficult at home and at school. For a long time the family is a searching for a larger house for a reasonable price. Until now they didn't succeed to find something.

**Hobbies**
None. He undertakes some activities with Turkish men in his neighbourhood.

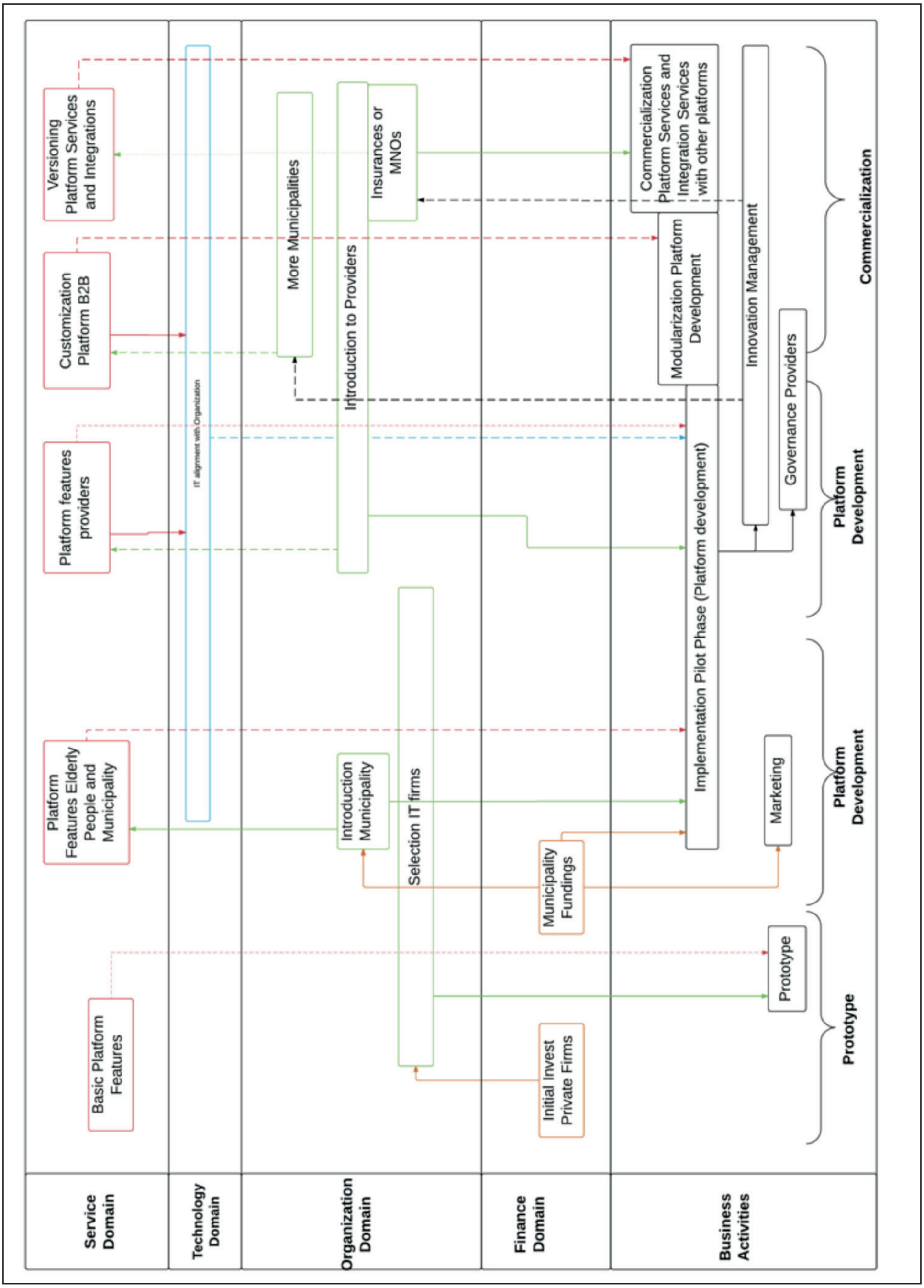
**Special needs**
There is a need for a larger home and guidance for the youngest children. Additionally Hakkan needs help finding a job.

# B Final version Zo-Dichtbij Architecture (Archimate)




*Originial version of the archictecture is availabe on request.*

# C Business Model roadmap



# D Decision steps and milestones 2013 (extracted from the ADR logbook)

february
- 22/2 inventorize existing platforms (health and wellbeing)

march
- 4/3 design theory as a starting point for my research
- 16/3 platform theory as a starting point 2
- 15/3 establish an expert team for SL platform
- 17/3 tree diagram for core functionalities of the platform (extracted from interviews)
- 20/3 STOF model as basic input for the platform business model (including critical design issues)
- 26/3 involve end-user groups from the start of the research
- 26/3 expert team (only girls at the moment: SL girls
- 27/3 stakeholder map as starting point for collaboration
- 28/3 establish a contingency table (what if it does not work out the way I planned, what is my back up plan)

april
- 4/4 follow my own path (stick to the plan) and get rid of distracting and negative people
- 5/4 smart living review (2009 - 2013)
- 12/4 start with a feuilleton of my research (divided in conference and journal papers) and simultaneously starting with my dump file for my monograph (thesis)
- 16/4 establish table of interview abstracts
- 18/4 Midden Delfland as possible pilot municipality of our platform project
- 21/4 list of functionalities of the platform based on all the interviews

may
- 29/5 involve UPC/Ziggo (multinational) in project

june
- 6/6 Wally's list (based on the USA version Angies' list: matchmaking
- 17/6 elaborate on triangle (providers, end-users and government)
- 19/6 open source communities as example for SL platform

july
- 1/7 first draft mindmap from the SL portal as starting point multi-sidedness
- 6/7 elaborate on propositions to involve stakeholders in the project
- 16/7 focus groups as next (qualitative) research step: evaluating interviews

august
- 2/8 involve elderlybonds: ANBO, Unie-KBO and PCOB
- 8/8 get municipality Midden Delfland on board for the platform pilot
- 19/8 consider: Zo-Dichtbij as name for the platform

september
- 6/9 involve patient bonds in Zo-Dichtbij
- 16/9 Zo-Dichtbij as intervention instrument for WMO desks from municipality
- 21/9 podium place for Comfort Installers in Zo-Dichtbij
- 20/9 add realization power versus obstruction power in potential partner table

october
- 1/10 Action Design Research as research method
- 28/10 search for another pilot municipality: MD = declined

december
- 17/12 decision making about collaboration with other platforms or elaborate on our own platform idea
- 12/12 integrate matchmaking for service providers in the platform
- 22/12 involve trajectory of transfer and district nurses in the platform

# Decision steps and milestones 2014 (extracted from the ADR logbook)

january
7/1 possible ADR researcher role: apprentice and learning on the job and/or participatory researcher (observer)

february
5/2 use Basecamp as collaboration platform with project partners
15/2 platform app as in-between solution for the platform
22/2 convince supervisors about ADR method

march
4/3 interviews as basis for the personas. Expert team in the lead
11/3 development of 7/8 personas (from four archetypes) as a design tool
17/3 involve multinational Conclusion in the project
18 /3 citizens, local governments and service providers as most important stakeholders for our social innovation
19/3 focus on envelopment (integrate existing reliable national and local web platforms)

april
15/4 inform architects ICTU and VWS about platform idea
29/4 use valorization center of TU Delft to investigate up-scaling potential for the platform

may
9/5 start up foundation Zo/Dichtbij (non-profit) with three board members

june
7/6 decide about business modeling in the project (using STOF)
15/6 main target group not age 50 - 70 but refer to young elderly age 55/75
19/6 catch-22 (chicken and egg story) in funding world

july
1/7 elaborate on Living Lab setting as construction for platform development phase (BIE)
13/7 prepare pitches to involve stakeholders to collaborate in the platform
27/7 how to deal with overcomplexity in the process

august
20/8 low-fidelity prototyping like paper prototypes and mock-ups instead of simulation of the platform

september
5/9 involve ICTU as intermediary between government and citizen
22/9 involve SMEs in Living Lab setting
25/8 conclusion probably not the multinational for the Living Lab: replacement?

october
7/10 involve panels: representatives informal caretakers and elderly people
30/10 involve different end-user groups for the survey

november
7/11 municipality Rotterdam as back up plan: Delft declined
17/11 lead to multinational as partner for the Living Lab: Ziggo
19/11 lead to multinational as partner for the Living Lab: IBM
21/11 how to get seed funding for the platform?
24/11 investigate VIMP (implementation subsidy) from ZonMW

december
16/12 prepare first revenue models for the platform

# Decision steps and milestones 2015 (extracted from the ADR logbook)

**january**

| | |
|---|---|
| 2/1 | define KPI's for the platform |
| 3/1 | elaborate on construct Capability Approach end-user perspective (kernel theory) |
| 23/1 | elaborate on critical design issues (workshop) |
| 29/1 | define the project start architecture for the platform (ICTU) |

**february**

| | |
|---|---|
| 2/2 | scenario descriptions for the personas (written text and illustrations) |
| 5/2 | integrate HBO (applied science students) in the research |
| 12/2 | apply for a VIMP (grant) implementation and research from ZonMW |
| 21/2 | quantify commitment from living lab partners and gentleman agreements |

**march**

| | |
|---|---|
| 5/3 | elaborate on basis architecture |
| 12/3 | arrange BM workshop with Living Lab partners |
| 23/3 | elaborate on ADR framework for a social innovation in a Living Lab setting |
| 27/3 | first user test paper prototype of the platform |
| 30/3 | combining Care plan and Diary in the platform |

**april**

| | |
|---|---|
| 1/4 | divide roles for the first testers (elderly people, voluntary caretakers, professional caretakers) |
| 3/4 | start connecting to other municipalities besides Rotterdam |
| 10/4 | arrange second user test based on input from the first testers |
| 15/4 | connect to chamber of commerce (KvK) to involve providers health and wellbeing in Rotterdam |
| 16/4 | use G4 CIO-table for up-scaling platform idea (municipality of Rotterdam, Amsterdam, Utrecht and Den Haag) |
| 20/4 | integrate paper prototype in end-user surveys |
| 29/4 | refine basic architecture Zo-Dichtbij |

**may**

| | |
|---|---|
| 1/5 | revise survey for informal caretakers groups |

**june**

| | |
|---|---|
| 1/6 | use Archimate for Zo-Dichtbij architecture |
| 5/6 | pitch the platform as an integral solution (not an ICT solution) |
| 18/6 | include a user experience stakeholder within the Living Lab |

**july**

| | |
|---|---|
| 10/7 | integrate business model stress testing in our workshop(s) |

**august**

| | |
|---|---|
| 12/8 | involve DSR strategy 2 (Iivari 2015) with 16 dimensions in the research |

**september**

| | |
|---|---|
| 8/9 | develop a business plan for Zo-Dichtbij |

**october**

| | |
|---|---|
| 13/10 | use SWOP panel (elderly people) for platform testing |
| 20/10 | involve WMO advisors and district nurses in user tests |
| 26/10 | design sprint workshop |

**november**

| | |
|---|---|
| 11/11 | more than 30 testers for the demo and counting |
| 19/11 | platform pitches ‚get in the ring' with multinationals |
| 25/11 | pitch platform at Nyenrode university |
| 28/11 | Zo-Dichtbij as part of work package and case study Envision (Horizon2020) |

**december**

| | |
|---|---|
| 1/12 | dissemination plan VIMP (ZonMW) |
| 15/12 | first outline of dissertation |
| 21/12 | report for Design team user tests |

# Decision steps and milestones 2016 (extracted from the ADR logbook)

january
2/1 start writing my dissertation (based on dumpfile)
20/1 involve insurance company DSW in future plans for Zo-Dichtbij

february
8/2 prepare experimental design with elderly people/informal caretakers (demo)
11/2 use Project Start Architecture as a basis for Solution Architecture (ICTU)
15/2 pitch platform for eHealth Forum
24/2 funding possibility Foundation by Rabobank Foundation declined
25/2 start developing interface (MVP) based on Bluemix (IBM)
29/2 start with functional design architecture overview in Archimate

march
5/3 start describing new and refined ADR design principles
7/3 refine revised ADR framework (adapted from Sein et al. 2011)
21/3 stakeholder map matchmaking functionality based on interviews, surveys and focus groups
24/3 First 6 chapters of my dissertation in draft

april
5/4 start with dialogues (answer pairs) for the help chat in the MVP
6/4 involve Midden Delfland in future plans of Zo-Dichtbij (discussed with new alderman)
10/4 Oracle involved in Living Lab (sanity check architecture)
12/4 IPR Zo-Dichtbij registered in BoiP I-depot
18/4 add input, throughput and output tables in the dissertation chapters
26/4 first draft MVP Zo-Dichtbij
29/4 first complete draft dissertation ready (12 chapters)

may
3/5 prepare test protocol experimental testing
6/5 internal testing chat bot (help chat Ann)
7/5 MVP ready for internal testing
11/5 experimental testing MVP with 36 participants (elderly people/informal caretakers)
25/5 panelist and pitch Design Science Research committee (DESRIST conference)
30/5 dissertation (V1) ready for review by promotor

june
21/6 pitch the platform by Medical Delta (possible research case)
27/6 overview of possibilities academic research (career path)
29/6 pitch platform at ZonMW Ambient Assistant Living success stories

july
11/7 involvement of private investor for valorization of the platform
21/7 green light for my dissertation
23/7 propositions for defense ready
27/7 defense date 28 October 2016 in the auditorium Delft University
30/7 UL involved in Living Lab (identity management and security)

august
2/8 pitch platform for ministry of VWS
5/8 platform pitches for local governments (Rotterdam, Den Haag, MD) and social domain

september
1/9 involve software developers developing Zo-Dichtbij interface

# Summary

Since 2015 the Dutch national government emphasizes the shift from a welfare society towards a participatory society. In the long term, this shift could have a huge effect on society and the social inclusiveness of elderly people. Mainly because participatory societies build on peoples own responsibilities for their health and wellbeing and making people help each other, which requires a different mindset on the part of citizens. New legislations in the Netherlands means new ways for municipalities to collaborate, but at the same time it is important to: 1) balance financial costs and benefits, 2) spread risks, 3) ensure service quality, and 4) manage and safeguard the social system.

One policy measure aimed at reducing healthcare expenditures is to encourage people to age-in-place which promotes independence and 'livability' of all types of house and refers to the ability of individuals to stay in their home or neighborhood as long as possible, regardless of their age or level of abilities. To improve the response to the government's push for people to age-in-place, the paradigm shift in the healthcare domain requires not only a changed attitude and an active involvement on the part of citizens, but from public and private parties as well.

To help people age-in-place, supportive products and services, day-to-day activities and social interaction need to be taken into account. Smart ICT-enabled solutions can help elderly people to organize their daily activities in a smarter way and maintain an independent and safe lifestyle for as long as possible. Although, we did not focus in this study on smart homes as such (with advanced automated appliances), the term aging-in-place reflects how to integrate smart solutions in our daily lives, which is related to people's quality of life because it involves connecting our daily activities when we are at home, on the road, or elsewhere, supported by integrated ICT. Although numerous smart living products and services are available to support people living comfortably at home they have not been widely adopted yet. Creating awareness of existing solutions to support age-in-place is challenging, with end-users being unable to find them in today's fragmented marketplace, with its overload on information, which can be seen as a mismatch between supply and demand.

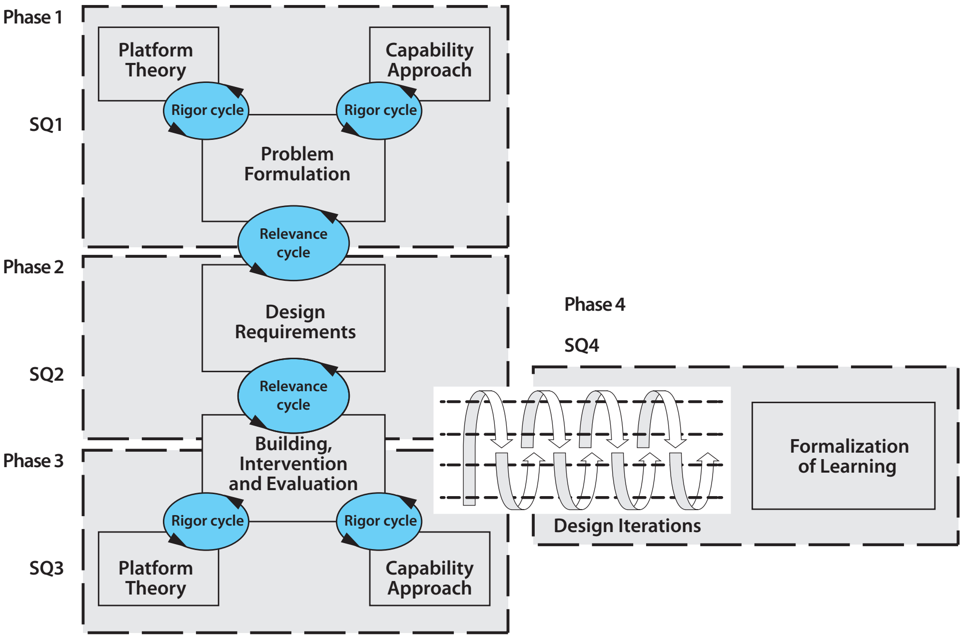
To solve the mismatch between supply and demand, we propose the development of a digital service platform in the context of health and wellbeing as a social innovation to support to aging-in-place, which serves both citizens (elderly and informal caretakers), service providers (in the health and wellbeing domain) and local governments. We

argue that a service platform is needed that 1) enhances the capabilities of citizens to age-in-place, 2) unburdens informal caretakers, 3) helps service providers promote their products and services and 4) contributes to the specific tasks of local governments to support social intervention for citizens in the context of health and wellbeing, while managing the costs. Developing, implementing and evaluating such a platform could provide a possible solution that helps people age-in-place. The aim of the digital service platform is to reach citizens and encourage them to change their circumstances or behavior, and improve their quality of life. The initial impulse for designing an IT artifact for Health and Wellbeing comes from a desire to solve an every day social problem how to support people age-in-place. Our research goal is to design and evaluate a socio-technical IT artifact (a service platform) that provides a potential solution (social innovation) for a class of real-world problems (aging-in-place).

***Research approach***

This dissertation presents the process to design, prototype, implement, and evaluate a digital service platform for Health and Wellbeing to support people age-in-place. The scientific relevance is to theorize the development of a digital service platform for Health and Wellbeing, and to contribute to the knowledge and the design process of service platforms. Therefore we used two kernel theories: Platform Theory and the Capability Approach within a Social Innovation context. Platform Theory helps us to understand what has to be done when developing a platform, how to identify potential and patterns for collaboration, and how to organize different groups of users and create a foundation for their interactions. The Capability Approach takes the freedom of choice into account and can be regarded as a framework for the assessment of individual wellbeing, social arrangements, the design of policies, and proposals about social change in society. In our research we contribute in terms of how a service platform can help people achieve independent living, and how the core concept of the Capability Approach in the context of a Health and Wellbeing platform for elderly people can be operationalized. In addition, our study bridges the gap between the current information exchange with regard to smart living and the ideal situation, where interaction and information exchange between different stakeholders groups (service providers and local government) and end-users (elderly people and informal caretakers) in this field are common practice. Describing all stages of the design cycle, while designing, prototyping and evaluating a social innovation within a real-life setting, designates the context of a societal problem that 'matters'.

We used Action Design Research (ADR) as our overarching research method, which allows us to 1) address the problem encountered in a real-life setting by intervening and evaluating, 2) use theory and research to analyze the problem, and 3) construct and evaluate an IT artifact that addresses a class of problems typified by the situation encountered. This study contributes to the design knowledge base involving service platforms. To that end, the design challenge will be addressed, by creating a specific solution for the Dutch Health and Wellbeing market, from which both practical and theoretical lessons can be learned. Fundamentally, ADR is a study of change and particularly appropriate for our study because 1) it combines action research (AR) and design research (DR) to generate prescriptive knowledge, 2) it is problem-driven and 3) it aims to build design principles based on iterative cycles. Our study is the first attempt to apply ADR while designing, developing, implementing and evaluating a digital service platform intended to improve the capabilities of elderly to age-in-place.




Revised ADR framework (Hevner, 2007; Sein et al., 2011; Verschuren & Hartog, 2005).

## *Research phase 1: Problem Formulation*

In the first research phase we did not start from a specific business problem or IT opportunity, but from a social problem with a potentially large impact, the transition in care provisioning from national to local government and the idea of controlling healthcare expenditures by having people live independently at home longer. Consequently, in the problem exploration phase, we had to understand the social problem and the social practice that underlies the current situation. Therefore we started from a rough idea about the societal problems in question, i.e. growing expenditures in elderly care, decentralization of elderly care to municipalities, and the trend of having elderly people live longer independently at home. Before initiating the design iterations, we had to translate the societal problem into a practical problem of one or more specific stakeholders. We did so by conducting two extensive rounds of interviews with potential stakeholders. These interviews were not only instrumental to understanding the societal problem and solutions, but also to identifying and motivating stakeholders to become involved in our design iterations.

One of the first outcomes of our research was that end-users have a lack of awareness of what smart living services are available and how these services could meet their needs. The highly fragmented market makes it difficult to find the right services, and the predominantly technological focus of service providers makes it hard for them to understand how services meet end-user needs. Especially people in need of healthcare services go through different stages in the progression of their disease or impairment, which means that their need for healthcare interventions at home changes over time, and end-users are often unaware as to what services they could use at a certain point in time. At the same time, product and service providers in the smart living domain find it difficult to reach end-users and to commercialize and promote their products and services. Another reason why the awareness process in the smart living area is complex is the large number of stakeholder groups involved (product and service providers, manufacturers, facilitators and end-users, etc.). Creating awareness is particular difficult in light of the complex interaction between the different stakeholders with regard to 1) the cooperation between the many key actors that in some way are involved in this domain, 2) the number of services and products, 3) the diversity of service providers from different sectors who focus on the house (Health, ICT, Building and Energy), and 4) a lack of integrated systems. This means that information sharing and collaboration in the smart living domain have to be encouraged, keeping in mind that the actors involved are from different sectors.

Therefore, in the first research phase, we focused on eliciting problems in the smart living domain and elicit possible solutions from a stakeholder perspective. We extracted the initial requirements, which should be included in the service platform, clustered as: for profit products and services (domestic, health and wellbeing); a marketplace for non-profit products and services (exchange or local supply and demand); contact with others (friends, family, neighbors and end-user groups); the integration of existing platforms for health and wellbeing (local and national) and information about local activities. Based on 70 interviews, we assume that a smart living service platform with a focus on health and wellbeing could persuade various experts to become active in the smart living environment and, at the same time, such a platform could accelerate the diffusion process of applications in the smart living domain with a focus on health and wellbeing.

***Research phase 2: Design Requirements***

In the second research phase, we focused on the main design requirements of the platform. To that end, we expanded the design cycle from Sein et al. (2011) by adding steps of the design cycle proposed by Verschuren and Hartog (2005), including the Requirements and Assumptions that are being defined by the frame of the first three platform goals, like creating awareness among end-users on what products, services and technologies can help them age-in-place, satisfying the requirements of end-users, service providers and local governments, and matching between (latent) needs and (yet unknown) services. Based on the input of four focus group discussions we were able to refine the requirements. In addition, we found that the main end-user needs are related to: 1) contact with others, 2) finding smart living products and services, and 3) having access to information about local activities.

***Research phase 3: Building, Intervention and Evaluation***

In the third research phase we focused on the development, evaluation and implementation of the service platform. For our social innovation, which focused on end-user needs, we investigated user-centered methods that matched our design approach. As such, we established a Living Lab setting with four large and two small-medium enterprises, the university, a public organization (i.e., municipality) and end-users (i.e., elderly people and informal caretakers). The main objective of the Living Lab was to 1) explore the platform idea, 2) experiment the IT artifact, and 3) evaluate breakthrough scenarios that could turn the platform idea into a successful social innovation. Because of the Living Lab setting we had access to a great deal of expertise to guide the design process of the social innovation. To focus attention on problems and opportunities of a specific target audience, we used different design tools (personas, user stories and scenarios), which are considered to be helpful in fleshing out the platform users and in simplifying the understanding of and communication about these users involving the Living Lab partners.

During the development of the service platform we included four design iterations, which resulted in several low-fidelity prototypes: like a paper prototype, mock-ups, a clickable model, a demo and a Minimal Viable Product, which were subsequently followed by user tests. To use multiple viewpoints to evaluate the prototypes, we were able to improve the platform before moving to the next design iteration. The platform testers stated that Zo-Dichtbij can be regarded as an effective tool enabling elderly people to live comfortably in their own homes. Next to that the platform can 1) inspire social innovation, simply by lowering the threshold to perform healthcare tasks for others, and 2) play a role in facilitating informal caretakers for vulnerably (older) people without a network to rely on for care tasks. In addition, if (non)profit caretakers on the platform are properly screened, regarding reliability, the platform could create a safe and trusted network for elderly people and their informal caretakers. Thereby, ensuring that also elderly without a network can benefit of the platform and more easily receive informal help.

Although, the test groups functioned as a proxy to measure the effect of a platform for Health and Wellbeing on capabilities for young elderly (> 55) in general, informal caretakers are assumed to be capable of determining the wellbeing of the ones they take care of. However, it could be argued that specific knowledge with regard to healthcare and wellbeing can be beneficial in determining whether or not a platform for Health and Wellbeing can in fact increase the wellbeing of elderly.

***Research phase 4: Formalization of Learning***

During our longitudinal study we attempt to solve a societal problem by building a concrete IT artifact (service platform for Health and Wellbeing) in a specific context (aging-in-place), which distilled prescriptive knowledge (about applying ADR for a societal problem) to be packaged into a general solution concept (social innovation) and to address a class of problems (matchmaking platform for social issues that matter). In our ADR case the artifact is still emerging from design, use and on-going refinement (from low-fidelity prototypes until a Minimal Viable Product) in context. Therefore we envision as a future research topic that the Minimal Viable Product will emerge into an implemented service platform in practice. Within the scope of the study we fulfilled our research objective of designing, developing and evaluating a service platform for Health and Wellbeing to support people age-in-place and came up with new and refined ADR principles, which can guide scholars and researchers to execute the ADR method when facing a societal challenge. Principles are derived from analyzing the logbook data collected throughout the project.

Next to that, we demonstrated that our social innovation, which addresses a social demand (aging-in-place and taking care of the elderly) contributes to addressing a societal challenge (aging society), and through its process dimension (active engagement of the elderly and healthy aging) can contribute in reshaping our society from a welfare state into a participatory state. The main focus of the platform was on the end-user. As such, the designed platform offers a podium, or is a resource of free choices to individuals to achieve wellbeing, including socializing, engaging relatives, friends and caretakers, and having a convenient marketplace for products and services.

***Conclusions and implications***

Our study can be regarded as a validation of the ADR method, based on primary data. However, we posit that the ADR method is relatively abstract and the specific characteristics of social innovation require adaptations to the existing approach of ADR. Therefore we propose that social-innovation inspired ADR should: 1) be based on an in-depth understanding of the social problem and underlying practices, 2) allow for reciprocal shaping between the changes to social practices and the IT artifact, 3) from the very start of the ADR process, involve citizens who are affected by the social innovation and 4) be led by change agents that can identify and motivate stakeholders, balance political, economic and social values, and bring about change. Therefore we suggest that these four refined design principles should be added to the ADR framework, to guide researchers who face societal challenges.

In addition, our study provided the empirical basis for creating a design theory on digital multi-sided service platforms, which is currently still lacking in literature. While digital platform literature is often concerned with evaluating profitability for platform providers or the generative potential for app developers, our study examined with how platform functionalities affect the capabilities of elderly people. As such, this dissertation provides a basis for developing design theory on how to design and implement a multi-sided service platform to improve the capabilities of elderly people.

***Limitations and future research***

As a participatory observer, the ADR researcher became part of the study and it was important that one acts and observes as an outsider. This was not an easy task, and therefore a researcher's bias could not always be prevented. To avoid some of this, the ADR researcher kept a logbook, with over 1.100 notes, to build a chain of evidence (see appendix D). This reflective journal ensured transparency and the decision steps make it possible to follow the research flow.

Although, we constantly had to balance between dilemmas related to light-weight versus heavy-weight user testing, the rigor of the ADR methodology versus other research methods, as well as budget and time constraints, our study provides avenues for future research. The overall question of our future research agenda could be: How to use Action Design Research to guide research initiatives in multidisciplinary settings and lead them from an initial idea, through design and development to the 'ready-to market' phase. This means multi-disciplinary collaboration and knowledge exchange between academia and industry, for instance to accelerate innovations, while BM and exploitation are discussed from the start.

# Samenvatting (Summary in Dutch)

Sinds 2015 legt de Nederlandse overheid de nadruk op de verschuiving van een welvaartsmaatschappij naar een participatiemaatschappij. Op de lange termijn heeft deze verschuiving een effect op de samenleving en de sociale integratie van de ouderen. Met name omdat participatieve samenlevingen bouwen op de eigen verantwoordelijkheid van mensen als het gaat om wonen, zorg en welzijn, terwijl de overheid er daarnaast vanuit gaat dat mensen elkaar zo veel mogelijk helpen. De nieuwe wetgeving op het gebied van wonen, zorg en welzijn in Nederland betekent nieuwe mogelijkheden voor gemeenten om samen te werken, maar tegelijkertijd is het belangrijk om: 1) de kosten en baten in balans te houden, 2) risico's te spreiden, 3) te zorgen voor kwaliteit van de dienstverlening, en 4) het beheer en de beveiliging van het sociale systeem veilig te stellen.

Een van de beleidsmaatregelen die gericht is op het terugdringen van de uitgaven in de gezondheidszorg is om mensen aan te moedigen zo lang mogelijk zelfstandig te blijven wonen. Dit betekent dat de onafhankelijkheid van mensen en de levensloopbestendigheid van huizen moet worden bevorderd, zodat burgers ook zo lang mogelijk thuis *kunnen* blijven wonen. Dit vereist niet alleen een veranderde houding en een actieve betrokkenheid van de burgers, maar ook van publieke en private partijen.

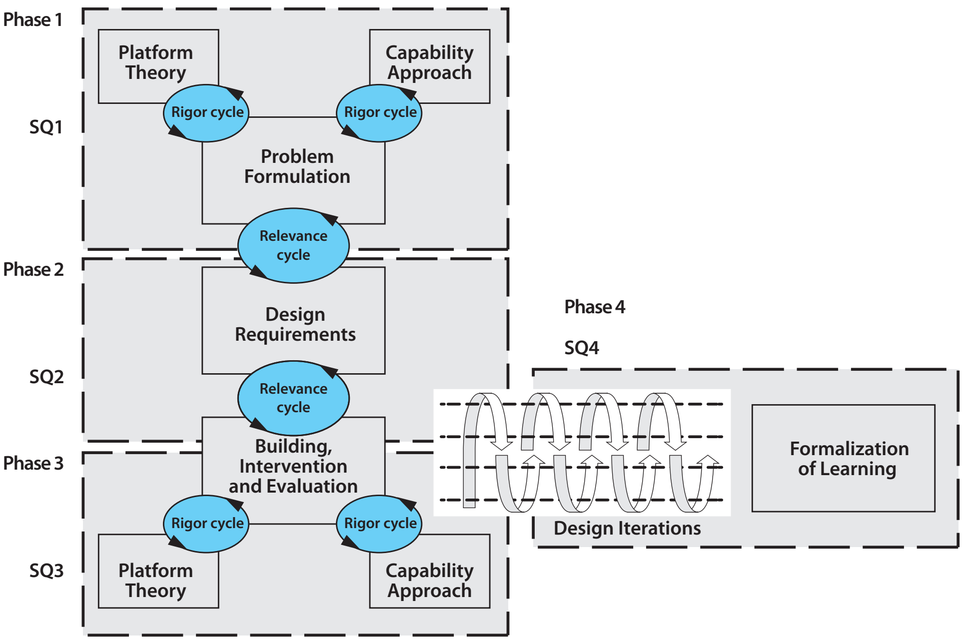
Door de vergrijzing is er een toenemende behoefte aan innovaties. Om met name ouderen te kunnen helpen zo lang mogelijk zelfstandig te blijven wonen, zal er aandacht moeten komen voor ondersteunende producten en diensten, het aanbieden van dagactiviteiten en het stimuleren van sociale interactie met anderen. Zo kunnen slimme op ICT gebaseerde oplossingen ouderen helpen om hun dagelijkse activiteiten op een slimmere manier te organiseren, zodat ze zo lang mogelijk hun onafhankelijke levensstijl kunnen behouden. Hoewel we in dit onderzoek niet focussen op intelligente huizen voorzien van huisautomatisering, weerspiegelt ons onderzoek wel hoe 'smart living' oplossingen zijn te integreren in ons dagelijks leven. Smart living oplossingen zijn gerelateerd aan de kwaliteit van leven, waarbij ICT kan ondersteunen. Alhoewel er op de markt tal van smart living producten en diensten beschikbaar zijn om comfortabel thuis te wonen, worden ze nog altijd niet op grote schaal toegepast. Het is een uitdaging om bewustwording te creëren omtrent bestaande oplossingen, met name omdat eindgebruikers niet altijd goed in staat zijn om de oplossingen te vinden, vanwege een versnipperd marktaanbod en een overkill aan informatie. Dit kan worden gezien als een 'mismatch' tussen vraag en aanbod.

Om vraag en aanbod beter op elkaar aan te laten sluiten hebben wij de mogelijkheden van een digitaal platform onderzocht met de nadruk op wonen, zorg en welzijn. Een platform dat niet alleen burgers (ouderen en mantelverzorgers) helpt om zo lang mogelijk zelfstandig blijven wonen, maar tegelijkertijd leveranciers in het zorg- en welzijnsdomein alsook lokale overheden ondersteunt om dit doel te realiseren. We stellen dat een platform nodig is dat 1) de mogelijkheden verbetert om burgers zo lang mogelijk zelfstandig te laten wonen, 2) mantelzorgers ontlast, 3) leveranciers helpt bij het vermarkten van hun producten en diensten, en 4) bijdraagt aan de sociale interventie van lokale overheden in het kader van wonen, zorg en welzijn, terwijl tegelijkertijd de kosten die hiermee gemoeid zijn beheersbaar blijven. Het ontwikkelen, implementeren en evalueren van een dergelijk platform zou een mogelijke oplossing kunnen zijn om het langere termijn doel van de overheid op het gebied van extramuraal wonen te bereiken. Het doel van het platform is om burgers aan te moedigen hun leefomstandigheden aan te pakken en daarmee hun eigen kwaliteit van leven te verbeteren. De eerste impuls voor het ontwerpen van een platform voor wonen, zorg en welzijn komt voort uit de behoefte van de onderzoeker om een sociaal probleem op te lossen rondom een vergrijsde samenleving. Ons onderzoeksdoel is het ontwerpen en evalueren van een socio-technisch ICT artefact (een platform) dat een mogelijke oplossing biedt (sociale innovatie) voor een landelijk probleem (zo lang mogelijk zelfstandig te blijven wonen).

***<u>Onderzoeksaanpak</u>***

Zoals gezegd beschrijft dit proefschrift het ontwerp-, ontwikkel-, implementatie- en evaluatieproces van een digitaal platform op het gebied van wonen, zorg en welzijn om mensen te helpen zo lang mogelijk zelfstandig te blijven wonen. De wetenschappelijke relevantie van het onderzoek is dat de ontwikkeling van een dergelijk platform een bijdrage levert aan de kennis en het ontwerpproces van platforms in het algemeen. Binnen de context van sociale innovatie maken we gebruik van Platform Theorie en de 'Capability Approach'. Platform theorie helpt ons om te begrijpen wat er gedaan moet worden om een platform te ontwikkelen, samenwerking te realiseren, gebruikersgroepen te organiseren en een basis te creëren voor hun interacties. De 'Capability Approach' daarentegen richt zich op de keuzevrijheid van eindgebrukers en dient als kader voor de beoordeling van het individuele welzijn, de sociale regelingen en een veranderende samenleving. In ons onderzoek dragen wij enerzijds bij aan hoe een platform mensen kan helpen om zelfstandig te wonen, en anderzijds hoe de 'Capability Approach' kan worden gebruikt om het platform te evalueren met eindgebruikers. Daarnaast overbrugt onze studie de kloof tussen de huidige informatie-uitwisseling met betrekking tot smart living en de ideale situatie, waarin interactie en informatie-uitwisseling tussen de verschillende groepen van belanghebbenden (leveranciers en lokale overheden) en eindgebruikers (ouderen en mantelzorgers) vanzelfsprekend is. Door alle stadia van de ontwerpcyclus van een sociale innovatie te beschrijven, namelijk het ontwerp-, ontwikkel-, implementatie- en evaluatieproces, gerealiseerd binnen een proeftuin, dragen we een mogelijke oplossing aan voor een maatschappelijk probleem dat er 'toe doet'.

Als overkoepelende onderzoeksmethode is 'Action Design Research' (ADR) ingezet, waarmee het platform op systematische wijze is ontworpen gebruikmakend van de sociale innovatie context. Dit onderzoek draagt bij aan ontwerpkennis over platforms, waarbij een specifieke oplossing wordt bedacht in het domein van wonen, zorg en welzijn en van waaruit zowel praktische als theoretische lessen kunnen worden getrokken. ADR is geschikt voor ons onderzoek omdat 1) het 'action research' (AR) en 'design research' (DR) combineert om normatieve kennis te genereren, 2) het probleem gedreven is en 3) het bijdraagt aan ontwerp principes op basis van iteratieve cycli. Het ADR onderzoek bestaat uit vier fasen: Fase 1. Probleemformulering; Fase 2. Ontwerpeisen; Fase 3. Bouw, interventie en evaluatie en Fase 4. Beschrijving van het leerproces.



***Onderzoeksfase 1: Probleem Formulering.***
In de eerste onderzoeksfase zijn we niet uitgegaan van een specifiek organisatie of ICT probleem, zoals expliciet beschreven in de ADR methode, maar van een maatschappelijk probleem met een potentieel grote impact, namelijk de transitie in de zorg. Voor deze transitie zijn verantwoordelijkheden overgeheveld van de centrale naar de lokale overheid en is de nadruk gelegd op kostenbeheersing in het gezondheidsdomein. Allereerst moesten we het maatschappelijke probleem en de sociale praktijk die aan de huidige situatie ten grondslag ligt trachten te doorgronden. Daarom zijn we gestart vanuit een globaal idee over de maatschappelijke problemen in kwestie, waaronder stijgende uitgaven in de ouderenzorg, decentralisatie van de zorg aan gemeenten, en de trend om mensen langer zelfstandig thuis te laten wonen. Vervolgens is het maatschappelijk probleem in twee interviewronden door vertaald naar een meer praktisch probleem van specifieke belanghebbenden. Deze interviews waren niet alleen belangrijk voor het doorgronden van zowel het maatschappelijk probleem als van het zoeken naar mogelijke oplossingen, maar ook voor het identificeren en motiveren van belanghebbenden die mogelijk betrokken wilden blijven in de ontwikkelfase van de oplossing.

Als een van de eerste onderzoeksresultaten kwam naar voren dat eindgebruikers zich onvoldoende bewust zijn van beschikbare smart living oplossingen en hoe deze producten en diensten kunnen voldoen aan hun behoeften. De sterk gefragmenteerde markt maakt het moeilijk om de juiste producten en diensten uit het aanbod te filteren en de overwegend technologische focus van leveranciers wordt gezien als obstakel in gesprekken met de eindklant. Vooral mensen die chronisch ziek zijn en ouderen gaan door verschillende stadia, wat betekent dat hun hulpbehoefte onderhevig is aan verandering. Burgers weten vaak niet welke diensten zij nodig hebben op welk moment in de tijd. Daarnaast hebben product en dienstenleveranciers in het smart living domein veelal moeite om eindgebruikers te bereiken en zijn ze op zoek naar kanalen om hun producten te promoten. Ook het grote aantal belanghebbenden dat betrokken is (product en diensten leveranciers, fabrikanten, uitvoerenden, etc.) zorgt voor extra complexiteit. Het creëren van bewustzijn wordt onder meer bemoeilijkt vanwege de complexe interactie tussen de verschillende belanghebbenden met betrekking tot 1) de samenwerking tussen belangrijke actoren, 2) het aantal producten en diensten 3) de diversiteit aan dienstverleners uit verschillende sectoren die zich richten op het huis (wonen, zorg, welzijn, ICT en energie), en 4) een gebrek aan geïntegreerde systemen. Dit betekent dat informatie-uitwisseling en samenwerking in het smart living domein moeten worden aangemoedigd.

In de eerste onderzoeksfase hebben we ons gericht op het in kaart brengen van de grootste obstakels in het smart living domein en de mogelijke oplossingen vanuit het perspectief van de diverse belanghebbenden (eindgebruikers, leveranciers en lokale overheden). De eerste behoeften zijn vervolgens geclusterd als: producten en diensten (wonen, zorg en welzijn); contact met anderen (vrienden, familie, buren en eindgebruikersgroepen); de integratie van bestaande platforms voor wonen, zorg en welzijn (lokaal en nationaal) en informatie over lokale activiteiten. Gebaseerd op 70 interviews, is vastgesteld dat een platform op het gebied van wonen, zorg en welzijn ervoor kan zorgen dat zowel de vraag als de aanbodzijde actief wordt bediend, waarbij er meer aandacht uitgaat naar een slimme leefomgeving en, op hetzelfde moment, het bewustwordingsproces bij de eindgebruikers wordt vergroot.

***Onderzoeksfase 2: Ontwerpeisen***

In de tweede onderzoeksfase, hebben we ons gericht op de belangrijkste ontwerpeisen van het platform, verdeeld over functionele en niet-functionele eisen van het ontwerp. Dit is gebaseerd op het creëren van bewustwording bij de eindgebruikers welke producten, diensten en technologieën zouden kunnen helpen om zo lang mogelijk zelfstandig te blijven wonen. Deze ontwerpeisen moesten niet alleen voldoen aan de eisen van de eindgebruikers, dienstverleners en lokale overheden, maar ook aansluiten op (latente) behoeften en (nog onbekende) producten en diensten. Op basis van de inbreng van vier groepsinterviews met 28 participanten waren we in staat om de ontwerpeisen uit de 70 interviews te verfijnen. Daarnaast vonden we dat de belangrijkste behoeften van eindgebruikers betrekking op: 1) contact met anderen, 2) het vinden van smart living producten en diensten, en 3) de toegang tot informatie over lokale activiteiten.

***Onderzoek fase 3: Bouw, Interventie en Evaluatie***

In de derde onderzoeksfase hebben we ons gericht op de ontwikkeling, evaluatie en implementatie van het platform. Voor onze sociale innovatie, die gericht is op de behoeften van de eindgebruiker, onderzochten we methodes waarbij de eindgebruiker in de ontwerpaanpak centraal stond. Om de eindgebruikers vanaf het begin te kunnen betrekken hebben we een proeftuin ingericht met vier grote en twee kleine en middelgrote ondernemingen, de universiteit, een publieke organisatie (gemeente) en eindgebruikers (ouderen en mantelzorgers). De belangrijkste doelstelling van de proeftuin was 1) verkennen het platform idee, 2) experimenteren met het platform, en 3) het evalueren van scenario's die het platform idee zou kunnen laten uitmonden in een succesvolle sociale innovatie. Dankzij de proeftuin hadden we toegang tot een grote hoeveelheid aan expertise om het ontwerpproces van de sociale innovatie te begeleiden.

Om de aandacht te vestigen op de problemen en kansen van een specifieke doelgroep, hebben we diverse ontwerpinstrumenten gebruikt zoals personas, gebruikersverhalen en scenario's.

Daarnaast hebben we tijdens de ontwikkeling van het platform vier ontwerpcycli ingebouwd, waarbij verschillende teams in een parallel traject hebben gewerkt aan het ontwerp en de ontwikkeling van het platform. Dit resulteerde in een aantal prototypes waaronder platform schetsen, klikmodellen, een demo en een vereenvoudigde versie van het eindproduct, die vervolgens werden gevolgd door gebruikerstesten. Door de prototypes steeds tussendoor te evalueren, konden verbeteringen worden doorgevoerd voordat we naar de volgende ontwerpcyclus gingen.

De platformtesters gaven aan dat het prototype van Zo-Dichtbij een effectief instrument was om ouderen comfortabel in hun vertrouwde omgeving te laten wonen. Volgens de testers werkte het platform drempelverlagend om mantelzorgtaken uit te voeren voor anderen, en kan het platform een rol spelen bij het faciliteren van mantelzorgers. Bovendien, als de betrouwbaarheid van zowel professionele zorgpartijen, mantelzorgers als producten en diensten leveranciers kan worden gegarandeerd, kan het platform de mogelijkheid bieden om een veilige en betrouwbare netwerk voor ouderen en hun mantelzorgers te creëren. Daarbij, zou het als hulpmiddel voor het WMO loket van de gemeenten en de wijkverpleegkundigen ervoor kunnen zorgen dat ook ouderen zonder eigen netwerk op dezelfde wijze hulp konden ontvangen.

Hoewel, de testgroepen voornamelijk zijn gebruikt om het effect van een platform voor wonen, zorg en welzijn te meten vanuit het gezichtspunt van de categorie jongere ouderen (> 55) en de mantelzorgers, kan worden gesteld dat een dergelijk platform verschillende doelgroepen kan helpen om langer zelfstandig te blijven wonen.

***<u>Onderzoeksfase 4: Beschrijving van het leerproces</u>***

Tijdens onze driejarige studie hebben we gewerkt aan een mogelijke oplossing voor een maatschappelijk probleem door het bouwen van een ICT artefact (platform voor wonen, zorg en welzijn) in een specifieke context (zo lang mogelijk zelfstandig wonen), waarbij kennis is gedistilleerd (over het gebruik van ADR voor een maatschappelijk probleem) verpakt in een oplossingsconcept (sociale innovatie) door in de toekomst mogelijk gerelateerde en/of soortgelijke problemen aan te kunnen pakken ('matchmaking' platforms voor maatschappelijke vraagstukken die ertoe doen). Het platform is nog steeds onderhevig aan verfijning, maar de verwachting is dat het laatste prototype zich tot een volwaardig platform zal ontwikkelen. Binnen de reikwijdte van het onderzoek hebben we onze doelstelling bereikt inzake het ontwerpen, de ontwikkeling, de implementatie en de evaluatie van een platform voor wonen, zorg en welzijn ter ondersteuning van burgers die zo lang mogelijk zelfstandig willen blijven wonen. Daarnaast hebben we nieuwe en verfijnde ADR principes afgeleid uit de analyses van het logboek en zijn deze toegevoegd aan de ADR methode. Dit kan onderzoekers helpen om de ADR methode toe te passen wanneer ze geconfronteerd worden met een maatschappelijke uitdaging.

Daarnaast hebben we aangetoond dat onze sociale innovatie, die een maatschappelijke behoefte adresseert (zo lang mogelijk zelfstandig te blijven wonen en het uitvoeren van mantelzorgtaken) bijdraagt aan de aanpak van een maatschappelijke uitdaging (vergrijzing), en door middel van haar procesdimensie (actieve betrokkenheid van de ouderen en gezond ouder worden) een bijdrage kan leveren aan het hervormen van onze samenleving van een verzorgingsstaat in een participatie samenleving. Zoals gezegd was de belangrijkste focus van het platform op dat van de eindgebruiker. Als zodanig biedt het platform een podium, of is het een bron van vrije keuzes om burgers op hun eigen manier hun leven te laten inrichten, met inbegrip van interactie van familieleden, vrienden en verzorgers, en het hebben van een marktplaats voor producten, diensten en lokale activiteiten.

***Conclusies en implicaties***

Onze studie kan worden beschouwd als een validatie van de ADR methode op basis van primaire onderzoeksgegevens. De ADR-methode is relatief abstract en de specifieke kenmerken van sociale innovatie moesten derhalve worden ingepast. Om die reden stellen we vier nieuwe ontwerp principes voor die aansluiten op maatschappelijk getinte problemen: 1) verkrijgen van diepgaand inzicht in het maatschappelijke probleem en de onderliggende praktijken, 2) zorgen voor wederzijdse beïnvloeding door wijzigingen in zowel de praktijk als in het ICT-artefact, 3) vanaf het begin van het ADR-proces betrekken van burgers die worden beïnvloed door de sociale innovatie. Daarnaast zouden sociale innovaties geleid moeten worden door zogenaamde 'change agents' die belanghebbenden kunnen motiveren, politieke, economische en sociale waarden in evenwicht kunnen brengen, en daadwerkelijk in staat zijn om verandering teweeg te brengen.

Onze studie biedt een empirische basis voor het maken van een ontwerptheorie over digitale platforms, dat momenteel nog ontbreekt in de literatuur. Terwijl digitale platform literatuur zich voornamelijk bezighoudt met het evalueren van winstgevende en succesvolle platforms, hebben wij onderzocht hoe het platformproces zich ontwikkelt van idee tot valorisatie en hoe functionaliteiten van invloed zijn op de keuzes en mogelijkheden van met name jongere ouderen. Als zodanig biedt dit proefschrift een basis voor het ontwikkelen van een ontwerptheorie over hoe een digitaal platform kan worden ontworpen, ontwikkeld, geïmplementeerd en geëvalueerd, en als mogelijke blauwdruk kan dienen voor verschillende doelgroepen en domeinen.

***Beperkingen en toekomstig onderzoek***

Omdat de ADR-onderzoeker deel uitmaakte van de studie was het belangrijk dat er zo neutraal mogelijk werd gehandeld. Dit was geen makkelijke taak, maar om vooroordelen zoveel mogelijk te voorkomen hield de ADR-onderzoeker een logboek bij met meer dan 1.100 notities (zie appendix D), om zodoende een bewijsketen op te bouwen van de genomen stappen, beslissingen en mijlpalen in het onderzoek. Het dagboek is gebruikt om te reflecteren op het onderzoek en beslissingen transparant te maken, maar ook om de onderzoekslijn te kunnen volgen.

Hoewel, we voortdurend moesten balanceren tussen dilemma's met betrekking tot lichtgewicht versus meer uitgebreide gebruikerstesten, het gebruik van de ADR-methode ten opzichte van andere methoden van onderzoek, evenals budgetbeperkingen en de tijdsdruk, zijn er diverse aanknopingspunten te bedenken voor vervolgonderzoek. De algemene vraag van onze toekomstige onderzoeksagenda zou kunnen zijn: Hoe is ADR te gebruiken om onderzoeksinitiatieven in een multidisciplinaire omgeving te begeleiden en hen te leiden van een eerste idee, via ontwerp en de ontwikkeling naar de 'ready-to-market' fase? Dit betekent dat er multi-disciplinaire samenwerking en kennisuitwisseling tussen de academische wereld en de industrie wordt nagestreefd, bijvoorbeeld om innovaties te versnellen, terwijl zowel business modellen alsook de exploitatie van de innovatie vanaf het begin van het onderzoek worden ingebed.

# Publications by the author

***2013***

Keijzer-Broers, W., De Reuver, M., & Guldemond, N. (2013). Designing a Matchmaking Platform for Smart Living Services In *Inclusive Society: Health and Wellbeing in the Community, and Care at Home* (pp. 224-229). Heidelberg: Springer Berlin, Proceedings of 11th International Conference on Smart Homes and Health Telematics (ICOST 2013) Singapore, June 19 – 21

Solaimani, S., Keijzer-Broers, W., & Bouwman, H. (2013). What we do - and don't - know about the Smart Home - An analysis of the Smart Home literature *Indoor and Built Environment 24*(3), 370-383

***2014***

Daas, D., Keijzer-Broers, W., & Bouwman, H. (2014) Optimal Bundling and Pricing of Multi-Service Bundles from a Value-based Perspective: A Software-as-a-Service case. Proceedings of BLED eConference (BLED 2014), Slovenia, June 1-5

Keijzer-Broers, W., De Reuver, M., & Guldemond, N. (2014). Designing a multi-sided health and wellbeing platform: Results of a first design cycle. Proceedings of 12th International Conference on Smart Homes and Health Telematics (ICOST 2014), Denver, US, June 25 – 27

Keijzer-Broers, W., Nikayin, F., & De Reuver, M. (2014). Main requirements of a Health and Wellbeing Platform: findings from four focus group discussions. Proceedings of The 25th Australasian Conference on Information Systems (ACIS 2014), Auckland, New Zealand, December 8 – 10

***2015***

De Reuver, M., & Keijzer-Broers, W. (2015). Trade-offs in designing ICT platforms for independent living services. Proceedings of IEEE International Conference on Engineering, Technology and Innovation/International Technology Management Conference (ICE/ITMC 2015), Belfast, Ireland, June 22 – 24

Keijzer-Broers, W., De Reuver, M., Florez Atehortua, L., & Guldemond, N. (2015). Developing a health and wellbeing platform in a living lab setting: An action design research study. Proceedings of the 10th International Conference on Design Science Research in Information and Technology (DESRIST 2015), Dublin, Ireland, May 21 – 22

Keijzer-Broers, W., Florez Atehortua, L., & De Reuver, M. (2015). Prototyping a Multi-sided Health and Wellbeing Platform. Proceedings of the 24th International Conference On Information Systems Development (ISD 2015), Harbin, China, August 25 – 27

***2016***

Keijzer-Broers, W., Florez Atehortua, L., & De Reuver, M. (2016). Prototyping a Health and Wellbeing Platform: an Action Design Research Approach. Proceedings of the 49th Hawaii International Conference on System Sciences (HICSS 2016), Kauai, Hawaii, January 5 – 8

Keijzer-Broers, W., & de Reuver, M. (2016). Applying Agile Design Sprint Methods in Action Design Research: Prototyping a Health and Wellbeing Platform. Proceedings of the 11th International Conference on Design Science Research in Information and Technology (DESRIST 2016), (pp. 68-80), St. John's, Canada, May 24 – 25

Keijzer-Broers, W., Florez-Atehortua, L., & de Reuver, M. (2016). Supporting People to Age-in-Place: Prototyping a Multi-sided Health and Wellbeing Platform in a Living Lab Setting. In *Transforming Healthcare Through Information Systems* (pp. 153-165). Springer International Publishing

Keijzer-Broers, W., & de Reuver, M. (2016). Action Design Research for Social Innovation: Lessons from Designing a Health and Wellbeing Platform. Paper to present at International Conference on Information Systems (ICIS), Dublin, Ireland, December 11 – 14

Keijzer-Broers, W., & de Reuver, M. (2016). Cooperation and knowledge challenges in realizing smart homes: The case of small installer businesses. *Indoor and Built Environment*, online: 1420326X16670227.

***Invited talks***

| | |
|---|---|
| 2013 - 2016 | Pitches Zo-Dichtbij for industry partners like Conclusion, IBM, Ziggo, ICTU, DSW, Oracle, UL and several local governments: Midden Delfland, Delft, Utrecht, Amsterdam, Den Haag, Rotterdam |
| 2014 | University of Applied Sciences Utrecht / Coventry University, Utrecht, The Netherlands. ICT Platforms for Health & Well-Being |
| 2015 | Staff meeting Innovation board G4 (four metropolitan cities: Amsterdam, Rotterdam, Den Haag and Utrecht) at municipality of Amsterdam, The Netherlands. |
| 2015 | VNG conference (association for local governments), Apeldoorn, The Netherlands |
| 2015/2016 | Panelist/workshops Tympaan (the Netherlands), Comodal (UK), EHFF (Germany), DESRIST (Canada) |
| 2016 | ZonMW Den Haag, The Netherlands. Success stories from AAL projects |
| 2016 | Ministry of Economic Affairs Den Haag, The Netherlands. Workshop Future of ICT and health care |

# Curriculum Vitae

Wally Keijzer-Broers was born on 29 October 1966 in Delft, the Netherlands. She attended Gymnasium at the Stanislas college in Delft before moving to the world of marketing, PR and communication.

Since 1988, Wally has been working as a journalist and editor at several publishers in the Netherlands. In 1992 she started at Branche Organization UNETO-VNI as editor-in chief and publisher, and together with her team, she was responsible for three magazines, installtv and the online platform Installmedia.
In 2009 she started her Master of Business Administration (Cross Media) at Lemniscaat from Conclusion, Utrecht. She completed this executive MBA with distinction in June 2011 with her master thesis about Smart Living Services, which was supervised by prof. dr. Harry Bouwman from Delft University of Technology.

In April 2011 she founded Smart Crossmedia with a focus on networking, (change) management, strategic communication and advise for print, online, tv and mobile. Particular working for firms that were related to the smart living domain: Comfort, Energy, Construction, ICT and Healthcare. Next to that she worked with Delft University of Technology, Faculty of Technology, Policy & Management (TPM), Department of Information & Communication Technology. In 2012 she was involved in the organization of the 11th International Conference on Mobile Business (ICMB): '*Mobile Business in Everyday life: users*' routines versus provider's turbulence'.

In february 2013 she started as a PhD researcher at the ICT section of TPM, under supervison of co-promotor dr. ir. Mark de Reuver (TPM) and external supervisor dr. Nick Guldemond (Chief Innovation Officer & Business Development, University Medical Center Utrecht). During her PhD (2013 – 2016) Wally has been involved in European projects like Care@Home (CARE services advancing the social interaction, health wellness and well-being of elderly people AT HOME), which was about enabling empowerment, wellness and social care services to the home of the elderly through interactive multiple devices (smartTV, tablets, mobile). The idea was to enclose the social support system for the elderly and carry this as a personalized communication and service channel in their home. Whereby the technology provide a two-way communication for family, friends and care givers as well as entertainment and services for household, shopping and community information. She contributed to the research on business models and platform concepts for the care platform. In addition, she has

been involved in the preparation phase of ENVISION, a Horizon 2020 program aiming at Understanding and supporting business model innovation, Empowering (European) SME business model Innovation.
Wally supervised 12 master, bachelor and applied science students and lectured in the MSc Service Systems Engineering course. In addition, she presented her work at international conferences like DESRIST, ICOST, ICIS, ACIS, BLED and HICSS, and is a frequently invited speaker for workshops, forums and panels. She is part of the European Health Future Forum community (EHFF).

During her research Wally established a Living Lab setting with public/private partners, with the aim to collaborate on an integral solution that connects existing networks and services to support citizens age-in-place. In 2015 she founded the Zo-Dichtbij Foundation with a non-profit status, to help people organize their daily activities in a smarter way and maintain an independent and safe lifestyle for as long as possible. Next to that, she became in the lead for the VIMP implementation budget from ZonMW to stimulate the implementation for the service platform as proposed in her dissertation. Currently Wally is working on the valorization phase of Zo-Dichtbij and continues to do research on the platform as well.

Wally is married to Joop Keijzer and they own an installer business in Den Hoorn, with the focus on sustainable solutions. Together they have four children: Kevin (1992), Doreth (1993), Julian (1996) and Beaudine (1999).

Globally, 40% of people over 60 live independently, which means completely alone or with a spouse. As countries develop and their populations continue to age, the percentage of people who live independently will increase. This dissertation presents the design process from idea into valorization of a digital service platform for Health and Wellbeing to support people age-in-place in the Netherlands. We used Action Design Research (ADR) as our overarching research method embedded in a Living Lab setting. We attempt to solve a societal problem by building a concrete IT artifact (service platform for Health and Wellbeing) in a specific context (aging-in-place), which distilled prescriptive knowledge (about applying ADR for a societal problem) to be packaged into a general solution concept (social innovation) and to address a class of problems (matchmaking platform for social issues that matter). During the development of the platform we included four design iterations, which resulted in several low-fidelity prototypes: a paper prototype, mock-ups, a clickable model, a demo and a Minimal Viable Product, which were subsequently evaluated in several user tests. Our study can be regarded as a validation of the ADR method, based on primary data. In addition, we suggest that four refined design principles should be added to the ADR framework, to guide researchers who face societal challenges: 1) be based on an in-depth understanding of the social problem and underlying practices, 2) allow for reciprocal shaping between the changes to social practices and the IT artifact, 3) from the very start of the ADR process, involve citizens who are affected by the social innovation, and 4) be led by change agents that can identify and motivate stakeholders, balance political, economic and social values, and bring about change.

Keywords:
*smart living, aging-in-place, elderly people, platform, informal caretakers, design science, action design research, capability approach, social innovation*

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