A start-up process for the design of a multi-sided digital platform for social innovation

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By

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To Miryam, Jairo and Sarah, who have given me wings…

Acknowledgments

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This is the final product of two years investment. I joined this master with the firm idea of becoming an engineer who could lead positive impact in society from a technology perspective – I wanted to better understand the dynamics between technology and people- decision making processes in the light of multiple interests – I wanted to dig in into sustainability, systems modeling, policy analysis and design. But I did not want to lose my focus on ICT. The last five months is the confirmation of the fulfillment of my expectations- and this thesis reflects the two things I am very passionate about: technology and leadership for a better world.

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Executive summary

The following is an executive summary of the master thesis research titled “A start-up process for the design of a multi-sided digital platform for social innovation”; this summary outlines the main outcomes and points out to the main steps of the process- however given the research approach taken in this work (Action Design Research) the essence is in the details (i.e. design choices, derivation of requirements, etc). Therefore, I invite the reader to read fully this document- in the case of lack of time, please refer to chapters 5-7 after reading the introduction.

The problem

A social innovation is a novel solution to a social problem that is more effective, efficient, sustainable for which the value created accrues primarily to society as a whole rather than private individuals. Social innovations come in various forms such as (1) doing something good in/for society; (2) changing social practices and/or structure, (3) contribute to urban and community development and (4) re-organize work processes. In an aging world where life expectancy is steadily increasing and there is decline in the number of children and in total fertility the consequences for the healthcare system and the elder population are significant; therefore, social innovations are needed (in the form of changed social practices) aiming to reduce healthcare costs and improve the life quality of those aging.

The potential solution

Smart Homes / Smart Living serve goals of wellbeing of the residents of the home and eldercare among others. Thus, the realization of these goals could be considered as a potential social innovation for eldercare in specific. However, these products and services in this domain are generally unknown by the general public – so potential consumers lack of awareness of the potential benefits that smart home products can help them realize. Thus, a social innovation is proposed in the context of health and wellbeing through the design of a smart living multi-sided digital platform. This platform is a mean to improve the lives of citizens in the context of health and wellbeing, especially for those aging through information access, information exchange around Smart Living products/services, interaction with the relatives/community/neighborhood as well as with caretakers. The focus of a solution in this work is on the group of end-users of elders and voluntary caretakers.

The design of the artifact

From previous research foundational requirements were identified for the platform: 1) an online community for contact, solutions, social wellbeing, interaction with the neighborhood and a digital marketplace for applications; 2) an information exchange platform, between providers and end-users (business to consumer), 3) a portal for bundled, services and solutions (business to consumer) and 4) an intervention instrument for the municipality (government to consumer). Through two workshops and considerable work within the project team 9 requirements and 3 critical issues were identified. The requirements are:

Requirement	Description
1. Online community	The platform shall be an online community for contact, solutions, social wellbeing, and interaction with the neighborhood in the form of social activities/events.

2. Marketplace	The platform shall offer 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.
3. Seamless navigation	The artifact shall ensure smooth and simple navigation.
4. Rating and review mechanism	The platform shall allow reviews of products, products providers, activities and activities providers. A rating system should be in place that allows consumers of products/service give a rating plus a qualitative feedback.
5. Diary management	The platform shall offer a diary for the end-user- a log in which the user (or someone else on the user's behalf) keeps a daily record of events and experiences shall be in place. The access to such diary should be in as few clicks as possible and always visible from the home page of the platform.
6. Tasks management	The platform shall offer a task manager mechanism for the end-user, on which the user itself (or someone else on behalf of the user) can introduce and manage tasks related to the health/wellbeing of the user.
7. Contacts management	The platform shall contain a module for contacts management. These should be divided into two different categories (1) Social Contacts and (2) Special Contacts. A messaging functionality between users should be added as part of the contacts management mechanism.
8. Text and buttons	The platform shall offer texts/buttons in a size that is readable for levels impaired vision. Buttons for menus shall contain text and image related to the function. Buttons shall contain an audio option that by hovering "speaks out" what it does and displays a text.
9. Help	The platform shall offer a functionality which can guide the user though the different menus and options. This guided tour through the system is available by default but it is optional. The user may decide to disable it. The help should be offered in text as well as in audio; this is when the help is offered an additional clickable icon is available to hear the text embedded.

The critical design issues are:

Critical Design Issue	**Description**
1. Usability	The extent to which the artifact being designed can be used by end users (citizens) in the context of health and wellbeing.
2. Trust	It is built in a three-stage and cumulative process that establishes (1) trust in the online landscape and the specific website or application, (2) trust in the information displayed and (3) trust in delivery fulfillment and service. These definitions have been given by Urban et al. (2012) and match our findings.
3. Data privacy	Concerns the level of protection of the data as well as what makes part of a private and public profile.

The requirements derived were built into a prototype (mockup) which was also built into a clickable model for its evaluation through usability testing with potential end-users. 100% of the participants agreed that they would use or recommend the platform if available and 4 out of 6 participants rated 4 or 5 in a scale of 1 to 5 the user experience of the artifact. Some issues regarding the navigation in two functionalities were pointed for improvement.

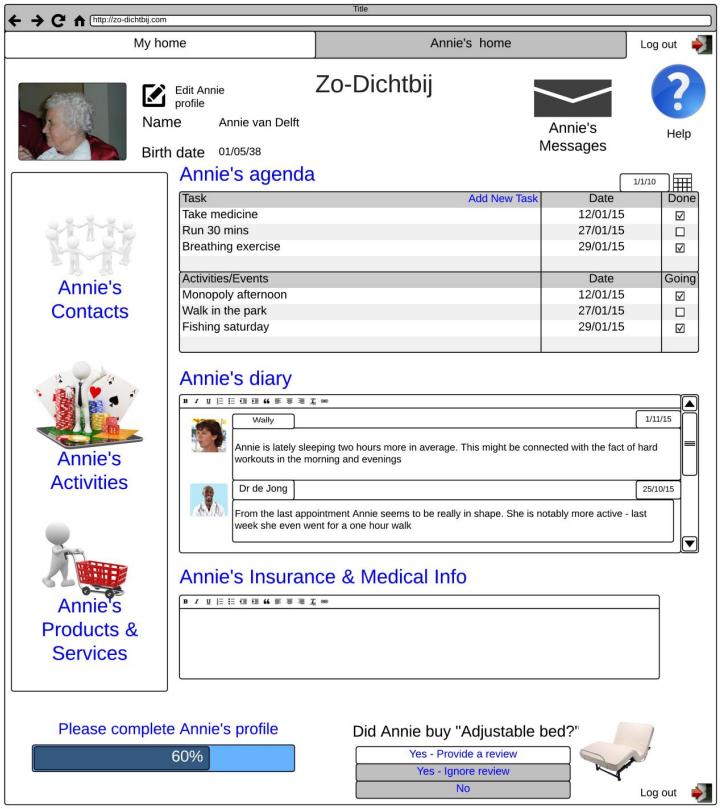

Figure 1: Home mockup version 1

There was learning of few important points in this design stage: (1) to collect requirements for the artifact and prioritize the critical design issues is key. (2) involve the end-user in the design process to validate and evaluate the artifact from the very beginning is a critical for acceptance (of the prototype), which is pre-condition for acceptance of the final artifact and (3) using familiar patterns when designing a prototype help potential users to feel more acquainted with the artifact.

The impact of the artifact

Building on the main outcomes of the design of the artifact section, a survey was prepared to further evaluate the design made- it was sent to 401 voluntary caretakers in the South-Holland province of the Netherlands with a response rate of 38% with an average age of 71 years – thus being a key target group of end users. A total of 7 questions were analyzed trying to understand the potential impact of the platform as well as to see who could potentially benefit among several stakeholders. In terms of who would benefit with the platform, the results suggest that Voluntary caretakers, Volunteers, People with physical disabilities and the Municipality would strongly benefit from the platform. Whereas Product providers, General Citizens, Service providers, People with mental disabilities, Young elderly (55 - 75 years old) and Elderly (75+) would somehow benefit from the platform.

Two questions in the survey were asked to explore a set of features that could help validate certain design options that were considered to be important by the design team. From these questions 5 new requirements were derived:

Requirement	Description
10. Multi-device/platform availability	The artifact shall be available for multi-devices and platforms that are most dominant in the market (web access, IOS, Android).
11. News about health and wellbeing	The artifact shall offer a channel or feed of noteworthy information around health and wellbeing targeted to the different groups of end-users, especially the elders.
12. Search based on key words	The artifact shall offer a type of search that looks for matching elements that contain one or more words specified by the user. In the context of this platform the it shall offer one input box in the main page and allow to retrieve elements like contacts, activities, documents (i.e. insurance policy), products/services.
13. Virtual helpline and telephone helpdesk	The artifact shall offer a link / contact information to reach out a telephone helpdesk. In addition, the artifact shall offer a live chat functionality that allows the users contact via-chat.
14. Medical and insurance information	The artifact should offer a mechanism to upload and easily retrieve file(s) that contain insurance policy and medical information of the main targeted users.

With the new requirements derived and results of the usability test the following mockup was constructed as an updated version that emerged from the previous one.

Figure 2: Home mockup version 2

In the survey the first mockup was shown to the voluntary caretakers and then they were asked the question 'the platform would help me with?'. A total of 14 potential benefits (capabilities) were presented to the respondents to be scored from 1 to 7 in terms of much the platform could help. After a dimension reduction using a statistical method (Principal Components Analysis), according to the caretakers' answers, the artifact's main impact is on two capabilities namely (1) socially inclusive active aging and (2) independent and comfortable aging in place.

A start-up process for the design of digital platforms for social innovation

Based on the findings and the knowledge drawn from the entire process the suggested main outcome is the following set of principles/steps for starting –up the design of digital platforms for social innovation:

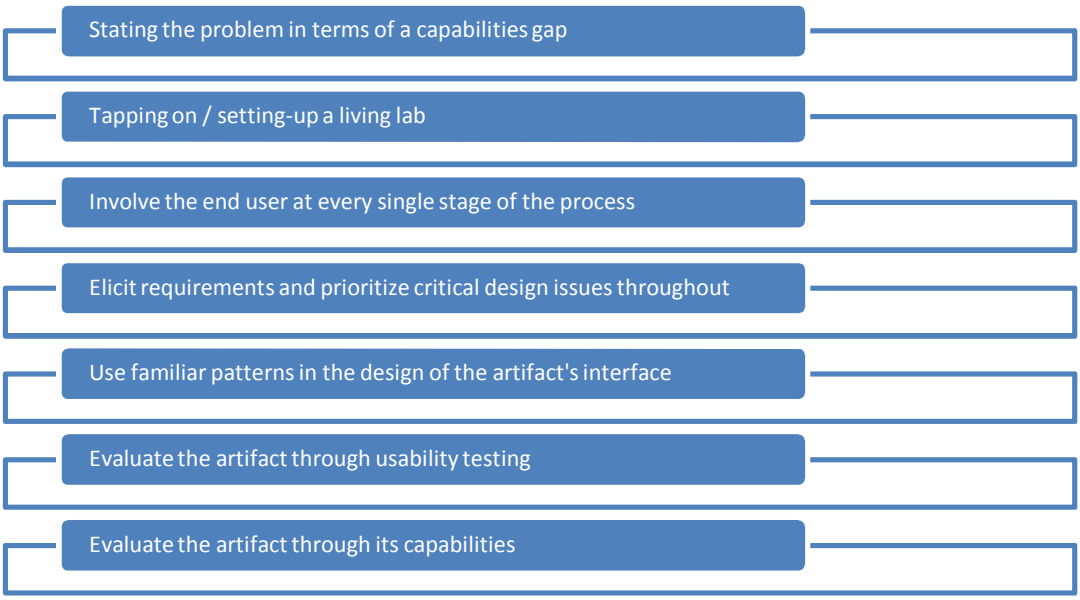

Figure 3: A start-up process for the design of digital platforms for social innovation (summary)

1 Introduction

1.1 Social innovations as an answer to a problematic situation

Social innovation refers to the creation, development, adoption, and integration of new concepts and practices that resolve existing social challenges. Some social innovations are systems-changing – they permanently alter the perceptions, behaviors, and structures that previously gave rise to these challenges, or in nutshell, an idea that works for the public good (Innovation, 2015). The results of social innovation are all around us, for instance self-help health groups and self-build housing; telephone help lines and telethon fundraising; neighborhood nurseries and neighborhood wardens; Wikipedia, coursera and the open university; complementary medicine, holistic health and hospices; microcredit and consumer cooperatives; charity shops and the fair trade movement; zero carbon housing schemes and community wind farms; restorative justice and community courts, etc - all of these are examples of social innovations that come in the form of new ideas that work to meet pressing unmet needs and improve society as a whole (Mulgan, Tucker, Ali, & Sanders, 2007). Rüede and Lurtz (2012) categorize social innovations into 4 different things, (1) doing something good in/for society; (2) changing social practices and/or structure, (3) contribute to urban and community development; and (4) re-organize work processes. The above provides lens to look at a problematic situation in hand to understand the kind of changes that are needed, and that we would like to tackle with this work.

Some of the present and future unmeet needs yet are the ones related to an increasing aging society worldwide - life expectancy is steadily increasing (46–89 years to 66–93 years) in the 21st century- UN forecasts a worldwide decline in the number of children and in total fertility; there will be more elderly people than children, especially in Europe (UN, 2004). An aging society leads to new challenges for healthcare and elderly care, two sectors under significant financial pressure in many countries (Hein et al., 2009). The implications seen already are that diseases and disabilities are growing, health care demands and costs are skyrocketing, demand for tele-homecare to avoid long-term hospitalization or nursing home care is also increasing, healthcare requires increased efficiency in the provision of services (Chan, Campo, Estève, & Fourniols, 2009). The kind of problematic situation described here creates opportunities for social innovations aiming to tackle the cost and life quality of those aging. Thus, the specific type of social innovation that this problematic situation may require is changing social practices and/or structure as previously defined by Rüede and Lurtz (2012) in order to make the overall system more sustainable, socially and economically speaking.

1.2 ICT as a mean to answer to the problematic situation

Information and Communication Technologies (ICT) play a crucial role in the development of any domain nowadays and will play even a more important one in the future; future generations of homes will be even more equipped with networked home appliances, smart power outlets, smart meters, smart sensors, among others (Kamilaris, Pitsillides, & Yiallouros, 2013). There is a tendency for this to increase in everyday's life even more in the future- the emergence of Internet of Things reflects this process; the number of devices connected to Internet was more than number of humans in 2008, it is expected by 2020 at total of 50 billion devices will be connected to Internet- in the end of 2011, 20 typical households generated more Internet traffic than the entire Internet in 2008 (Jackson, 2011). Thus, households and the way they are set-up are also being shaped by ICT, and this notion along with specific devices and configurations can fall under the notion of Smart Homes / Smart Living. The vision of the Smart Homes / Smart Living ranges around goals from the wellbeing of the residents of the home, energy efficiency, security, entertainment and eldercare (Solaimani, Keijzer-Broers, & Bouwman, 2013). The realization of this vision creates several possibilities for a more sustainable future and a convenient one for household inhabitants, and in effect it could also be considered as a potential social innovation for eldercare if realized.

Aldrich (2003) defines smart home as a residence equipped with installed ICT that can anticipate and respond to the needs of its occupants, for their comfort, convenience, security and entertainment by managing technology and connecting them to the world outside beyond their homes. Chan et al. (2009) focus the definition of Smart Homes to serve healthcare objectives: "smart home is used for a residence equipped with technology that allows monitoring of its inhabitants and/or encourages independence and the maintenance of good health". The smart homes concept has evolved into Smart Living (Solaimani, Bouwman, & Baken, 2011). Smart Living is defined as "a bundle of ICT-enabled services made available to homes that can be accessed from within and outside aiming energy efficiency, surveillance, health and entertainment to facilitate comfort, so it differs from Smart Home definition as it goes beyond the household boundaries" (Nikayin, 2014, p. 49).

Although products and services considered part of the Smart Living domain have been around for a while, citizens lack of awareness of them, therefore it has limited their access to them. According to Gann, Barlow, and Venables (1999) the marketplace for these technologies is still immature, consumers do not know of the products or are skeptical of the potential benefits and the industry is fragmented (no "one-stop-shop" provider supplying a full package of products. More recently exemplifying this lack of awareness Peine stated that "all of us have basic ideas of the products and services that occupy our homes; few of us, however, will have experienced what it is like to actually live in a Smart Home" (Peine, 2008). The Smart Living domain needs to reach a higher level of maturity by resolving a wide range of technological and non-technological aspects (Solaimani et al., 2013). Hence, a broken link between customers and service providers exists at the moment in the Smart Living market, or in other words, the market is currently fragmented; in the case of the Netherlands, this has also been confirmed recently by more recent work through interviews with different stakeholders (Keijzer-Broers, de Reuver, & Guldemond, 2013).

1.3 A multi-sided digital platform for the smart living case in the Netherlands

Zooming-in for a particular case, the aging figures mentioned in 1.1 and its implications are also applicable to The Netherlands. As of January 1st, 2015 the responsibility and the execution of healthcare is passed on to the municipalities; the Social Support Act (referred to as the Wet maatschappelijke ondersteuning – WMO) was introduced in all municipalities in the Netherlands since 2007. Under the act, policy responsibility for setting up social support for vulnerable groups in society will lie with the municipalities (Peters, 2007). Given the new regulatory landscape municipalities have strong incentives to control costs and maintain/increase quality of healthcare provision opening the door for new possibilities that can help them deal with the new healthcare model. Thus, given the new regulatory landscape, a social innovation is proposed in the context of health and wellbeing through the design of a smart living multi-sided digital platform as a mean for such social innovation. This platform is a mean to improve the lives of citizens in the context of health and wellbeing, especially for those aging. This happens through information access, information exchange around Smart Living products/services, interaction with the relatives/community/neighborhood as well as with caretakers. In the context of health and wellbeing an adequate definition of such service platform is "a grouping of related services that are similar in resource type and constitute a component of a continuum of care" (Lee et al., 2014). In addition, from the literature there is not description of such platform (Solaimani et al., 2013); in addition, as far as we know there are no examples of service platforms that involve more than one group of stakeholders in the smart living domain, therefore our case.

Thus, a multi-sided service platform can serve as a link between citizens and service providers (and other stakeholders at a later stage such as ICT, Energy, etc). Such service platform should help defragment the Smart Living marketplace in the context of health and wellbeing to ultimately also

improve the lives of those aging. Deriving the requirements, identifying design issues and evaluating such platform for the end-user (one side of the platform) as a first step could lead to improve the lives of aging citizens in the context of health and wellbeing. Also, it can lead to the generation of knowledge to approach similar set of problems on which social innovations can be facilitated through the design/implementation of digital platforms from scratch. The scientific relevance is to theorize social innovation through the design, development, and evolution of a digital platform, and to contribute to the knowledge of adoption, use and effects of Information Systems.

1.4 Context of the research project

TU Delft[1] is currently conducting research in the development and emergence of service platforms on which issues regarding its design, governance and business models are addressed (Keijzer-Broers, de Reuver, & Guldemond, 2015; Keijzer-Broers et al., 2013; Keijzer-Broers, Nikayin, & De Reuver, 2014; Nikayin, 2014; Nikayin & de Reuver, 2012; Nikayin, Skournetou, & De Reuver, 2011; Solaimani et al., 2013). Keijzer-Broers is currently investigating whether information transfer and exchange between service providers and end-users through the design and implementation of a multi-sided platform can contribute to better adoption of products and services in the Smart Living domain. As of today, this work is still in theoretical phase. Hence, this research is a direct and practical contribution to the efforts taking place at the moment at TU Delft during design and implementation phase of Smart Living platforms, specifically from the end-user perspective.

1.5 The living lab

The Living Lab is a collaborative multi-stakeholder group responsible to design, implement and evaluate the suggested platform. Today, as part of the Living Lab there are scholars and students (TU Delft and HBO), two large multinational organizations, two SMEs (small and medium enterprises), a foundation, end-user group and the municipality of Rotterdam. From this large group, two other sub-groups are conformed for specific functions; the first one is the design composed by a front-end developer, one security analyst, and developers at a later stage to be led by me (the author of this proposal). The second one is the expert team which will oversee and advise the first one. The Living Lab setting offers a unique opportunity to perform research; it increases opportunities for effective output of the work performed; for example, coordination of workshops that require access to end-users and data collection are easily set. There is already a high level of engagement and commitment of the different stakeholders participating which facilitates to achieve the research objectives, but due to the diverse views and interests, it also adds a challenge for decision making and implementation of solutions to common problems or goals, thus turning the research process into a complex and likely a “messy” one. The Living Lab setting serves as a research methodology for sensing, prototyping and validating complex solutions in real-life contexts- studying behavior in a real-life context allows researchers to gain a better understanding how the creation of artifacts fit into the complexity of daily life (Niitamo, Kulkki, Eriksson, & Hribernik, 2006).

My role in the living lab is to lead the artifact design team. There are two other members at the moment one as front-end developer, and a second student as security expert. My unique practical contribution to the project is to derive the requirements from the end-user perspective, to develop prototypes (mockups) that represent functionally how the platform would look like. Given my role I am also responsible for leading various sessions of workshops, design meetings and usability testing.

1.6 Research Objective

Considering the context of this project and the complexity surrounding it in terms of stakeholders setting and problems at hand, the objective of this research, through the design and

[1] Delft University of Technology; http://www.tbm.tudelft.nl/en/about-faculty/departments/engineering-systems-and-services/ict-section/research/current-phds/?amp%253bL=0

evaluation of a digital multi-sided platform in the context of health and wellbeing, is to derive a process that can serve as a roadmap for starting-up digital platforms for social innovation.

1.7 Research Approach

Before stating the research question it is necessary to introduce the research approach since the research sub-questions use it. Since this research is placed within a wider Smart Living research project at TU Delft and also contributes to the efforts of a larger multi-stakeholder collaboration group (The Living Lab), a method that provides a scientific research framework for designing the platform as an iterative, complex and 'messy' process is required. Action Design Research (ADR) fulfills this criteria; this method reflects the principle that IT artifacts are shaped by the organizational context during development and use. It conceives the research process as three interdependent activities which are building, intervention and evaluation of the IT artifact simultaneously. It deals with need for both knowledge generation through theoretical contributions (from researchers) and solving a problem situation encountered in a specific organizational context (from IT practitioners) (Sein, Henfridsson, Purao, Rossi, & Lindgren, 2011). The Living Lab is composed by both researchers and practitioners in need of knowledge generation and the resolution of a problematic situation, respectively. Chapter 2 details the approach.

1.8 Research Question(s)

Given this background, the main research question to be addressed in this study is:

"How can a multi-sided platform be designed as a mean for social innovation?"

To achieve those goals the following sub-questions need to be answered:

- *RQ1. What are the requirements from an end-user (elder/caretaker) perspective for a multi-sided platform for Smart Living (health and wellbeing)?*

  The first research question (RQ1) will derive what are the operations and activities that one-side of the service platform must be able to perform, which corresponds end-users who are citizens (elders/caretakers). This question sets functional boundaries for the artifact (the platform) that is to be designed. Keijzer-Broers et al. have already made progress in identifying requirements for a multi-sided platform for health and wellbeing (Keijzer-Broers et al., 2015; Keijzer-Broers et al., 2013; Keijzer-Broers et al., 2014). We build on this to answer this question. Subsequently, the analysis of the results of a survey already partly defined for which there are already respondents will help us complete/feedback this question.

- *RQ2. How does a multi-sided platform for health and wellbeing look like (functionally) from an end-user (elder/caretaker) perspective?*

  The second research question (RQ2) results into a functional prototype of the specifications coming from (RQ1). This prototype simulates key aspects of the artifact to be later built. It helps to compare whether the design matches the specification established in (RQ1). User-centric design concepts from literature yet to be determined will be applied as input for the construction of the prototypes. This will be an iterative process that will gather input from the Living Lab group. In addition, since 'usability' was identified as a critical design issue in building the platform (Keijzer-Broers et al., 2015), two workshops with the end-users sub-group will take place to run usability tests- one for early validation and the second for full evaluation.

- *RQ3. How does the artifact emerge?*

  The third research question (RQ3) is a qualitative description of how the service platform evolves in the phase of design and evaluation, in other words the steps taken towards evolving the artifact. "Reflection and Learning" is one of the stages in ADR which helps to move

conceptually from building a particular solution to applying that learning to a broader class of problems. This happens through conscious reflection on the problem framing, theories chosen and the evolution of the artifact (Sein et al., 2011). Thus, it contributes to answer the main question by the application of ADR, documenting the steps and drawing knowledge in the process.

- *RQ4. How does the platform get evaluated?*

  The fourth research question (RQ4) is answered by an ongoing application of the ADR method principle of "Authentic and Concurrent Evaluation". In ADR, evaluation is not a separate stage that follows "building", instead, decisions about design, re-shaping the artifact are blended with ongoing evaluation. Also, similar to (RQ3), this is also part of the stage "Reflection and Learning" of ADR to draw knowledge. This is also a qualitative description of the design process in terms of the acceptance and adoption of the artifact that can lead to a critical mass of users. Such acceptance and adoption of the platform can helps us answer the main question by telling us whether the 'social innovation' proposed is having favorable reception from end-users (elders/caretakers).

1.9 Theories

Social Innovation, Platform theory, Capability Approach and User-Centric Design are theories and concepts which are relevant in this research. Social Innovation theories help us place the problem in context and objectives as a social innovation attempt for municipalities. Platform theory selected as a theory since the success of a platform goes beyond the hands of a platform owner as it also depends on a multitude of ecosystem partners and their ability to deliver (Adner, 2012). The capability approach can help explain the benefits of the platform by improving people's capabilities in the long run towards health and wellbeing. Lastly, User-centric Design helps us determine the needs, wants, limitations of end-users, as well as to guide the process of test the validity of the assumptions made using theories regarding user behavior in real world tests with actual users of the platform design.

1.10 Scientific Relevance

The scientific relevance is to theorize social innovation through the design, development, and emergence of a multi-sided digital platform, and to contribute to the knowledge of adoption of Information Systems. This research aims to compare the theoretical analysis of service platforms design and the adoption and diffusion of Information Systems. It builds upon earlier research on social innovation, platform theory and capability approach and it aims to contribute in the development of such theories. In addition, this work contributes to Action Design Research approach through a case in real life. Research in platforms for the Smart Living domain has been improving and this work contributes to it; a lot is known about successful platforms, but how to start up a successful platform is not clear.

1.11 Thesis structure

The ADR approach and its stages give us a framework to structure this document. The number of each item described represents also the chapter number in this document.

Problem formulation: the problem formulation besides the introductory part as a research contains the theoretical background (and theoretical framework) along with an introduction to the Smart Living domain.

1. Introduction (Research background, problem formulation, theoretical background, research objectives, scientific relevance, research design, thesis structure)

2. Research approach (Action Design Research and its application to this work, research methods, research agenda)
3. Theoretical background (Social Innovation, Platforms theory, User-Centric Design, Capability Approach, theoretical framework)
4. The Smart Living Domain

Building, Evaluation and Intervention, Reflection and Learning: the design of the artifact proposed in this thesis contains several iterations on which building, evaluation and intervention altogether take place; this will be reflected in the process description itself of chapter 4 and 5. Two full cycles are specified though, as there are two critical evaluation moments (usability test and capability approach survey).

5. The design of the artifact (foundational requirements, new requirements, critical design issues, prototypes, usability test, conclusions)
6. The impact of the artifact (new requirements, new critical design issues, refreshed prototypes, capability approach impact evaluation, conclusions)

Reflection and Learning and Formalization of Learning: In this section we abstract the learning into concepts for a set of similar problems. Articulation of outcomes and principles in light of the theories selected are done here.

7. Discussion and conclusions (conclusions research sub-questions, conclusions main research question, generalized outcome, contribution to theories)

2 Research approach

2.1 Introduction

This chapter explains how Action Design Research (ADR) stages and principles as our approach in this work are applied, as well as other activities that took part in the research and how they fit in the overall approach.

2.2 ADR

As stated in section 1.7, in this work we need a method that provides a scientific research framework for designing the platform as an iterative, complex and often very 'messy' or unstructured process. ADR fulfils these criteria; it recognizes artifacts as ensembles emerging from design, use, and ongoing refinement in context –ensembles mean "the material and organizational features that are socially recognized as bundles of hardware and/or software'' (Orlikowski & Iacono, 2001). Introduced by (Sein et al., 2011), ADR is a method that contains the inseparable and inherently interlinked activities of building the IT artifact, intervening in the organization, and evaluating it at the same time. ADR aims to generate prescriptive design knowledge through building and evaluating IT artifacts in an organizational setting. It deals with two challenges: (1) addressing a problematic situation encountered in a specific organizational setting through intervention and evaluation; and (2) constructing and evaluating an IT artifact that addresses the class of problems represented in the problematic situation. ADR recognizes that the artifact emerges from interaction with the organizational context even when the design is guided by the objectives of the researchers. Figure 4 shows the structure of ADR.

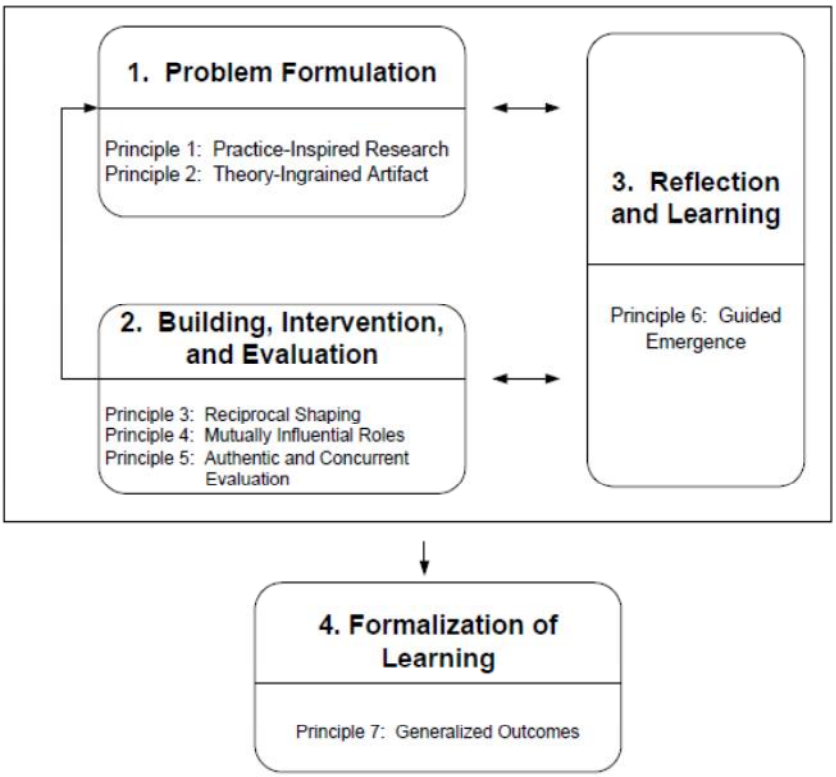

Figure 4: "ADR Method - Stages and Principles" (Sein et al., 2011, p. 41)

In a nutshell we explain what each components means literally from the author (Sein et al., 2011). In stage 1 the problem is formulated as perceived by researchers, thus setting the ground for the research effort. It provides the motivation for formulating the research effort. Principle 1 (Practice-Inspired Research) emphasizes viewing the problems as knowledge-creation opportunities.

Principle 2 (Theory-Ingrained Artifact) emphasizes that the artifacts designed and evaluated using ADR are always informed by theories.

Stage 2 (Building, Intervention, and Evaluation (BIE)) uses the problem formulation and theoretical premises set in stage one, using it as an input for an initial design of the IT artifact, which is further shaped by organizational use and subsequent design cycles. It can be either an IT-Dominant BIE or Organization-Dominant BIE. The former emphasizes creating an innovative technological design, the latter generates mainly design knowledge with the primary source of innovation as the organizational intervention. Three principles are considered; principle 3 (Reciprocal Shaping). emphasizes the inseparable influence between the IT artifact and the organizational context. Principle 4 (Mutually Influential Roles) points out to the importance of mutual learning amongst the different project participants both researchers and practitioners. Principle 5 (Authentic and Concurrent Evaluation) emphasizes that evaluation is not a separate stage of the research process that follows building, that is decisions about designing, shaping, and reshaping the artifact and intervening the organization are in parallel with ongoing evaluation.

Stage 3 (Reflection and Learning) moves from building a solution for a particular case to applying that learning to a broader class of problems; this is also an ongoing stage and parallel to the first two. Conscious and constant reflection on the problem, the theories, and the evolving artifact are necessary to generate knowledge. One principle is applicable here; principle 6 (Guided Emergence) combines playing with two apparently conflicting perspectives which are design and emergence, meaning intentional intervention and organic evolution.

Stage 4 (Formalization of Learning) aims to formalize the learning by developing general solution concepts for a class of field problems. One principles applies here; principle 7 (Generalized Outcomes) emphasizes generalization of the problem instance, solution instance, and derivation of design principles.

2.3 ADR and the organization of this research

The organization of this document follows the stages of the ADR approach, to see this please refer to section “Thesis structure 1.11”.

As mentioned the nature of the overall process of building, evaluation and intervention of the artifact is ‘messy’ or unstructured in nature and the steps are not necessarily in a chronological sequence (ADR first three stages are concurrent), this first design chapter (Chapter 5) has a logical structure that allows informing how the initial phase of design process took place so far and gives a structure to the natural ‘messiness’ of this process.

As this work contributes to the current research on Smart Living platforms taking place at TUDelft, we took as the initial steps their findings on Critical Design Issues (CDIs) and initial requirements. This was followed by a first workshop on which some participants of the Living Lab setting elaborated on those initial findings. The main outcome of the first workshop is a new set Critical Design Issues for the design of the platform which are further elaborated on a second workshop. All this work is taken as input for the design team and later on translated into end-user Mockups. This work represents several iterations before a partial version is made into a clickable model for its evaluation.

Chapter 5 presents the process of an initial design cycle of the artifact. It contains elements from the stages in ADR of “Building-Intervention-Evaluation” and “Reflection and Learning”. Figure 5 visually represents the first design cycle of the artifact.

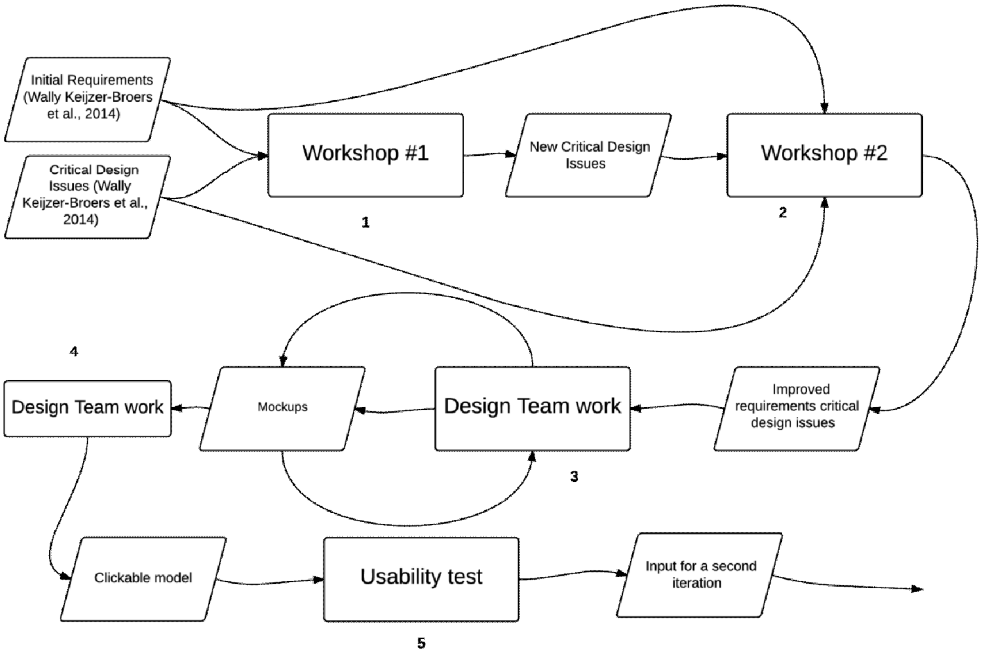

Figure 5: the design of the artifact process

Chapter 5 is divided in 7 sections. The reason is that they capture the main outcomes of the process flow specified in Figure 5. The first and second section are foundational requirements and critical design issues; here we present the initial findings by (Keijzer-Broers et al., 2014) and reflect upon them as the foundation of our work – thus we can contribute to the work already done. The third section is new critical design issues and new requirements which are the main outcomes of the initial stage of the design process from the two workshops organized. The fourth section describes in more detail the kind of work and process that the ADR performed along with its findings. This resulted into a navigation map and mockups (appendix C) which is the fifth section. The last part of chapter 5 is the first evaluation of the artifact. Usability testing is the method chosen for the evaluation. Usability testing is a technique used in user-centered design to evaluate a product by testing it on users. It gives direct input on how real users use the artifact (Nielsen, 1994). The main reason for this is the role that the end user plays in this design as our main stakeholder. The role of usability testing in this work besides providing fundamental input for the evolution of the artifact towards a 'usable tool' is to measure the artifact acceptance in the early stages of the design. As previously mentioned, although the ultimate objective of the artifact is to achieve a social innovation by the means of a digital platform, its impact can only be measured in the long run through presumably a social impact assessment; however early acceptance is critical for the artifact to be adopted. In this thesis one usability tests is performed for the first design iteration aimed to identify problems with the information architecture and navigation as well as to improve even further the artifact design achieving usability objectives and seamless navigation as well as further acceptance by potential end users. Chapter 5 also presents the results of the usability testing.

Chapter 6 "The impact of the artifact" corresponds to a second iteration of BIE (Building Intervention and Evaluation). In this part, the research takes a more quantitative approach- that is, it involves collecting and converting data into numerical form to then perform statistical calculations and draw conclusions- we use a survey that gets sent to a potential key group of end-users using the capability approach. Chapter 6 is divided into 6 sections (see Figure 6); the first section is general

description of the survey, dates, participants, sample characteristics of the group surveyed. The following two sections correspond to the analysis of two survey questions, one regarding target groups who would benefit with the design and the other one regarding features that the platform should include; this is done to understand potential stakeholders impacted by the artifact designed in the eyes of one specific group of users (voluntary caretakers). The fourth section draws the new identified requirements from the analysis of the two previous questions. The fifth section is the statistical analysis of a question of impact of the platform plus a principal components analysis to establish findings regarding this analysis.

As presented chapter 5 is an evaluation of the platform regarding usability; whereas chapter 6 takes the first iteration design and evaluates the artifact as a potential mean for social innovation described in terms of new or improved possibilities (capabilities) for the users.

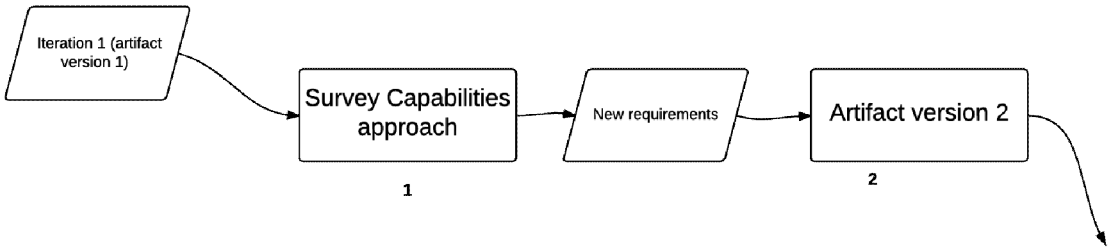

Figure 6: the evaluation of the artifact process

Thus, ADR is put into practice in this work through different research activities that combine both quantitative and qualitative methods. Chapter 5 and 6 will go into the details of the activities mentioned.

3 Theoretical background and theoretical framework

This chapter reviews platform theory, user-centric design, the capability approach theory and social innovation concepts and relates them to each other to create a theoretical framework for this research.

3.1 Social Innovation

3.1.1 Definition

A suitable definition of social innovation for this work is the one given by Caulier-Grice, Davies, Patrick, and Norman (2012) "Social innovations are new solutions (products, services, models, markets, processes etc.), that simultaneously meet a social need (more effectively than existing solutions) and lead to, new or improved capabilities and relationships and better use of assets and resources. In, other words, social innovations are both good for society and enhance society's capacity, to act".

Although some definitions are found, academic research on social innovation is still rare. The published work has mainly focused on practices (Choi & Majumdar, 2015). Some of the work published varies depending on the lens of the authors. Choi and Majumdar (2015) in their work 'Social Innovation: Towards a Conceptualisation' perform a literature review on social innovation theoretical work and cluster their findings in 7 perspectives (sociological, creativity research, entrepreneurship, welfare economics, the practice-led, the community psychology and the territorial development).

Our interest in this thesis is on social innovations that can be replicated and "emancipated" through specific programs or organizations. Therefore, given the practical nature of this work, we use 'the practice-led' perspective which is focused in the practical applications of social innovation rather than in building theories on the topic. Hence, we use theory and approaches on Social Innovation developed by Mulgan et al. (2007) in the paper 'Social innovation: what it is, why it matters and how it can be accelerated'; in this work the author explains how social innovation is rooted, who are the key actors and their dynamics, how it evolves, how it can get emancipated, and what is the state of the art is in terms of research. Again, in this thesis we refer mainly to this work and conceptualization.

Mulgan et al. (2007)'s definition of social innovation is very similar to the introductory one on this section: social innovations are novel solutions to social problems that are more effective, efficient, sustainable, or just than present solutions and for which the value created accrues primarily to society as a whole rather than private individuals. These solutions meet the social needs of many in a variety of fields which can be from working conditions and education to community development and health. Social innovation is considered a construct for understanding and producing lasting social change (Phills, Deiglmeier, & Miller, 2008). Social innovation is about how to improve the capacities of a society to solve their problems. A considerable amount of examples of social innovations can be cited over the last two centuries from cognitive behavioral therapy for prisoners to Wikipedia, have moved from the margins to the mainstream (Mulgan et al., 2007).

Mulgan et al. (2007) argue that there are two main drivers for innovation. The first driver is purely need; social innovation becomes necessary when issues exacerbate, when systems are obsolete or when institutions fail to deliver on their promise. The second driver is awareness of a gap, or in other words a clear view from people of what there is and what could/should be.

3.1.2 Stages of social innovation

Mulgan et al. (2007) further build on social innovation by separating the process in four different stages: (1) Generating ideas by understanding needs and identifying potential solutions, (2) Developing, prototyping and piloting ideas, (3) Assessing then scaling up and diffusing the good ones and (4) Learning and Evolving as further developed in Table 1.

Stage	*Description*
Generating ideas	This has to do with awareness of a need. Needs can be very obvious, for example hunger or poverty, but at other times they are, not so obvious like racism at the workplace and have to be spotted through other means. Thus, an idea that can potentially fulfill that need makes the first stage.
Developing and prototyping	This has to do with validation. Taking the promising idea and testing it out in practice. A benefit of prototyping is that innovations often require several goes before they work. However, social innovations are often implemented early on without piloting,, since social innovators are so motivated that they are too impatient to carry out the this stage.
Assessing and diffusion	Once an idea is proving itself in practice, and can then be grown, potentially through organic, growth, replication, and adaptation or franchising.
Learning and evolving	Innovations continue to change and it often happens that the innovation has unintended consequences therefore it needs suitable adaptations.

Table 1: Stages of the social innovation process according to Mulgan et al. (2007)

3.1.3 Who are the social innovators?

According to Mulgan et al. (2007), social innovations are brought forward by different type of actors such as individuals, movements as well as innovative organizations. One example of an individual who is considered a social innovator is Muhammad Yunus pioneering concepts of microcredit and microfinance (loans that are given to entrepreneurs too poor to qualify for traditional bank loans). Mulgan states also that social innovators have very diverse backgrounds; for instance politicians, bureaucrats, intellectuals, entrepreneurs, as well as activists in the citizen sector. Social movements such as environmentalists, feminists, and the disability rights movement have given rise to many social change inducing, innovations. Another group which 'does' social innovation is the group of innovative organizations; for instance Ashoka[2] which is a global organization that identifies and invests in leading social entrepreneurs. Governments through smart policy can also be considered social innovators.

3.1.4 A criteria for social innovation

A separation to meet that something is 'innovative' and 'social' is necessary. Phills et al. (2008) state that two criteria shall be met for a solution to be recognized as innovative: (1) novelty and (2) improvement. Novelty does not necessarily imply that the innovation has to be wholly new; it can actually be combinations or hybrids of existing elements at hand, or just even a new context. According to the authors (idem) improvement means that the solution is more effective or efficient, or more sustainable or fair than other alternatives. The authors (idem) in trying to establish a criterion for a solution considered to be 'social' suggest to observe if the solution addresses a social need or social problem and the type of value that is creating is considered to be social too (i.e. it benefits the society or the public).

[2] http://www.ashoka.org/

3.1.5 Function of social innovation in this study

In this section we have shortly summarized the concept of social innovation; we described the stages of social innovation, the actors who lead it, as well as a criteria. This concept helps us define the ultimate objective of what we are intending to do when designing a multi-sided digital platform that can serve as a mean to create a social innovation- that is an instrument that is novel in itself and benefits the society/public- or to improve the capacities of the society.

3.2 Capability approach

This work uses the capability approach theory to study why and how a service platform can be built as a mean to create a social innovation- the social innovation being measured in terms of improving capabilities as this chapter will describe.

3.2.1 Definition

Robeyns (2005) in his paper 'The Capability Approach: a theoretical survey' presents this theory in an accessible way. It brings together the main conceptual and theoretical aspects of the capability approach mainly developed by Sen (1985) and Nussbaum (1992). Robeyns recapitulates the capability approach as a broad normative framework for assessment of individual wellbeing, social arrangements, the design of policies, and proposals about social change in society. It is applied in development studies, welfare economics, social policy and political philosophy. It can be used to evaluate certain aspects of people, such as inequality, poverty, the wellbeing of an individual or the average wellbeing of the members of a group. The capability approach is an instrument for evaluation to the aforementioned aspects, but not a theory that can explain those. Robeyns (2005) explains that according to the capability approach the end of wellbeing should be conceptualized in terms of people 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. More recently the capability approach has been used in ICT4D (Information and communication technologies for development - the use of ICT in the fields of socioeconomic development, international development and human rights) in the perspective of human development for the poor by Hamel (2010).

3.2.2 Functionings

Functionings comprise of "beings and doings" (Sen, 1992); they are the states and activities that a person can undertake. Examples of "beings" are being happy, being healthy, being calm, being safe having self-respect, etc. Examples of "doings" are traveling, caring for a child, voting, participating in a civil demonstration, taking drugs, eating animals, etc. Functionings are necessary in understanding the capability approach; capability is conceived as a reflection of the freedom that a person has to achieve relevant functionings (idem).

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, or in other words the functionings they are able to do.

3.2.3 Capabilities

Capabilities are the chosen combinations of functionings that are feasible for a person to achieve. There are two parts important to formulate capabilities: functionings and the opportunity of freedom; the latter is the actual freedom of a person to seek different functioning combinations (Alkire et al., 2009). Ultimately, capabilities denote a person's opportunity and ability to generate valuable outcomes, considering also relevant personal characteristics and external factors. The important part of this definition is the "freedom to achieve" (idem). Thus, the capability is concerned with freedom of choice of direct importance to a person's quality of life (Sen, 1992).

For better understanding, (Sen) in his book 'Development as freedom', provides a good example regarding the freedom of choice: the difference between fasting and starving on person's wellbeing, is whether the person is choosing not to eat. In this example, the functioning is starving but the capability to obtain an adequate amount of food is the key element in evaluating wellbeing of an individual. That is, having a lifestyle is not the same as choosing it; wellbeing depends on how that lifestyle came to be. While the combination of a person's functionings represents their actual achievements, their capability set represents their opportunity freedom — their freedom to choose between alternative combinations of functionings.

3.2.4 Agency

Sen (1999) defines an agent as someone who acts and brings about change, whose achievement can be evaluated in terms of his or her own values and goals – on his/her own behalf, and not someone else's. Agency leans on the ability to individually choose the valuable functionings- this is a choice that not necessarily correlates with personal wellbeing. The aforementioned example of fasting, the person chooses to pursue a goal he/she values but that may negatively affect one's wellbeing. A person as an agent is not necessarily driven by the pursuit of wellbeing. This means that achieving agency considers the success of an individual in terms of the individual's pursuit of the whole of their own goals (Sen, 1992).

Agency is also crucial term to understand the capability approach. The approach is essentially a 'people-centered' one, which puts human agency at the center rather than organizations such as markets or governments; thus, it gives the role to institutions like governments to expand the realm of human agency and freedom- "We shall be particularly concerned with those opportunities that are, strongly influenced by social circumstances and public, policy..." (Dreze & Sen, 2002).

3.2.5 Conversion factor

Sen (1992, pp. 19-21) explains another important aspect of the capability approach which is the notion of conversion factor. Goods and services coming from the market and non-market economy have certain characteristics that make them of interest to individuals. Consider a bike, one may be interested in a bike not because of the materials and the bike itself but because it can help us reach other places faster. Thus, a bike allows the 'functioning' of mobility - Sen (1992, pp. 19-21) calls the relation between a good/service and the achievement of beings and doings a 'conversion factor'; that is the extent in 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.

There are three typical categories of conversion factors: (1) personal, (2) social and (3) environmental; (1) personal conversion factors are inherent to the individual, such as metabolism, physical condition, sex, or intelligence- (2) social conversion factors come from the society in which the individual lives, such as public policies, norms, practices that unfairly discriminate, societal hierarchies, or power relations related to class, gender, race, or caste – (3) environmental conversion factors emerge from the physical or built environment in which an individual lives, for example climate, pollution, proneness to earthquakes, the stability of buildings, roads and the means of transportation and communication (Robeyns, 2005, p. 99). Following the example of a bike, a personal conversion factor is if a person is disabled, then a traditional bike will not be of much help in enabling mobility; a social conversion factor if for example women are not allowed to ride a bicycle; an environmental conversion factor is the state of the roads or bike paths for cyclists. Figure 7 captures graphically the elements mentioned and explained of the capability approach.

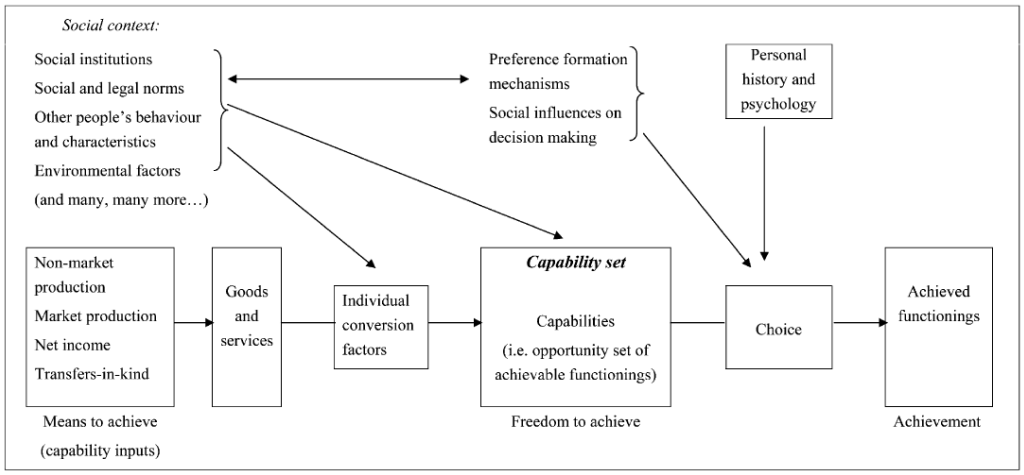

Figure 7: Key elements of the capability approach (Robeyns, 2005, p. 98)

3.2.6 Function of the capability approach in this study

In this section we have shortly described the capability approach theory and its key elements; those key elements will help us later to establish the foundation of the theoretical framework of this thesis by providing a skeleton that will bring together all concepts and theories described in section 2, as well as an evaluation tool for the objectives of the platform to be designed.

3.3 Platforms

3.3.1 Definitions

From platform theory, there is a variety of definitions of what platforms are according to the lens and background of the author. In product development literature platforms are defined as a set of elements and interfaces that are common to a family of products (M. H. Meyer & Lehnerd, 1997); a good example is a car which in itself is a mean to realize different customer requirements such as transportation, entertainment, socializing, etc. From the economics perspective a platform represents any product, system, service or even organization that mediates interaction between two or more groups of agents (David Sparks Evans, Hagiu, & Schmalensee, 2006); a proper example is a social network like facebook, which bring together networkers with advertisers.

The business strategy and management literature sees platforms as "building blocks (they can be product, technologies or services) that act as a foundation upon which an array of firms (sometimes called business ecosystem) can develop complementary products, technologies or services" (Gawer, 2009); Microsoft Windows exemplifies this definition by for example letting other software developers to build products that run on windows. In addition, Gawer states that there are two conditions for a potential platform: 1) it should perform a critical function of an overall system or should solve a crucial technological issue of an industry and 2) it should be 'easy to connect to' and 'build upon' and provide space for new and unplanned usage (idem). Information systems literature defines them as "digital infrastructures": large complex information systems, like enterprise resource planning systems, are serving as digital platforms on which new services can be added to benefit from shared data resources (Tilson, Lyytinen, & Sørensen, 2010). An alternative definition in the same field is "the extensible codebase of a software-based system that provides core functionality shared by the modules that interoperate with it and the interfaces through which they operate" (Tiwana, Konsynski, & Bush, 2010). What can be seen as common in the aforementioned definitions is that platforms provide a foundation of functionalities that are set to be reused for new products/services on top of the "platform" (Baldwin & Woodard, 2008).

3.3.2 Network effects

A network effect is the effect that one user of a good or service has on the value of that product to other people- when a network effect is present, the value of a product or service is dependent on the number of others using it (Shapiro & Varian, 1999). Consider WhatsApp, the more users the more value for those users this network has.

Thus, the platform value to any given user mainly depends on the number of users on the other sides of the platform – that is, value grows as the platform matches demand from all sides (Eisenmann, Parker, & Van Alstyne, 2006). Eisenmann et al. (2006) explain that due to these networks effects successful platforms enjoy constant increasing returns to scale- margins will grow as users base grows too.

Network effects become significant after a critical number of users is achieved, this is the so called 'critical mass'. At the critical mass point, the value obtained from the good or service is greater than or equal to the price paid for the good or service- this is an equilibrium point (Himmelberg, 1995). Since the value of the service the value of the good is determined by the user base, this implies that after a certain number of people have joined the service or purchased the good, additional people will join the service or purchase the good since the value is greater than the price paid to join it. Therefore, a key business concern in platforms settings is to determine how to attract users prior leading up to a critical mass- in this realm D. S. Evans (2009) has done some work proposing some strategies to reach the so called 'critical mass', hereby some he mentions; (1) the zig-zag which builds on two sides of the platform incrementally – the platform starts small number of members on both sides. It then persuades members on either side to join; (2) pre-commitment to both sides approaches potential early adopters on both sides to show up at the start of the platform to make it credible; (3) single and double-marquee which is getting one influential member on one side to attract members on the other side.

3.3.3 Multi-sided platforms

A multi-sided platform (MSP) is a platform that facilitates interactions/transactions between two or more sides (constituents o the platform) that it serves, in such a way such that members of one side are more likely to get on board the platform when more members of another side do so- In other words, there are positive indirect network effects among the various customer groups that an MSP brings together (Hagiu, 2009). As an example more advertisers will be keen on advertising on Google, the more users Google has.

(Hagiu, 2009) argues that at the most fundamental level there are two types of basic functions that MSPs, can perform:

- Reducing search costs: search costs are costs incurred by the multiple sides before they actually interact, in order to find each other as the best "trading partners".
- Reducing shared costs: transactions costs can be reduced as well. After search is over and the "sides" have found each other- a portion of these costs is generally common to all transactions between different members of the relevant sides of the MSP. Payment systems are classic examples of shared cost-reducing MSPs since they provide the infrastructure that significantly eases transactions between providers and consumers eliminating the need for barter (i.e. PayPal).

3.3.4 Function of platforms theory and concepts in this study

The artifact to be designed in this thesis, and the settings in which it will be deployed and the sort groups of users aimed at correspond to a multi-sided platform. Therefore, the aforementioned concepts and definitions are of use in the rest of this work.

3.4 User Centric Design

User-centered design (UCD) is to describe design processes in which end-users inputs shape the final design of the artifact; there is different ways in which users are involved in UCD but what is core is that users are involved somehow- typically during requirements gathering and usability testing or as partners, with designers throughout the design process – UCD is a philosophy in itself and includes several methods (Abras, Maloney-Krichmar, & Preece, 2004).

3.4.1 Foundation

UCD terms is first introduced Donald Norman in a co-authored book named: User-Centered System Design: New Perspectives on, Human-Computer Interaction (Norman & Draper, 1986). In later work recognizes the needs and the interests of the user and focuses on the usability of the, design offering four basic suggestions on how a design should be:

- Make it easy to determine what actions are possible at any moment.
- Make things visible, including the conceptual model of the system, the alternative actions, and the results of actions.
- Make it easy to evaluate the current state of the system.
- Follow natural mappings between intentions and the required actions; between, actions and the resulting effect; and between the information that is visible, and the interpretation of the system state (Norman, 1988, p. 188).

These set of recommendations place the user at center of design and are the foundation of UCD. Thus, the role of the designer is to make things easy for the user by designing the product in a way that there is minimum effort to learn how to use it (Abras et al., 2004).

Norman (1988, pp. 189-201) realized that telling designers to design seamless products was not enough; therefore he created 7 principles to facilitate the designer task:

3.4.1.1 Use both knowledge in the world and knowledge in the head. By building, conceptual models, write manuals that are easily understood and that are written before the design is implemented.

3.4.1.2 Simplify the structure of tasks. Make sure not to overload the short-term memory or the long term memory of the user. On average the user is able to remember five things at a time. Make sure the task in consistent and provide mental aids for easy retrieval of information from long-term memory. Make sure the user has control over the task.

3.4.1.3 Make things visible: bridge the gulfs of Execution and Evaluation. The user should be able to figure out the use of an object by seeing the right buttons or devices for executing an operation.

3.4.1.4 Get the mappings right. One way to make things understandable is to use graphics.

3.4.1.5 Exploit the power of constraints both natural and artificial in order to give the user the feel that there is one thing to do.

3.4.1.6 Design for error. Plan for any possible error that can be made this way the user will be allowed the option of recovery from any possible error made.

3.4.1.7 When all else fails, standardize. Create an international standard if something cannot be designed without arbitrary mappings

3.4.2 Function of User-Centric Design in this study

The main group of users we are designing the platform for are elder citizens and those who take care of them; as Balakrishnan, Salim, and Hong (2012) state there is a need to address the needs of the elderly in using Internet Technologies and account for potential functional impairments, virtual barriers of an elderly age group in using e-services. Thus, user-centric design is an input theory in this research. The principles presented above guide this task. User-Centric design as an input theory plays a crucial role in the design options that we make as a design team when the options are not sourced from data gathered during the research (i.e. workshops, interviews or surveys).

3.5 Theoretical framework

In this section we use key elements relate theories and concepts from the capability approach, platforms, social innovations and User-Centric Design.

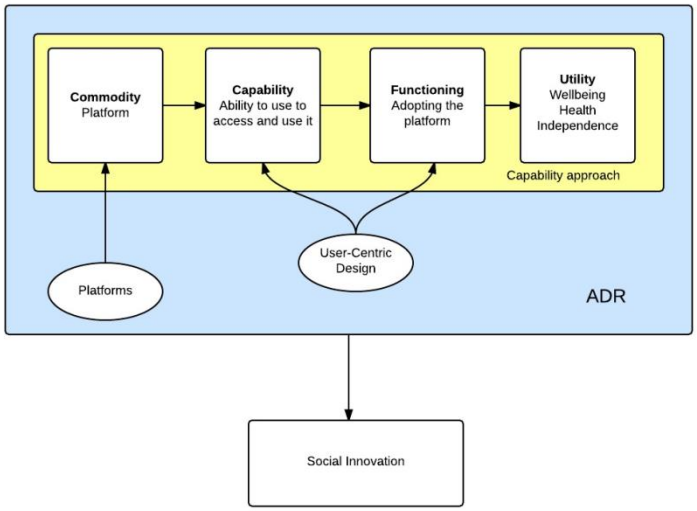

Figure 8: Theoretical framework

In this study we want to design a potential **social innovation** – recapitulating on the definition aforementioned, that is an artifact that serves as a proxy that helps us influence, motivate or activate social change that is lasting and benefits the public; from a consumer perspective the specific change is how elder citizens have opportunities to socialize (decrease isolation), more convenient basic health care tracking as well as access to good and services in the context of health and wellbeing. From a producer perspective is the creation of a more efficient model of delivering services and products in the same context of health and wellbeing. The main focus on this work however, is on the consumer side (elders).

The platform (**commodity**) to be designed offers a podium, or in our case again, resource of free choice to individuals (citizens who are end users) to achieve **wellbeing** – in this case, socializing, easily following a care plan, engaging relatives friends and caretakers in the process as well as a convenient marketplace for products and services seeking health and wellbeing. In the long run we are interested to improve the **capabilities** of those elders who could use this platform for their own wellbeing.

Since it is a MSP it has several constrains to be successful. One of the critical success factors is that it needs to be seamless (easy to navigate and access) – so usability is critical, that's why **User-Centric Design** is key in the design of the artifact with citizens who are end-users (elders and caretakers). Thus, the platform being 'easy' to use and access opens room for many potential users to have the freedom of choice to use it and to improve the **conversion factor** of the platform. Also, adoption is critical, and the importance of achieving **network effects** by reaching to a critical mass of users is imperative for a MSP success. Therefore, platforms considerations are considered throughout the entire design. For example, one of the requirements of the platform coming from previous research has to do with social activities or events hosted by different type of users, so such functionality is only relevant in the context of a critical mass of users that can create and join such activities/events.

We expect a long term impact and that sets a ground for our design choices, however the assessment of such impact is not in the scope of this work due to the timeline of this project; the scope is rather focused on early acceptance of the artifact being designed which is a necessary condition for long term relevance of the platform. In other words, we are interested in the end in improving capabilities of people as our social innovation, but we focus our efforts on the beginning of process to achieve early acceptance of the platform.

3.6 Function of the theoretical framework

Thus, in this thesis, the function of the theoretical framework is to structure and inform the design process, which is crucial when doing Action Design Research; drawing knowledge from a design exercise occurs in the "Reflection & Learning" and "Formalization of learning" stages- this gets materialized in a recipe on how to approach later a similar problem.

The theoretical framework also helps us in the operationalization of the design variables and the evaluation criteria of the artifact. That is, design variables in terms of components that we can control and tune, and the evaluation criteria in order to assess whether the artifact that is being defined is appropriate.

4 The Smart Living domain and Smart Living platforms

This chapter is an overview of the smart living domain and Smart Living platforms. It aims to have a deeper understanding of the domain and the state of the art of digital platforms in the same domain. The goal is to provide an overview of the domain of the selected case for our Action design Research. For that purpose, key authors have been chosen based on the input of current researchers in the topic at Delft University of Technology in the Netherlands on Smart Homes / Smart Living and platforms and based on initial findings and citations of those authors other work has been added as part of the overview. In the Smart Homes / Smart Living topic the key works reviewed in order were (Aldrich, 2003), (Chan et al., 2009) and (Gann et al., 1999). A literature review already performed in the domain of Smart Homes (Solaimani et al., 2013) was well guiding in this task for selecting additional work and identifying gaps. In the domain of Platforms for Smart Living the work done by Nikayin and de Reuver (2012) linked to other important work facilitating the finding of existing platforms in the domain as well as the possibilities for Smart Living realization from a platforms perspective. Lastly, the recent published PhD dissertation "Common Platforms Dilemmas" (Nikayin, 2014) as results of her research in the field was well guiding for understanding the Smart Living domain as a whole.

This chapter is divided in three sections. The first section covers the Smart Home/ Smart Living domain; key conceptual definitions are presented, and further, some challenges in the realization of the vision are introduced. The second section explores the state of the art in terms Smart Living (or Smart Homes) platforms, and the impact of these ones. Subsequently the last section presents the conclusions in the format of main findings and connection with our research.

4.1 Smart Homes / Smart Living

4.1.1 Definitions

In this review different definitions of Smart Homes have been found; what is immediately derived is that the concept is wide and its notion is determined by the lens of the author or their background (construction, eHealth, sustainability, etc). In the construction domain the Smart Home is viewed as a living environment that contains the technology to allow devices and systems to control it automatically (Hu, Wei, & Cong, 2013). Chan focuses the definition of Smart Homes to serve healthcare objectives: "Smart Home is used for a residence equipped with technology that allows monitoring of its inhabitants and/or encourages independence and the maintenance of good health" (Chan et al., 2009). Reinisch et al. referred to Smart Homes as the embedded automation with the promising effects of increased comfort, peace of mind and reduced energy consumption (Reinisch, Kofler, & Kastner, 2010). A more comprehensive definition that includes most of the elements aforementioned is the one by Aldrich: Smart Home is a residence equipped with ICT that can anticipate and respond to the needs of its occupants, for their comfort, convenience, security and entertainment by managing technology and connecting them to the world outside beyond their homes (Aldrich, 2003).

The Smart Homes concept has evolved for over 40 years; it went from domotica to more recently Smart Living (Solaimani et al., 2011). Smart Living can be defined as a bundle of ICT-enabled services made available to homes that can be accessed from within and outside aiming energy efficiency, surveillance, health and entertainment to facilitate comfort, so it differs from Smart Home definition as it goes beyond the household boundaries (Nikayin, 2014). Smart Homes and Smart Living are two concepts which marginally differ from each, however in the light of this work we will rather use Smart Living and adopt the definition of Nikayin (2014) .

The most mentioned goals of Smart Living are the wellbeing of the residents of the home, eldercare, security, entertainment and energy efficiency (Hu et al., 2013). The realization of this vision creates several possibilities for a more convenient and sustainable future.

4.1.2 Challenges for Smart Living realization

From the definitions aforementioned, the goals that Smart Living envisions are comfort, eldercare, security, entertainment and energy efficiency. With these goals in mind some of the impediments for their realization are stated.

Solaimani et al. (2013) arrived to important findings; they performed a literature review in the Smart Living domain arguing that in order for it to live up to expectations and fully enter the market, the domain has to grow more mature by working on a different set of elements, from both technological and non-technological nature. In the works analyzed they found that the technology domain is by far the most prevalent one in terms of scientific work with a great level of detail. However, non-technological elements have not had as much attention from Smart Living researchers; most of these issues are treated as side ones, mainly in a few publications. One could derive then that non-technological aspects of the domain are the ones that future research efforts should be focused on to reach the level of maturity that the Smart Living domain is currently lacking.

A set of challenges are provided from the literature regarding the "lag" in the Smart Living goals realization. In 2003, Aldrich stated that until that date although the concept of the "smart house" was well established by then only a small number of expensive "Smart Homes" had been built and sold in the market against the expected rapid diffusion. Other reasons for the slow uptake of Smart Home technology were also suggested; 1) the initial investment for end-consumer is high restricting middle/low class from access, also, even high income potential buyers need to be convinced of the benefits before acquiring (Gann et al., 1999); 2) suppliers have adopted a narrow "technology push" approach and paid too little attention to understanding the needs of users- consumers want systems which will help them with managing everyday tasks, offer labor saving and task simplification, ease of operation, remote control and cost reduction between consumer requirements and the products currently available – as an important point Meyer and Schulze suggested that suppliers need to win the acceptance of women, who still remain responsible for domestic tasks (S. Meyer & Schulze, 1996); 3) suppliers have not done much little to assess the usability of their products- although this is not an easy task because of the diversity of the potential users, the differences in context of these users user population, variation in the context of use, prior training necessary, and the challenge of investigating products not yet in existence (Barlow, 1997). 4) in terms of marketplace technologies and suppliers are still immature, consumers do not know of the products or are skeptical of the potential benefits and the industry is fragmented (no "one-stop-shop" provider supplying a full package of products) (Gann et al., 1999); 5) standardization in the industry is slow, the technologies are difficult to integrate interoperability (idem); 6) the pace of technological change is rapid. Lifestyles changes are also rapid, therefore new expectations or demands arise. Thus, it is clear the presence of elements both technological and non-technological in the slow uptake of Smart Living / Smart Homes in the market; the main issues identified are mainly of a non-technology nature strongly related to commercialization, market maturity and usability.

4.2 Platforms for Smart Homes / Smart Living

It is widely known that Information and Communication Technologies (ICT) play a crucial role in the development of any domain nowadays and will play even a more important one in the future; within the domain future generations of smart homes will be even more equipped with networked home appliances, smart power outlets, smart meters, smart sensors, among others (Kamilaris et al., 2013). The management of these is indeed an ICT task in the form of software controlling hardware,

and thus the importance of successful incorporation of ICT in the Smart Living domain for the realization of its goals.

In the context of digital platforms the vision of Smart Home / Smart Living is to anticipate and respond to the needs of its occupants, for their comfort, convenience, security and entertainment via ICT-enabled services driven by objectives of health, energy, security and entertainment services. The energy sector as an example has the governments paying special attention to smart metering and energy management services in households encouraging inhabitants to better control and manage their energy consumption, reduce their electricity bills and benefit the environment. In the health sector, increasing costs of healthcare and elderly care services triggered many healthcare service/products providers to seek new ways for delivering. In the same way, security service providers are also trying to utilize new communication technology and devices for more advanced security services. In general, Smart Living services are delivered to households through service platforms (Nikayin & de Reuver, 2012). Service platforms can be understood as a package of hardware and software and networks that host a set of core functions deployed by service providers to build, run and deliver value-added services to customers (Royon & Frénot, 2007). Consider a smart meter; this represents a good example of service platforms that are used for better energy efficiency within a house- thus, with extra technology in place such as sensors and mobile technology offer the potential for automation and liner user management of the household energy system leading to saving. However, even technology progress with advanced devices and mobile technology have enabled more flexible and advanced ways of service, Smart Living services are not commercialized on a large scale and there is still no customer base for the services (Peine, 2009). Collective action for developing common service platforms that cross traditional industries is needed to break the deadlock of Smart Living service innovation. (Nikayin & de Reuver, 2012).

Service providers from different sectors have become interested to offer smart home services. For example, energy providers are developing energy to better control consumption and reduce costs. In the healthcare area service providers are looking into facilitating independent living for the elders and disabled (Nikayin et al., 2011). Entertainment industries are also doing their job to have a place at 'home', consider Netflix[i] as a star entertainment venture. It is clear that different platforms are being offered, however restricted to one specific industry or sector.

As aforementioned, a service platform is a series of components including hardware, software, network, etc. required to offer its services. Such service platform usually includes several components required by the services running on that platform, and which those services would otherwise need to include themselves (David Sparks Evans et al., 2006).

Having platforms save resources for developers in writing applications on top of the platforms (D. Evans, 2009). From economic point of view, a platform creates a two-sided market in which the number of users influences service providers to develop services for the platform and on the other side users only pay for a platform with plenty of services on it (David Sparks Evans et al., 2006). Such multi-sided platform, "generally faces a critical mass constraint that must be satisfied if the business is to be viable", or colloquially known as the chicken and egg problem (David S Evans & Schmalensee, 2010). High speed internet and technologies like SOA (Service-Oriented Architecture) and cloud computing could allow service providers to share the generic functionalities that are required for multiple service offering (Nikayin et al., 2011). Such idea of sharing and making common development can facilitate the realization of a common service platform in the Smart Living domain, thus, the real challenge is far from purely technological anymore; it comes down to collaboration of different actors with different interests from multiple industries and sectors, and the usability of such artifacts.

4.3 Conclusions

Smart Living as a concept places itself in the context of healthcare, wellbeing, convenience, comfort as well as sustainability in the line of energy efficiency. Authors approach the definition using their background field lens, thus the variety and evolution of the concept over the years.

The Smart Home literature review main contribution on this study is to help understand the domain, its main challenges and how from a digital platforms perspective certain solutions can be conceived and designed for the realization of the Smart Living vision.

Several examples of platforms for the Smart Living domain were presented and studied showing that there is not quite yet a common platform that has been built across industries and sectors in the market. All successful examples are restricted to one specific industry or sector. Given the challenges of Smart Living realization of usability, fragmentation of the marketplace and skepticism of potential users the design of a multi-sided service platform could be explored with the objective of brining users and suppliers together in a “digital marketplace”. The ideal of developing a common service platform is challenge that lies ahead for the stakeholders in the Smart Living domain.

5 The design of the artifact

This chapter presents the process of an initial design cycle of the artifact. It contains elements from the stages in ADR of "Building-Intervention-Evaluation" and "Reflection and Learning".

5.1 Foundational requirements

As mentioned, this thesis builds upon a larger research group in the Smart Living domain. The first set of requirements for the platform were identified by (Keijzer-Broers et al., 2014). According to the authors the main purpose of the platform should be 1) an online community for contact, solutions, social wellbeing, interaction with the neighborhood and a digital marketplace for applications; 2) an information exchange platform, between providers and end-users (business to consumer), driven by the need for matchmaking between service providers and end-users; and 3) a portal for bundled, services and solutions (business to consumer), driven by the one-stop-shop, philosophy for 'ageing in place', where end-users can find all relevant applications in the smart living domain 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 health care and legislations.

These four general requirements although general and not detailed, are the foundation for our work which is the specification of the design of the artifact from the end-user perspective. Keijzer-Broers et al. (2014) makes a separation between providers (service and products) and end-users; this is useful when looking at a platform as a multi-sided market, however, given the scope of this work on focusing on one side of the platform (end-users who are citizens) we simplify into two initial requirements:

> ***Requirement 1*: online community;** *the platform shall be an online community for contact, solutions, social wellbeing, interaction with the neighborhood in the form of social activities/events.*
>
> ***Requirement 2: marketplace;** the platform shall offer 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.*

Note that the requirement 4) "an intervention instrument for the municipality (government to consumer) to get in contact with citizens about needs for services and questions about health care and legislations" is not included in the requirements above. The reason is that we consider this more of a goal than a requirement per se. Our final goal is to achieve a social innovation by the means of a digital platform; the platform being an intervention instrument is a goal in itself as part of such social innovation. This requirement though may have implications for specific requirement on one extra side of the platform (i.e. local government).

5.2 Critical design issues

Critical design issue (CDI) is a concept defined by (Faber et al., 2003) as "a design variable that is perceived to be (by practitioner and/or researcher) of eminent importance to the viability and sustainability of the studied business model". For our purpose we can re-use such concept and adapt it accordingly to our design efforts, therefore we can re-define it as a design variable that is

perceived (or identified by interaction with stakeholders) to be (by a practitioner and/or a researcher) of eminent importance to the viability and sustainability of the artifact being designed. CDIs set the foundation for further specifications of the artifact; they are key findings in the design process itself which are agreed by researchers/practitioners to be decisive or of crucial importance in the success of the artifact.

From previous research Keijzer-Broers et al. (2014) identified an initial set of critical design issues (CDIs) for the platform coming from strategic level stakeholders, affiliate level stakeholders and end users. The strategic level stakeholders were mainly concerned over how the platform could add value to different stakeholders for example in terms of business models and revenue generation. They were concerned about the collaboration among parties and how to reach a critical mass in order to create networks effects as explained in the theoretical framework of this work. This same group had little attention for the usability of the platform although they mentioned that easy access to the platform through multiple devices would be necessary. The affiliate stakeholders raised issues about the usability for the end-users or consumers of such a platform and how to deal with the chicken-and-egg problem to reach critical mass, again, to achieve network effects. They were skeptical about the revenues and collaboration between different parties, especially because of competitive considerations such as technical integration or free-riding issues. On the other hand they considered that such a platform could help them to reach customers in the domain. The end-users displayed high concern for the usability of the platform, safety and privacy, if the online platform, combines online with offline information (i.e., information about gatherings in the neighborhood) and finally if there would be a helpdesk for the platform.

From this previous work the CDI that we want to first highlight is the one regarding 'usability', Safety and privacy come also further in this chapter more in detail. The definition of usability from ISO 9241-11 (Guidance on usability) is "the extent to which a product can be used by specified users to achieve specified goals with effectiveness, efficiency and satisfaction in a specified context of use" (DIN, 1998). Thus, we use this definition to better specify our first CDI.

> ***Critical Design Issue 1: usability;*** *the extent to which the artifact being designed can be used by end users (citizens) in the context of health and wellbeing.*

When linking requirements 1 and 2 identified above with usability in the artifact, one can foresee already different options offered for the end-user on which to navigate around. Thus, if the ease of use of the artifact is a condition within a multi-option setting a 'seamless navigation' requirement emerges:

> ***Requirement 3: seamless navigation****; the artifact shall ensure smooth and simple navigation.*

This is to enable users to choose from a small selection of options to visit for simplicity. Provide clear labels for the pages where navigation tabs take the user. It should inform the user where in the platform he/she is and how to go back to the main page. According to (Leavitt & Shneiderman, 2006)

5.3 New critical design issues and new requirements

As part of the Living Lab setting, through two workshops performed during February and March of 2015, two new critical design issues were identified.

The first workshop agenda contained three key points: recap on requirements identified and critical design issues, a brainstorming exercise for indentifying new requirements/CDIs and an open discussion to elaborate and zoom-in into those. There were in total four participants from the Living setting and the ADR team, including two SMEs (Small Medium Enterprises) representatives, one from an eHealth solutions company, and the other one from an ICT developing firm.

I facilitated the workshop with the leading question of "as an end-user (citizen) what should I be able to achieve in the platform?"- we handed out a "personas" description (See appendix X) which was used by Keijzer-Broers et al. (2014) describing different type of potential users; the purpose of personas is to create reliable and realistic representations of a key audience segments for reference based on based on qualitative and some quantitative user research[3]. All participants individually spent around 15 minutes on it and took their own notes, and then it was socialized as a brainstorm exercise. Furthermore after categorizing all ideas, an open discussion took place which brought all the previous work and derived into important outcomes. A key outcome was a set of new CDIs.

The first CDI is ***trust***; it 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 consumers and providers of products; from the UCD literature (Urban, Sultan, & Qualls, 2012) we found that a common practice to create 'trust' is to provide thorough information (e.g reviews and ratings) and moderation. Thus, based on the workshop participants' input and the literature we derived two requirements. The first requirement is a rating and review mechanism for products and services offered in 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 in the platform) to present the feedback to other users in order to reduce the customer's 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 offered; this requirement also enhances confidence in the platform by supporting dispute resolution and mediation services between consumers and providers.

> ***Critical Design Issue 2: trust;*** *it is built in a three-stage and cumulative process that establishes (1) trust in the online landscape and the specific website or application, (2) trust in the information displayed and (3) trust in delivery fulfillment and service. These definitions have been given by Urban et al. (2012) and match our findings.*

The second CDI derived is ***user data privacy***; mentioned already in previous research (Keijzer-Broers et al., 2014) this CDI implies that there should be a clear separation between 'social' data in the context of the platform and the data (e.g., medical) that must remain private to the user or those who are authorized (i.e., care takers, relatives). It was of common agreement among all participants this consideration. Next to that, the data privacy policy of the platform should be concise and transparent to create trust related to the platform; also from the literature we found that also trust can be enhanced by ensuring user data privacy- users increasingly demand that their personal data be kept private and they want to be clear about these policies (Urban et al., 2012). Thus we specify:

> ***Critical Design Issue 3: data privacy;*** *concerns the level of protection of the data as well as what makes part of a private and public profile.*

[3] http://www.usability.gov/

Requirement 4: rating and review mechanism; *the platform shall allow reviews of products, products providers, activities and activities providers. A rating system should be in place that allows consumers of products/service give a rating plus a qualitative feedback.*

In addition, during the workshop during the open discussion the participants discussed what would be critical functionally speaking in the platform to attract users and make it relevant for them; thus, the concept of a 'careplan approach' was brought up by the representative of the eHealth solutions company- he argued that this should be a driver in the platform. Careplan can be understood as an agreement between the patient and health professional (or social services) to help manage the health day to day[4]. The concept was of general consensus based on his experience. In the context of the artifact it refers to a 'homepage' where items like the user health goals, key contacts, list of prescribed medicines, eating plan, an exercise plan, agenda are displayed. In other words, the careplan constitutes the foundation of the 'home' of the artifact from an end-user perspective. Thus taking this as key input the design process we divided the careplan approach into two elements which are tracking and tasks, and we added essentials from the UCD literature regarding number of clicks and easy accessibility (Urban et al., 2012). Thus we derive two functional requirements:

Requirement 5: diary management; *the platform shall offer a diary for the end-user- a log in which the user (or someone else on the user's behalf) keeps a daily record of events and experiences shall be in place. The access to such diary should be in as few clicks as possible and always visible from the home page of the platform.*

Requirement 6: tasks management; *the platform shall offer a task manager mechanism for the end-user, on which the user itself (or someone else on behalf of the user) can introduce and manage tasks related to the health/wellbeing of the user.*

During the same discussion in the first workshop, and further elaborated in the second workshop an additional point the participants touched upon was the implications of the 'data privacy' CDI and the 'online community requirement' , and inputted that there was a need to separate the type of 'contacts' a user should have in the platform. Such separation should be clear for medical/personal data and social data. Thus we took initial description on the work of Keijzer-Broers et al. (2014) description of contacts as part of the 'online community' requirement and derived another requirement:

Requirement 7: contacts management*; the platform shall contain a module for contacts management. These should be divided into two different categories (1) Social Contacts and (2)*

[4] http://www.nhs.uk/Planners/Yourhealth/Pages/Careplan.aspx

Special Contacts. A messaging functionality between users should be added as part of the contacts management mechanism.

Zooming-in into this requirement and using familiar design patterns of successful IT platforms or it specification, social contacts refer to 'friends' or list of trusted contacts to which the user can interact with in the platform. The user should be able to create their own list of social contacts, by adding or removing contacts. The artifact shall provide a functionality in which the user can search for new contacts using basic data such as name, surname or e-mail address. Contacts requests are sent and these are approved by the user; when approved this user becomes part of the social contact list. A user should only be able to message each other only if they are part of their contact list previously approved. Special contacts are close contacts that can see full profile, act in the platform on the user's behalf. The artifact should offer a set of permissions for the different options (edit profile, read medical information, edit medical information, or diary).

5.4 ADR team work

The ADR team is composed by practitioners (those designing the artifact) but also as researchers (those drawing knowledge from this process). In total 6 people are part of the team including one security expert, one front-end developer, two entrepreneurs, the research leader and myself as the design leader. Along with the front-end developer and the research leader we worked on putting all the pieces together of this research and formalizing the outcomes in terms of the artifact and the academic part.

As part of this work, I attended a startup weekend in Berlin in March 2015 organized by the Impact Hub[5]. The idea was pitched in front of 70 people including a jury of experts on social innovation. The main input given was that this idea needed validation all throughout, from the concept to its launch. An initial mockup was shown to the jury and it was suggested to immediately validate it with elders who would be potential end-users. Although we were aware of early validation and inclusion of potential users, this meant that the validation should happen earlier than we anticipated. Thus, a lightweight validation exercise was performed with a couple of potential end-users (75+); we presented our initial mockups (Figure 9: Zo-Dichtbij home) to with them to check whether all the elements were clear. Without any help of the ADR team, these elderly could give a good description of what the platform's purpose was. They came up with helpful suggestions on how to improve the mockups and they even suggested extra features like integrating video-audio contact with relatives and caretakers- although this suggestion is not considered as a functional requirement at this stage, we do take it into account for the future development of the platform.

Another important aspect of the work is the research and usage of previous work that can help us design a successful artifact, in this case user-centric design as aforementioned plays a huge role as well as the usage of familiar design patterns of successful IT artifacts. In this effort some relevant guidelines were found to include in our design which translated into requirements. This has to do with the main target group of this artifact: aging can be seen to cause vision impairment in various forms such decreased visual acuity, decreased contrast sensitivity, difficulties with glare (harsh light leading to discomfort) and low ability to focus- the potential design solutions as suggest are to improve illumination, provide user interface options (Pattison & Stedmon, 2006); thus as UCD input we applied to the specification of our artifact. We also consider that for an aging population there may be more impediments in terms of using digital artifacts, therefore a "guided-tour " if needed should help them in using the platform. Thus, we derive the following requirements:

[5] http://www.impacthub.net/

Requirement 8: text and buttons; *the platform shall offer texts/buttons in a size that is readable for levels impaired vision. Buttons for menus shall contain text and image related to the function. Buttons shall contain an audio option that by hovering "speaks out" what it does and displays a text.*

Requirement 9: help; *the platform shall offer a functionality which can guide the user though the different menus and options. This guided tour through the system is available by default but it is optional. The user may decide to disable it. The help should be offered in text as well as in audio; this is when the help is offered an additional clickable icon is available to hear the text embedded.*

5.5 Mockups

The ADR team elaborated further on the suggested features to visually represent them in a mockup from the perspective of an end-user (Figure 9). Additional User-centric design principles were considered in this effort such as visual hierarchy, simplicity and usage of design patterns from successful IT artifacts (e.g., Facebook, google calendar) during the design of the mockups. In addition to this, consistency; users need to know that once they learn to do something, they will be able to do it again. Language, layout, and design are just a few interface elements that need consistency. A consistent interface enables users to have a better understanding of how things function increasing their efficiency (Leavitt & Shneiderman, 2006). The following mockup tries to include those principles. This is an example that represents the view of an informal caretaker responsible for an older person (i.e., Annie). This is illustrated in the top bar of the mockup where it is shown on whose profile the user is acting, self (My home) or some else's (Annie's home).

The following elements help us describe the mockup and show how it meets our requirements:

(1) The left menu gives access to the three main features earlier identified as requirements, such as contacts, activities and smart living products and services (requirements 1 and 2; online community and marketplace; and requirement 7 of contacts management).

(2) The agenda; this contains the tasks assigned to the user (i.e., Annie) given by a doctor, caretaker or relative (or any other user with the 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 left menu) as part of her social agenda (Requirement 6 of tasks management and requirement 1 of online community activities and events requirements).

(3) The diary; this keeps a record of events, observations and experiences of Annie so others can have a traceable log of Annie's health and wellbeing. This comes from the careplan approach (requirement 5 of diary management).

(4) Insurance and medical info; this contains the insurance policy file of Annie and other medical information that is important for Annie and those surrounding her. This is a space yet to be defined in the next design cycle where the medical and insurance information gets defined.

(5) The bottom notification section; this reminds the user to complete the profile (so relevant social activities can be suggested for Annie) and to review products and services acquired (in order to present the feedback to other users and to reduce the customer's perception of risk with the platform when purchasing products and services. Requirement 4 of rating and review mechanism).

(6) The help option (top-right) provides the user the option to enable a guided tour mechanism (requirement 9 of help).

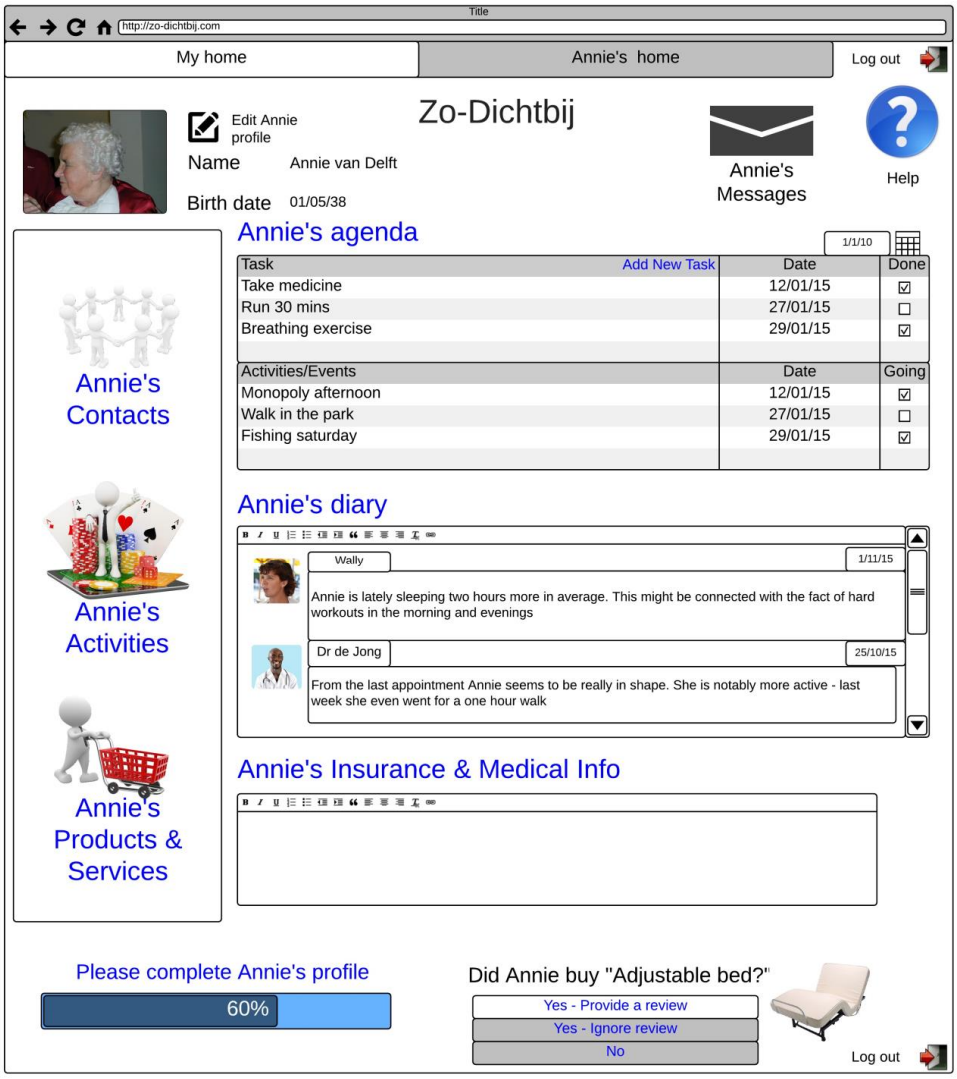

Figure 9: Zo-Dichtbij home

5.6 Evaluation of the artifact

5.6.1 Introduction

Two important considerations when conducting usability testing are (1) to conduct a test where representative participants interact with representative scenarios and (2) to ensure that an iterative approach is used. After results are provided to designers, changes are performed and then the artifact should be tested again. Data on the participant's success speed of performance, and satisfaction is collected. This data is both quantitative data and qualitative and are incorporated in a test report (Leavitt & Shneiderman, 2006).

Leavitt and Shneiderman (2006) suggest that early in the design process, the usability testing should be performed with a small number of users (approximately six) in order to identify problems with the information architecture (navigation) and overall design issues. If the artifact has different types of users (e.g. beginners and experts) then six or more tests should be executed with each type of user. Once the navigation, basic content, and display features are in place, quantitative performance testing (measuring times, wrong pathways, failure to find content, etc.) can be conducted to ensure that usability objectives are being met. To measure each usability objective to a

particular confidence level, such as ninety-five percent, requires a larger number of users in the usability tests.

The first usability test was laboratory-based testing, which means the tester and participants were in the same physical location. The usability test intended to determine the extent that Zo-Dichtbij user's interface facilitates a user's ability to complete key tasks performed in the artifact. This was conducted with a group of six potential users a usability lab. Users were asked to complete a series of tasks with an end goal that are derived from the functional requirements identified (i.e. Diary management -> Create entry in the diary) (See details in APPENDIX A). The sessions were recorded and minutes were taken to identify critical areas for improvement to the artifact.

5.6.2 Methodology

The first six participants were recruited using our professional networks. The criterion was to select users who were formal/informal caretakers, senior elders who were internet users and a relative of elders. The ADR team invited the participants in different time slots for two different days.

Based on the Mockups a clickable model was provided (See Appendix C) for the participants to perform the tasks. Each individual session lasted approximately 25 minutes. During the session, the ADR team explained the test session, gave a brief introduction of the objective of the test and asked the participants to fill out a brief background questionnaire (see Appendix A). Afterwards, the ADR team read-out loud one task at a time and took minutes and time of how the participants performed. After the tasks a post-test survey was provided to the participants (see Appendix A).

5.6.3 Results

Figure 10: summarizes the usability test tasks along with the criteria set. These tasks are related to the three functionalities described in the mockup for which a clickable model was developed in this first iteration. Our benchmarking norm is 5 out 6 successful tasks by the participants as suggested by Leavitt and Shneiderman [26]. As a result only one task ('Create an entry in the diary') didn't fulfill the completion criteria, and two ('Create an entry in the diary' and 'Join activity') the time criteria. The diary concept/functionality in the artifact was not clear for everyone and needs to be revisited and enhanced; participants were unfamiliar with the type of text input that we offered.

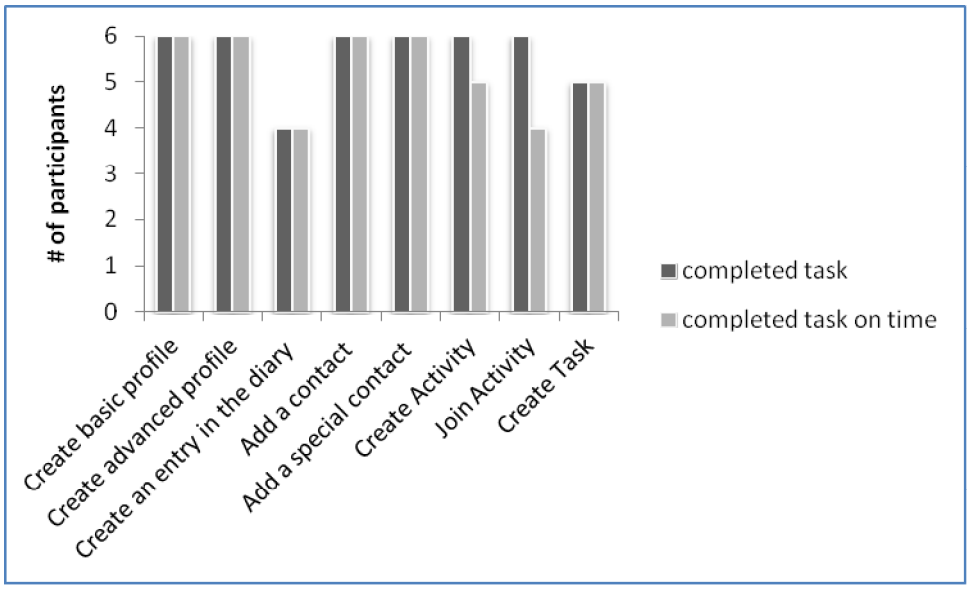

Figure 10: Usability tasks and criteria (N=6)

In a post-test survey participants were asked whether they would use/recommend the platform as well as their satisfaction with their experience; all the participants (6/6) agreed that they would use or recommend the platform if available and 4 out of 6 participants rated 4 or 5 in a scale of 1 to 5 the user experience of the artifact. The prototype tested was a simple HTML model with no efforts on visual design as yet. Participants also provided qualitative input during the usability test. Font and images size, simplicity and structure of the artifact were praised; whereas specific functionalities as the diary were suggested for improvement.

5.7 Reflection and learning of the design of the artifact

The main steps in the process of the design of the artifact version shown sequential (Figure 5) it has been rather iterative; especially in the construction of mockups and the work of the design team when trying to include previous academic research into the design, outcomes from the workshops, evaluations as well as experience our own experience as IT practitioners.

Following Action Design Research reflection learning stage some insights are drawn at this stage. Early acceptance of the platform is critical in this research; therefore the results given by the usability test suggest that the right steps are being taken during design stage. Using familiar patterns when designing a prototype helps potential users to feel more acquainted with the artifact. This is also applicable for the consistency in the navigation and other elements of the interface. Preparing a clickable interactive model for a usability test is a much smaller effort compared to the one when a fully functional artifact is provided, however the effects of testing can be comparable. Although the participants are not provided yet with a full experience, the test can be designed in a way that really evaluates critical elements of the artifact based on the tasks and goals given to the participant creating the 'feeling' a finalized artifact. Therefore, the approach taken in this iteration for the evaluation of the design of the platform is suggested for next iterations. These evaluation moments are part of the iterative design steps of the overall ADR project. We have learned few important points in this design effort so far: (1) to collect requirements for the artifact and prioritize the critical design issues is key. (2) involve the end-user in the design process to validate and evaluate the artifact from the very beginning has been a critical success factor for acceptance (of the prototype), which is pre-condition for acceptance of the final artifact and (3) using familiar patterns when designing a prototype help potential users to feel more acquainted with the artifact.

6 The impact of the artifact

This chapter builds on the main outcomes of the previous one and develops further the artifact. It starts with an additional and highly important evaluation of the artifact through analysis of a survey. Then it is followed by the new requirements identified and a new version of the main home page (prototype) is presented. By contrast to the previous chapter the evaluation is at the beginning- this time it is regarding of the artifact's potential impact for improving the capabilities of the elders- or in other words, we showed the artifact to a key group of end users (voluntary caretakers) and then evaluated whether it suffices the criteria for improving the capabilities.

6.1 Survey

The ADR team prepared a survey consisting of 28 questions (See Appendix B). Since this survey serves the purpose of a much larger research, only few questions were selected for the analysis that have to do with identification or validation of requirements, as well as the potential impact of the artifact at hand as a mean for social innovation – the questions selected for the analysis were questions 1, 2, 3, 24, 25, 26 and 28; basically demographics in order to understand the characteristics of the group of respondents, and the questions regarding the digital platform section in order to evaluate the current design of the artifact. Table 2 explains the rationale of the questions selected.

Question	Rationale
24. Who will benefit from the platform	Identification of stakeholders or key groups of end users that would benefit with the platform according to the voluntary caretakers.
25 & 26 Which elements/features would be important on the platform	Exploratory questions to identify features that were not yet defined as requirements, but that we considered could be included, as well as the validation of previous requirements/features.
28. The platform would help me with	Evaluation of the potential impact that the platform could have among the voluntary caretakers

Table 2: Survey questions selected

The survey was sent to different groups of people including a key stakeholder group in this research which are voluntary caretakers. These individuals were reachable via the Tympaan institute[6] which is a research organization in South Holland in different social domains, ranging from youth and culture, through care and voluntary participation for better quality of quality of life. In this chapter we call these voluntary caretakers as 'caretakers'. The main reason for us to send the survey to such group of people is that according to our contact at Tympaan institute the potential respondents (401 in total) were mainly elders with an average age of 71 years who all provided voluntary care for other elders. Thus, this target group could give us more insights regarding the features to include in the artifact design as well as to help evaluate the first version of the artifact.

The outline/structure of the survey followed a certain structure. We first asked some basic demographics such as gender, country of residence, age and occupation; followed by a set of questions regarding the sort of family and household situations such as children, number of people living their households. These questions were followed by some regarding caretaking and spent time on it plus the conditions of the person(s) they take care of. Then, a set of questions regarding advice, products, services around health and wellbeing were asked. The last set of questions are the ones we analyze in this work; they have to do with the artifact that we are designing here, regarding its requirements, features, and foremost in this chapter, its potential impact though its evaluation.

[6] http://www.tympaan.nl/

Our survey (online) was sent in April 2015 to a total of 401 people with a total response of 152 (38% response rate), 54% female (82) and 46% male (68). All respondents come from the Netherlands. The average age of the respondents is 71 years with a standard deviation 8.78 years, 75% of our respondent are older than 66, which is an age that falls within the range of a key target group to benefit from the platform; in other words they are potential end-users who could benefit from the artifact directly, and also help others benefit from it (those who they care of) - Figure 11 is a bloxpot that displays the suitable distribution of age for this part of the research. Although there is not a population (that we are aware of) for us to test representativeness of this sample, the characteristics of the group surveyed fit well into key a target group of end-users (elders and voluntary caretakers).

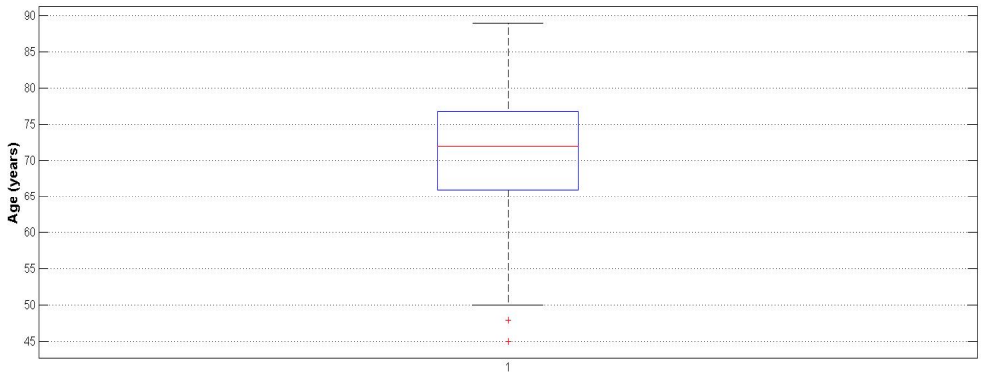

Figure 11: Boxplot age of survey respondents (N=152)

6.2 Who will benefit from the platform?

This is a question we asked regarding whom would benefit using the platform (stakeholders). In a 7-points scale the average of all items got a score above 4. The one sample t-test (95% confidence interval) for value 4 shows that all suggested end-user groups would somehow benefit from the platform (See Table 3).

Statistics				Test value = 4		Test value = 5	
Variable	N	Mean	Std. Deviation	Sig. (2-tailed)	Mean Difference	Sig. (2-tailed)	Mean Difference
Citizens in general	128	4.71	1.883	.000	.711	.085	-.289
Young elderly (55 - 75 years old)	128	5.17	1.517	.000	1.172	.202	.172
Elderly (75+)	126	5.22	1.971	.000	1.222	.208	.222
People with physical disabilities	123	5.44	1.685	.000	1.439	.005	.439
People with mental disabilities	125	4.90	1.932	.000	.904	.580	-.096
Product providers	120	4.67	1.853	.000	.667	.051	-.333
Service providers	120	4.90	1.826	.000	.900	.550	-.100
Voluntary caretakers (relatives included)	133	5.94	1.353	.000	1.940	.000	.940
Volunteers	124	5.81	1.480	.000	1.806	.000	.806

Municipality (Social Act Care)	122	5.41	1.840	.000	1.410	.015	.410

Table 3: Descriptive statistics and one sample t-test for question "Who will benefit from the platform?

Considering 4 (test value = 4) as the neutral value in the scale from 1 to 7, then anything above 4 can be considered as a positive perception among respondents that the artifact will somehow or strongly benefit the given group of stakeholders. However if we consider anything above 5 (test value = 5) to be of strong benefit, then we see that after performing the same statistical test can see that People with physical disabilities, Voluntary caretakers (relatives included), Volunteers, Municipality (Social Act Care) would 'strongly' benefit from the artifact. Citizens in general and service providers are seen as the group of people who would benefit the less from the artifact; thus we could see that the design as seen by the voluntary caretakers benefit themselves the most. The analysis tells us that the design meets the criteria of targeting its main group of end users (Elders and those around them). Table 4 shows also this in ascending order of according to our respondents of who would benefit the most. Or in other words applying our theoretical framework, whose capabilities can improve the most by using the platform.

Stakeholder	**Average score**
Product providers	4.67
General Citizens	4.71
Service providers	4.90
People with mental disabilities	4.90
Young elderly (55 - 75 years old)	5.17
Elderly (75+)	5.22
Municipality (Social Act Care)	5.41
People with physical disabilities	5.44
Volunteers	5.81
Voluntary caretakers (relatives included)	5.94

Table 4: Benefited stakeholder and average score (N=152)

6.3 Which elements of the platform would be important?

As it can be seen here there are few features that have not been mentioned neither in the previous chapter nor in the previous research that this work builds on. This constitutes an exploratory set of features on which we validate design options that we consider may be important but before including in the specification and prototype we should validate our assumptions. Table 5: Descriptive statistics and one sample t-test for question "Which elements of the platform would be important? presents the results of statistical testing on which we test whether the results are significantly above 4 (as the neutral value) or 5 (as a high value).

Statistics				**Test value = 4**		**Test value = 5**	
Variable	N	Mean	Std. Deviation	Sig. (2-tailed)	Mean Difference	Sig. (2-tailed)	Mean Difference
Marketplace products and services	115	4.34	1.942	.064	.339	.000	-.661
Careplan (medical information and insurances)	124	5.48	1.679	.000	1.476	.002	.476
Agenda for social and	122	5.27	1.505	.000	1.270	.049	.270

medical activities							
Personal profile	118	4.64	1.856	.000	0.644	.039	-.356
Review possibilities product and services	116	4.70	1.761	.000	.698	.067	-.302
Finding local activities	122	5.44	1.455	.000	1.443	.001	.443
News about health and wellbeing	122	5.58	1.425	.000	1.582	.000	.582
Diary (to share with relatives and caretakers)	125	4.78	1.899	.000	0.784	.206	-.216
Anonymous use	125	5.31	1.977	.000	1.312	.080	.312
Available for different devices (mobile, tablets)	125	5.27	1.948	.000	1.272	.121	.272
Private and secured	126	6.39	1.277	.000	2.389	.000	1.389
Search based on keywords	123	6.06	1.308	.000	2.057	.000	1.057
Local search (postal codes)	124	5.26	1.724	.000	1.258	.098	.258
Multilingual	121	4.31	2.058	.096	.314	.000	-.686
Helpdesk online	122	5.46	1.745	.000	1.459	.004	.459
Telephone helpline	122	5.63	1.697	.000	1.631	.000	.631

Table 5: Descriptive statistics and one sample t-test for question "Which elements of the platform would be important?

In addition, Table 6 shows the averages of the score given by the respondents for the question in ascending order for us to identify those of more importance with previous analysis with the statistical test.

Feature	**Average score**
Multilingual	4.31
Marketplace products and services	4.34
Personal profile	4.64
Review/rating mechanism	4.70
Diary (to share with relatives and caretakers)	4.78
Agenda for social and medical activities	5.27
Available for different devices (mobile. tablets)	5.27
Anonymous use	5.31
Finding local activities	5.44
Helpdesk online	5.46
Careplan (medical information and insurance)	5.48
News about health and wellbeing	5.58
Telephone helpline	5.63
Search based on keywords	6.06
Private and secured	6.39

Table 6: Which elements of the platform would be important (N=152)

Hence, given these results we find that private and secured it is a confirmation of the Critical Design Issue that we identified previously (data privacy)- it is the top feature of importance for the caretakers, and it is significantly greater than 5 from the statistical test. Availability for different devices has been part of the conversation in the Living-lab setting as well as in the design team; thus,

this confirms our initial assumption of the need of a multi-device platform, hence we derive the following requirement:

> ***Requirement 10: multi-device/platform availability;*** *the artifact shall be available for multi-devices and platforms that are most dominant in the market (web access, IOS, Android).*

The platform being designed is targeted for elders in general- our research has been specifically targeted to a Dutch public- regardless, we asked in the survey regarding the need for multilingual features but it is of low importance at the moment- therefore we do not add this as a requirement.

News about health and wellbeing should be an integrated feature in the platform rated of high importance by the caretakers; thus we derive the following requirement:

> ***Requirement 11: news about health and wellbeing;*** *the artifact shall offer a channel or feed of noteworthy information around health and wellbeing targeted to the different groups of end-users, especially the elders.*

In the survey we have also explored the possibility of a feature of search based on keywords with a high confirmation from caretakers scoring 6.06 in average and also significantly above 5, therefore the following requirement:

> ***Requirement 12: search based on key words;*** *the artifact shall offer a type of search that looks for matching elements that contain one or more words specified by the user. In the context of this platform the it shall offer one input box in the main page and allow to retrieve elements like contacts, activities, documents (i.e. insurance policy), products/services.*

The question also explored the need and preference for a more personal support channel in the platform when there are questions or inquiries. Both helpdesk online, telephone helpline scored 5.46 and 5.63 respectively and both significantly above 5, meaning a strong preference for such functionality. We can derive the following requirement:

> ***Requirement 13: virtual helpline and telephone helpdesk;*** *the artifact shall offer a link / contact information to reach out a telephone helpdesk. In addition, the artifact shall offer a live chat functionality that allows the users contact via-chat.*

The Careplan (medical information and insurances) is already described in the previous chapter. The requirements 5 and 6 respond to it in the form diary and tasks management. However the medical and insurance feature required extra validation with users at that stage; we have just done

this in the survey, therefore a new requirement will be specified. The diary bit is confirmed as a requirement although not strongly. Thus we derive the following requirement:

> ***Requirement 14: medical and insurance information;*** *the artifact should offer a mechanism to upload and easily retrieve file(s) that contain insurance policy and medical information of the main targeted users.*

The results presented also confirm the feature already included in our initial requirements for local activities, scoring in average 5.44 and also significantly above 5. Last, marketplace products and services is rather a functionality that the caretakers do not consider of high importance; they may not see the link between seamless access to products and services and the improvement of capabilities.

The following mockup (Figure 12) builds on the one presented in Figure 9 in section 5.5. This is a version that has emerged by the identification of new requirements introduced in this section as well as the main outcomes of the usability test performed and described in the previous section.

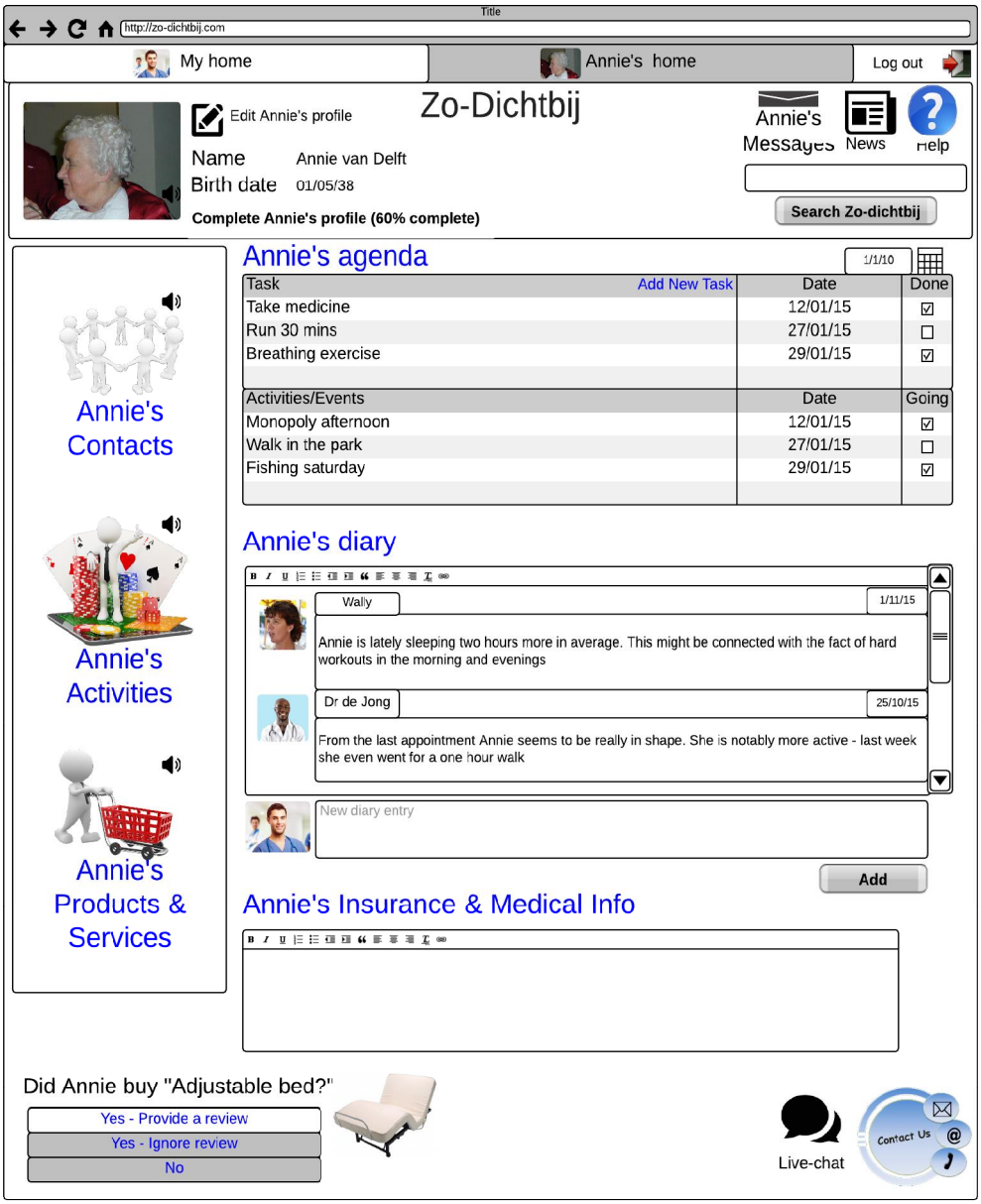

Figure 12: Zo-Dichtbij home version 2

The new requirements identified are reflected into the new options in the home page. Requirement 11 is a link that takes the user to a feed of news and information regarding wellbeing and health (see top right set of icons). The requirement 12 is also reflected in the home page (top right search option) and takes the user to a list of elements by category (contacts, activities and product/service). Requirement 13 is also accessible from the main page bottom right option. Requirement 14 is visually already present there since the artifact version presented in section 5.5.

Regarding an important outcome of the usability test, earlier we mentioned in 5.6.3 that the new diary entry was not clear enough, thus, we applied a familiar pattern (Twitter[7]) as a principle of User-Centric design to make it clearer for the user; please see the button 'Add' under 'Annie's diary' along with the text box, this allows the user to enter a diary entry directly in the home page. Last, the progress bar of profile completion was moved to the top next to the profile info itself and adjusted to text as suggested a by a visual designer who looked into our mockup- the reasoning was that it was

[7] https://twitter.com/

taking more space than needed and it should be placed somewhere where it relates to its main function.

6.4 Capabilities and the artifact

As part of the survey in the last part, after we showed the caretakers the initial mockup of the home page we made a key question which would tell us a lot regarding our process design and the ultimate objective of this work: design an artifact that could potentially be a mean towards a social innovation. The question was 'the platform would help me with?'; we tap a set of 'capabilities' that we considered as the objectives that the artifact was designed for, and had the caretakers to rate each capability from 1 to 7 with the same logic as the previous questions. The set of capabilities along with its average score sorted in ascending order are displayed in Table 7.

Capability	Average score
1. Arrange daily schedule	4.37
2. Help others in an easy way	4.75
3. Filter local demand and supply	4.77
4. Add extra comfort at home	4.77
5. Improve interaction with others	4.80
6. Share a care plan with others	4.85
7. Unburden myself or others	4.93
8. Monitor my relatives	5.02
9. Be social involved	5.12
10. Live in a comfortable way	5.16
11. Avoid moving to another place	5.34
12. Find information about health and wellbeing	5.48
13. Age in place	5.57
14. Stay independent as long as possible	5.72

Table 7: Capabilities and average score (N=152)

Although all of the average scores are above the neutral value of 4, a one sample t-test is performed to determine whether all capabilities are significantly greater than 4. After performing the test the only capability that is not significantly greater than 4 is '1. Arrange my daily schedule'. Then in theory this would reduce our set of capabilities down to 13. Then, in order to better interpret this in terms of potential impact, we performed an exploratory factor analysis (principal component analysis) to reduce the dimensions and tap the meaning of these capabilities to a much simpler message, or statistically speaking in terms of latent variables. Thus, a principal component analysis was conducted on the 13 'capabilities' selected. The Kaiser-Meyer-Olkin (KMO) measure verified the sampling acceptability as superb (Field, 2009), KMO = 0.92; in addition all KMO values were > 0.85, which is well above the acceptable limit of 0.5 (idem). The rotation varimax method was chosen since it simplifies the interpretation of factors; it is used to simplify the expression of a particular sub-space in terms of just a few major items each (idem). An initial analysis was run to obtain eigen values for each component in the however the output had 4 elements strongly loading in the two the two final components as shown Table 8 that makes the separation unclear.

Rotated Component Matrix		
	Component	
	1	2
1. Unburden myself or others	.824	
2. Improve interaction with others	.813	
3. Help others in an easy way	.788	
4. Find information about health and wellbeing	.768	.419
5. Filter local demand and supply	.749	
6. Be social involved	.728	
7. Share a care plan with others	.671	
8. Monitor my relatives	.641	.515
9. Add extra comfort at home	.617	.577
10. Age in place		.918
11. Stay independent as long as possible		.916
12. Avoid moving to another place		.872
13. Live in a comfortable way	.507	.736

Table 8: Rotated component matrix varimax rotation

Since the varimax rotation method did not provide a clear output in terms of the two components found, we changed the method to direct oblimin- the output of this method was clearer in terms of separation of the components – this output still had one element with strong load on both components (Monitor my relatives) – therefore we proceeded to remove it from the analysis. Table 9 shows the final components with the respective loadings.

Pattern Matrix	Component	
	1	2
1. Be social involved	.750	
2. Improve interaction with others	.872	
3. Unburden myself or others	.822	
4. Arrange daily schedule	.987	
5. Find information about health and wellbeing	.693	
6. Filter local demand and supply	.697	
7. Help others in an easy way	.783	
8. Share a care plan with others	.631	
9. Live in a comfortable way		-.665
10. Avoid moving to another place		-.897
11. Age in place		-.979
12. Stay independent as long as possible		-.972

Table 9: Pattern Matrix direct oblimin rotation

Thus, by reducing the set of capabilities analyzed into two components we can label these two new components. The new labels given are words that substantively encompass those items that have 'heavy loads' into the new components. Figure 13 shows graphically the process we performed. According to the caretakers' answers, the artifact's main impact is on two capabilities namely (1) socially inclusive active aging and (2) independent and comfortable aging in place.

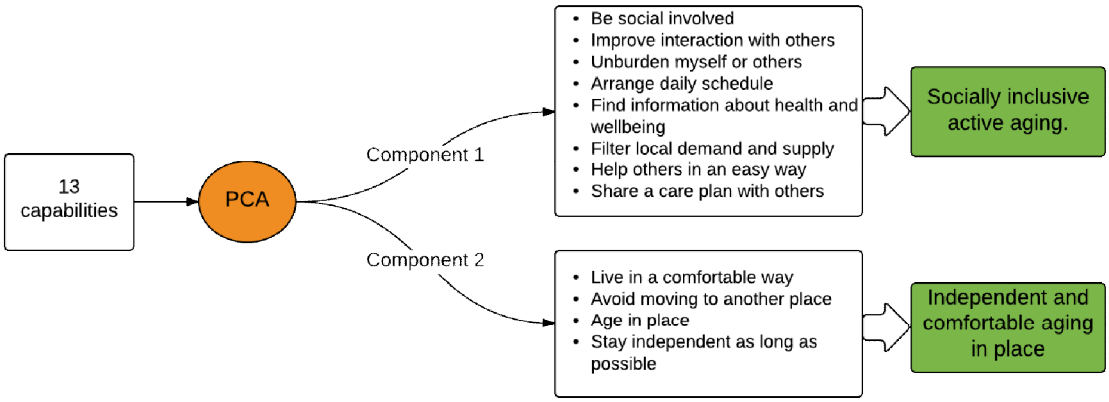

Figure 13: Dimension reduction (Principal Components Analysis)

6.5 Reflection and learning of the impact of the artifact

Once again applying Action Design Research reflection and learning stage and principles, some insights are drawn in this chapter.

The feature of marketplace has 'neutral-low' demand from the voluntary caretakers. This was a requirement previously identified but that in the survey is almost neutral. Perhaps, in their view there is a disconnection between improvement of capabilities and the access to a marketplace functionality; however this assumption is suggested to be explored in future research. The marketplace feature as a matchmaking mechanism between end-users and service/product providers may not be clear, so future work in the design should make clearer how a seamless access to products and services can help to improve the overall capabilities that the platform may improve. The Multilingual feature is important from a practitioner perspective to reach to more users and for inclusiveness; perhaps it is not from the user perspective- the user may naturally expect the artifact available in their own language or a language they may master (i.e. English); somehow this feature is taken for granted. Requirement 13 'virtual helpline and telephone helpdesk' has high implications that may impact a business model, since it inherently requires workforce to execute these tasks. For a minimum viable product it could start offering a simple FAQ (frequently asked questions). Requirement 10 'multi-device/platform availability' impacts the future efforts for implementation, since fulfilling this requirement entails more effort and investment would be required.

7 Discussion and conclusions

This chapter concludes this work. It provides an overview of our main findings and gives an answer to our main research question and sub-questions. As stated in the introduction and research approach parts, in this chapter we apply the principles stated in the stages of reflection and learning, and formalization of learning as ADR mandates. We abstract the learning into concepts for a set of similar problems as the one discussed in this work where social innovation is an aim.

The main outcome of this research is made of two parts. The first is the description of the findings throughout the design process and the conclusions that arise along the way and the second are steps that we suggest can be applied when starting-up a multi-sided digital platform as a mean for social innovation; the process as such responds the main research question that we introduced in the introductory chapter, 'how can a multi-sided platform be designed as a mean for social innovation?'- this process is the result of the application of Action Design Research as the guide of the different research methods and activities applied throughout.

7.1 Main findings

We identified 3 elements to be of eminent importance to the viability and sustainability of the artifact being designed, or as we called them Critical Design Issues: (1) usability, (2) trust and (3) data privacy. Also we derived 13 requirements that the platform should fulfill: (1) online community, (2) marketplace, (3) seamless navigation, (4) rating and review mechanism, (4) diary management, (5) tasks management, (6) contacts management, (7) text and buttons, (8) help/guide mechanism, (9) multi-device/cross-platform availability, (10) news about health and wellbeing, (11) search based on key words, (12) virtual helpline and telephone helpdesk and (13) medical and insurance information. These requirements all explained in detail in sections 5 and 6, were reflected in the artifact design.

The requirements that we derived answer the first research sub-question (RQ1) of 'what are the requirements from an end-user (elder/caretaker) perspective for a multi-sided platform for Smart Living (health and wellbeing)?'. These requirements were also translated into prototypes (mockups); the latest 'home' presented in Figure 12 plus the appendix C answer the second research sub-question (RQ2) 'how does a multi-sided platform for health and wellbeing look like (functionally) from an end-user (elder/caretaker) perspective?'. In addition, the text in chapter 5 and 6 that include the design and evaluation of the artifact, the decision choices, the direction the design too is a narrative of how the artifact emerged throughout and gives an answer to the research sub-question (RQ3) 'how does the artifact emerge'?. Lastly, also part of chapter 5 and 6, we used two different evaluation methods for the artifact that were critical in the process, that is, usability testing and a capability approach survey including the artifact home page mockup- thus, this answers the research sub-question (RQ4) 'how does the platform get evaluated'?.

In our problem statement, from the theory we showed how a social innovation was an approach to solve a specific societal challenge. We mentioned one of the present and near future unmeet needs regarding an aging society and the consequences of this for the healthcare system and in particular the elders; we also mentioned that a social innovation (in the form of changed social practices) could help tackle the mentioned unmeet need by the means of ICT – subsequently we showed the impact that ICT has in general and how it can be a mean towards tackling a given problematic solution as the one we have in hand, being that the social innovation. With this in mind we started a process aiming to derive requirements, design and prototype a digital platform that could be a mean to social innovation in the specific case of smart living the Netherlands in the context of health and wellbeing. If successful, such platform could offer new opportunities in the context of health and wellbeing- from the seamless access to services and products to the way daily care takes place intending to facilitate a higher quality aging period for the citizens by changing the

way relationships and interactions happen between them and caretakers, municipalities, etc. by adopting our artifact (change social practices).

Since we followed ADR as research approach, the knowledge and conclusions were drawn during the design process itself. The main two lessons learned in this process have to do with the usage of the capability approach framework when designing IT artifacts for social innovation and the role of usability in the process. In addition, we have relied on previous research mainly on user-centric design to carry out our work, thus some of the ideas inherently are not new, but they were instrumental in this process.

As mentioned, a social innovation aims to fill a gap of a societal problem. This gap can be expressed in terms of target group's power or ability to do something – which is defined in this work as capabilities, those to be improved or new capabilities that are not there yet in the target group. Such perspective helped us to frame concrete objectives for the artifact to lead the design process towards one that can help tackle the issues mentioned in the problem statement; this perspective also helped us to ease the communication towards the different stakeholders in terms of the potential benefits of the artifact, from the living lab members to the potential end users, and to determine whether the starting-up process of the design of the artifact was promising. Thus, as the key finding of this work, our findings suggest that stating the problem gap in terms of capabilities to improve, and using the same approach for the artifact evaluation can show whether the artifact suffices the criteria of improving those capabilities. This is derived from our specific case in health and wellbeing- according to one of the target groups of end –users (voluntary caretakers) who evaluated the design, through the specific question in our survey of 'the platform would help me with', the specific artifact would potentially help to improve (create) several capabilities, which after performing a dimension reduction using factor analysis came down to two set of components that we named *(1) socially inclusive active aging* & *(2) independent and comfortable aging in place*.

Our findings also confirm that evaluation of the artifact through usability testing with potential end-users is critical. As a matter of principle if we ask potential users whether they would use the artifact by showing them a prototype and we had a negative answer, ignoring this would become a recipe for failure. Not only formal usability testing but lightweight validation exercises with potential users allowed us to identify critical points that strongly influenced the design. We mentioned that early acceptance of the platform was critical in this research; and the results given by the usability test suggested that the right steps were being taken during design stage- preparing a clickable interactive model for a usability test is not that costly compared to a fully functional artifact, however the effects of testing can be comparable; that is, although the participants were not provided with a full functional experience, the test was designed in a way that really evaluated critical elements of the artifact based on the tasks and goals given to the participant creating the 'feeling' of a finalized artifact. We also confirmed that using familiar patterns when designing a prototype helps potential users to feel more acquainted with the artifact by just quickly exploring it.

Based on these findings and the knowledge drawn from the entire process we suggest as a main outcome the following set of principles/steps for starting –up the design of digital platforms for social innovation (see Figure 14), and as an answer to our main research question of 'how can a multi-sided platform be designed as a mean for social innovation?'.

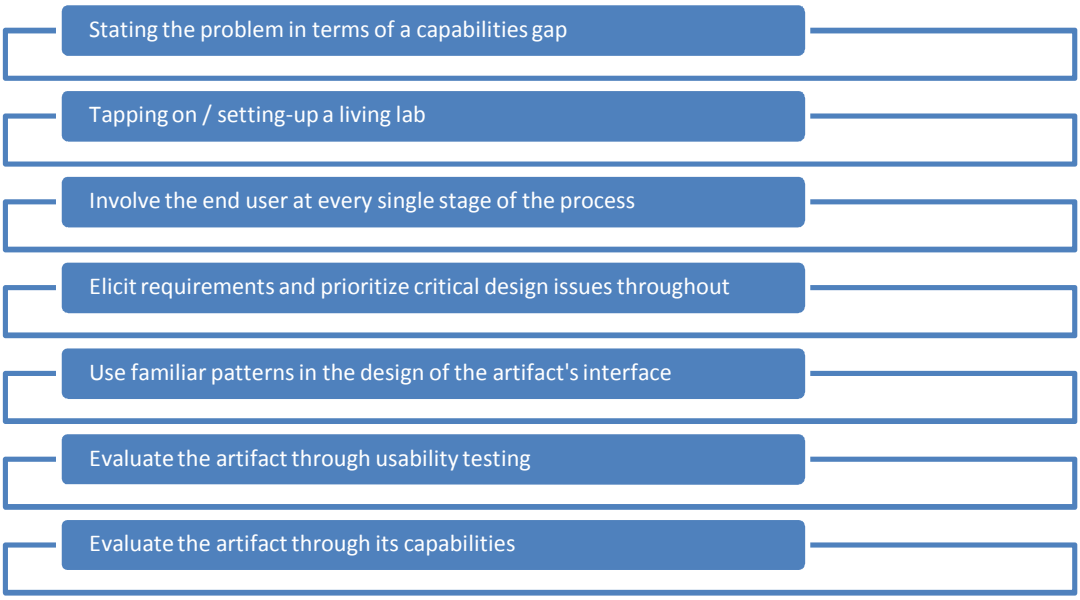

Figure 14: A start-up process for the design of digital platforms for social innovation

Stating the problem in terms of a capabilities gap

As suggested in our main findings stating the problem gap in terms of capabilities makes clear the potential positive impact of the artifact. It gives a north of what kind of stakeholders need to be involved in the design/research process. In addition, it also provides a language that facilitates the communication among stakeholders regarding the artifact at all stages and uses a framework for assessment of individual wellbeing, social arrangements and proposals about social change in society.

Tapping on / setting up a living lab

In our work this was already in place at the moment we started this research, the living lab setting was a fundamental piece in the construction of this process and the viability of our research. As mentioned in the introduction this research is within the context of a living lab which has supported for sensing, prototyping and validating the solutions that we proposed here- many of the most influential inputs came from the living lab (i.e. during the workshops). Once there is clarity of the kind of capabilities the platform should tackle a living lab found to tap on or set-up. We have been able to deepen our understanding of how the design of this artifact fits into the complex reality, which is shown in the next steps of the process.

Involve the user at every single stage of the process

Involve end-user groups (i.e., elderly) from the beginning and throughout the whole process. Some of the decisions as design team that we were making felt trivial, but when taking them to the users we realized they were not (i.e. the diary management functionality as described in chapter 5)- thus the end-user should be omnipresent throughout. We mentioned the main takeaway from the social innovation weekend in Berlin which led to earlier validation than we anticipated. This principle (rather than just a step) kept us grounded to the user perspective and helped us make a difference on the details.

Elicit requirements and prioritize critical design issues throughout

It was important in this work to be aware that any activity outcome during the design cycle needed to be stated clear; that is why as we progressed with the different design activities the different sort of outcomes were analyzed and reflected upon to state what they meant in terms of requirements and critical design issues.

Use familiar patterns in the design of the artifact's interface

With the intention of making the user feel 'home' we used user-interface familiar patterns of well known and adopted platforms (i.e. facebook, twitter, Google calendar, etc). Those interfaces in many cases already solved some of the problems in the definition of certain details of elements that we were creating (i.e. when we defined an interface for creating activities, we were inspired by Google calendar). In this way we do not reinvent the wheel.

Evaluate the artifact through usability testing

As mentioned in the previous section usability and usability testing were identified as critical elements of this research. Early adoption criteria can be validated through usability testing plus asking potential users whether they would use/recommend the artifact if available.

Evaluate the artifact through its capabilities

As mentioned in the previous section this has proven to be of high importance in our research. Thus the artifact once designed should be shown to the potential users, let them interact with it (potentially during a usability test) and afterwards prepare questions related to the set of capabilities that the artifact may improve (or create) to validate the design.

To sum up, the inclusion of user-centric design principles, the living-lab setting, and the capability approach from the evidence in this work seems to be a promising first step for starting up platforms that have altruistic purposes, especially for social innovations. It is a digital age and there are several examples of 'platforms' that have changed the rules of the game and became a mean to make the society better off. Thus, the process/principles described here are the formalization of learning of how to start-up this type of platforms and answer our main question.

7.2 Contribution and reflection on the theories

This work also contributes to the literature of social innovation. We stated in the theory section for social innovation (3.1) that our interest in this thesis was on social innovations that could be replicated and 'emancipated' through specific programs or organizations. Thus this work offers a process/set of principles that could help organization or individuals guide the initial steps of designing a digital platform that could help tackle type of issues or problems that can be stated in terms of a capabilities gap – although the case we worked here was in the context of health and wellbeing, the contribution to the literature goes beyond health and wellbeing since we attempted to derive knowledge through the implementation of ARD for a similar set of problems. For example in the process of social innovation that Mulgan et al. (2007) stated, our process fits well in the first two stages of 'Generating ideas' or awareness of needs (stating the problem in terms of capabilities) and 'Developing and prototyping' or validation (usability testing and early user involvement)- thus our process/principles becoming instrumental for a social innovator.

The capability approach is set as a framework for assessment of individual wellbeing, social arrangements, the design of policies, and proposals about social change in society. From the theoretical survey Robeyns (2005) performed the approach has been mainly applied in development studies, welfare economics, social policy and political philosophy – an more recently in ICT4D (Information and communication technologies for development) in the perspective of human development for the poor by Hamel (2010). Thus, the use of the approach in relation to IT artifacts as a whole has been considered – but the perspective has been developing capabilities for the poor. Hence, our work shows a new different application of the capability approach in relation to IT artifacts which are not necessarily aimed for development purposes in the perspective of the poor, but rather in the lens of social innovation in the perspective of change of social practices. In addition we used User-Centric design as an input theory- mainly its principles in the design process. Thus

usability testing, involvement of the user at every single stage of the process and the use of familiar patterns in the design of the artifact's interface are not new ideas when designing IT artifacts – so in this work we confirm the promising usage of those. Nevertheless, in connection to the capability approach usability testing and user plays the role of an enabler as a 'conversion factor' - the extent in which an individual can transform a resource (the platform) into a functioning.

Platform theory has mainly focused on explaining and understanding the dynamics of platforms, how networks effects happen and strategies around it; D. S. Evans (2009) has done some work on how to start-up referring to users in the different sides of the platform as economic agents- his work is mainly focused on economic aspects and strategies to attract members for the different sides of the platforms to reach a 'critical mass' that makes the platform (economically) viable. Our work though, is focused on other aspects that are not of economic nature but rather on potential benefits that users on one side of the platform could have (capabilities) -this work presents a set of steps/principles to start-up that process in the type of platforms that aim for social innovation. The big concern which is how to attract users (economic agents in his words) leading up to a critical mass; here we presented a first step towards tackling that concern at a early stage, thus contributing to platform theory in terms of strategies on how to attract users one side of the platform by addressing societal needs.

Action Design Research is the approach we used in this work to guide all our efforts during the design of the artifact and drawing knowledge in the process. It was very instrumental in this work. The role it played was mainly guidance – using the principles and stages played the function of scoping our work to make sure we were drawing scientific insights during the design of the artifact. ADR also helped to structure our work to an inherently iterative, complex and 'messy' process. Also, the structure of this document reflects ADR stages. However, we did not entirely apply he method due to our setting. Stage 2 of ADR (Building, Intervention, and Evaluation) used the problem formulation and theoretical framework as an input for an initial design of the artifact, which was further shaped during subsequent design cycles- this stage also assumes that the artifact is shaped by organizational use – and also the 'intervention' element has to do with intervening in the organization where ADR is being carried; in our case there was not such organization as such, meaning that the perhaps the problem owner (potentially a municipality) was not taking part in this project- therefore that element was not included in this work. Thus, from stage two we only used the Building and Evaluation elements, and they sufficed our needs and scope in this research. Hence, this work also shows how ADR can be customized in the absence of an organization at a certain stage of the design process.

To sum up, if we consider the different contributions here exposed, the combination of these make a unique contribution to the adoption and diffusion of information systems. The socio-technical lens of this work reflected in the theoretical premises used, the artifact design and the role of people (end-users) in combination in this work, formalize a new approach on how to facilitate adoption and diffusion of information systems at an early stage for IT artifacts that aim to tackle specific societal needs.

7.3 Limitations and delimitations

We used usability testing as an evaluation method for our design. Usability testing is a central point of this study as well as a fundamental step in the process we propose. However it also has its limitations. Usability testing, is not 100% representative of a potential real life scenario; usability testing is performed under somehow controlled settings which can make us miss out on unanticipated aspects (i.e. end users can be performing other activities in parallel when using the artifact in real life, which was not the case in the test). The testing was also mainly qualitative and

there were only few people doing it, which lacks of representativeness that a survey for example gives.

The start-up design process that resulted as outcome of this work based on the results obtained seems promising for a similar set of problems. However, as a socio-technical work this is about interactions of technology and people. Hence, it may not be replicable. Whether this start-up process is replicable always depends on many other variables and factors that we either don't know of or cannot control; for instance outcomes such as the critical design issues and requirements could have taken a different direction if the living lab participants were from different backgrounds, or their level of engagement/commitment with this project would have been different. Our work was focused on one specific case where the understanding of the problematic situation was clear and shared among participants of the living lab – the objectives were the same so the discussions were fluent and focused- if this wasn't the case the dynamics of the collaboration could have also influenced the outcome of this work- human behavior influences in the context of socio-technical contexts.

In the impact of the artifact chapter (6), we used a survey based on the capability approach – with the specific question of 'the platform would help me with' – a different set of capabilities were scored by the respondents – with this we performed factor analysis ((Principal Component Analysis) to reduce the dimensions of the question that evaluated the potential impact of the artifact. The two components found are a key finding in this study. However, factor analysis has its limitations too; it assumes that we are applying the method to an entire population which was not the case- especially in the absence of a population in our case. In addition, due to our scope we only surveyed one key group of end-users (voluntary caretakers)- which from we drew key conclusions, however in our scope no more stakeholders were in involved. Therefore this is also as delimitation per se. For example Doctors or nursing staff, or healthcare products/service providers' involvement could have given different type of insights or driven the results into a different direction.

7.4 Future research or next steps

This process is only a start-up towards designing a multi-sided digital platform for social innovation. The set of requirements and critical design issues were mainly derived from the end-user perspective. A similar exercise is necessary in the future with other type of stakeholders on the other sides of the platform, such as municipalities, services/products providers, doctors, nurses, etc. in order to have wider and strong set of conclusions. It is a multi-sided platform; therefore all the sides shall be included in the future research (not only end-users)- requirements for all the different sides shall be derived. A proper research question that can be answered for this is 'what are the requirements from a service provider/ product provider / municipality perspective for a multi-sided platform for Smart Living (health and wellbeing)?'. The sort of research approach used for such question(s) can be the same as in this work (ADR) combining design and usability testing workshops as well as

We built a prototype based on the requirements derived, but in order for us to determine whether our design does become a mean for social innovation, it needs to be specified and implemented. In terms of specification prior to implementation an agile methodology such Scrum can be used, thus, the requirements are translated into user-stories that developers can implement thought many iterations; each iteration should be evaluated in order to improve the artifact and derive/revise requirements as the process carries. Once implemented, and after a certain period of time of being fully operational (assuming adoption) its impact should be assessed. Thus a research question at this stage that should be answered is 'what is the impact from a social perspective of the implementation of a multi-sided digital platform for social innovation in the context of health and wellbeing?'- Thus, such research is in the form of a social impact assessment that may use interviews,

surveys of the impacted stakeholders. The knowledge derived in this process can be also specified as a series of steps that can come as additional steps for the process we derived in this work to start-up a digital platform for social innovation.

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8 Appendix

8.1 Appendix A: usability test #1 - protocol

8.1.1 Introduction

First, participants are briefly introduced on what the purpose of the exercise is. Participants are asked to feel free to make any comment or assessment on what they are doing and being asked. Participants are also informed that there will be some questions beforehand and post test set of questions as well.

8.1.2 Pre test question

8.1.2.1 After the introduction, what do you expect to see in a website/app especially designed for the elders where they can be more socially connected, access products and services for health and wellbeing?

8.1.3 Task 1

This is the homepage of a site dedicated to elders and how they can access functionalities, products and services that will improve their lives. Please give me your initial reactions to this page. Feel free to explore this page as you normally would. You can scroll around with your mouse, but please don't click on anything just yet.

Facilitator will ask:

- Please give me your initial impressions about the layout of this page and what you think of the colors, graphics, photos, etc. (not in this first round)
- Without clicking on anything yet, please describe the options you see on the home page and what you think they do. Feel free to move around the page, but again I'll ask you not to click on anything right now.
- Without clicking on anything yet, if you were exploring, what would you click on first?
- Whose platform is this?

8.1.4 Functionality tasks

The facilitator will brief the task below that the user can perform and briefly explain them. Following the facilitator will ask the participant to:

- Create basic profile
- Create advanced profile
- Edit profile
- Create an entry in the diary
- Add a contact
- Add a special contact
- Create Activity
- Join Activity
- Create Task

8.1.5 Post test questions

After the test, participants are asked to fill in a survey containing the following questions:

- Which suggestions do you have to improve the design of the site? (not in this first round)
- What are your overall impressions of the site?
- If you had to give the site a grade, from 1 to 5, where 1 was failing and 5 was exemplary what grade would you give it, and why?
- Name two words or characteristics that describe this site.
- What are the three things you like best about the site?
- What are the three things you like least about the site?
- If you could make one significant change to this site, what change would you make?
- Would you use (if relevant for you) or recommend someone to use it (if relevant for them) ?

8.1.6 Task and usability criteria

The following offers a guide to measure usability at an initial stage. Data needs to be gathered and aggregated for analysis. The following table represents the tasks for the users along with category, priority and criteria.

Category	Level	Task	Priority	Measurable Requirements
Success	Scenario Level	Create basic profile	Low	83% of users will be able to create a basic profile in under 2 minutes
Success	Scenario Level	Create advanced profile	Medium	83% of users will be able to create a an advanced profile in under 2 minutes
Success	Scenario Level	Edit profile	Medium	83% of users will be able to edit basic profile in under 2 minutes
Success	Scenario Level	Create an entry in the diary	High	83% of users will be able to create an entry in the diary in under 2 minutes
Success	Scenario Level	Add a contact	Medium	83% of users will be able to add a contact in under 2 minutes
Success	Scenario Level	Add a special contact	Medium	83% of users will be able to add a special contact in under 2 minutes
Success	Scenario Level	Create Activity	Low	83% of users will be able to create an activity in under 3 minutes
Success	Scenario Level	Join Activity	High	83% of users will be able to join an activity in under 1 minute

Success	Scenario Level	Create Task	Medium	83% of users will be able to create a task in under 2 minutes
Time	Scenario Level	Create basic profile	Low	83% of users will be able to create a basic profile in under 2 minutes
Time	Scenario Level	Create advanced profile	Medium	83% of users will be able to create a an advanced profile in under 2 minutes
Time	Scenario Level	Edit profile	Medium	83% of users will be able to edit basic profile in under 2 minutes
Time	Scenario Level	Create an entry in the diary	High	83% of users will be able to create an entry in the diary in under 2 minutes
Time	Scenario Level	Add a contact	Medium	83% of users will be able to add a contact in under 2 minutes
Time	Scenario Level	Add a special contact	Medium	83% of users will be able to add a special contact in under 2 minutes
Time	Scenario Level	Create Activity	Low	83% of users will be able to create an activity in under 3 minutes
Time	Scenario Level	Join Activity	High	83% of users will be able to join an activity in under 1 minute
Time	Scenario Level	Create Task	Medium	83% of users will be able to create a task in under 2 minutes
Satisfaction	Artifact Level		Medium	83% of users will rate the experience using the artifact a four or five on a one to five scale where five is the best

Acceptance	Artifact Level		High	83% of users will answer that they would use/recommend the artifact

Table 10: Tasks and usability criteria

8.2 Appendix B: Capability approach survey

Survey used in chapter 6. Survey divided in sub-sections of Independent living/ demographics, take care of others, comfortable life, digital platform and conclusion.

Independent living and demographics

Question 1
What is your gender?
○ man
○ woman

Question 2
What is your year of birth?

_____

Question 3
What is your nationality?

_____

Question 4
Do you have children?
○ yes
○ no

Question 5
How many children live under your roof?

_____ (Min. 0 - Max. 6)

Question 6
How many children live away from home?

_____ (Min. 0 - Max. 6)

Question 7
What are you doing in daily life?
☐ working
☐ studying
☐ pension
☐ voluntary caretaker
☐ Other: _____

Question 8
What is or was your occupation

_____ ○ N/A

Take care of others

Question 9

Do (or did) you take care of someone in your neighborhood? Arrange help with for example grocery, household, finance, doctors appointments etc.

- ○ Yes
- ○ No

Question 10

How much time do/did you spend on this tasks on a weekly basis?

- ○ 1 - 3 hours
- ○ 4 - 8 hours
- ○ 9 - 12 hours
- ○ more than 12 hours

Question 11

Can you describe the tasks you are/were doing?

_____

_____

_____

_____

Question 12

Are you the only person who takes (or took) care of this person?

- ○ Yes
- ○ No

If no, how many are/were involved: _____

Question 13

How is the health of the person you take care of

- ○ no complaints
- ○ light complaints
- ○ heavy complaints
- ○ chronic condition

Which are those complaints: _____

Question 14

Do you think these healthcare problems effect ....

	No influence	A lot of influence
Daily life pleasure	○	○
Degree of independence	○	○
Social life (contacts)	○	○
Daily activities	○	○
Mobility in and around the house	○	○
Performance of work or hobbies	○	○
Traveling	○	○

Something else: _____

Question 15

Who would you ask for advice about health and well-being?

	Probably not	Probably
Family	○	○
Friends	○	○
Healthcare insurance	○	○
Healthcare professional (GP, therapist etc)	○	○
Healthcare shop	○	○
Healthcare and well-being advisor	○	○
Local health and well-being provider	○	○
Local Care Act desk (municipality)	○	○

Explanation: _____

Question 16
Where would you search for products and services for health and wellbeing?

	Probably not	For sure
Print (magazines, brochures)	○	○
Online (internet)	○	○
Television	○	○
Meetings (exhibitions and presentations)	○	○

Somewhere else: _____

Question 17
What is your satisfaction level in finding products and services for health and wellbeing?

	Not satisfied at all	Completely satisfied
Finding information	○	○
Get advice	○	○
Know who to turn to	○	○
Find help for family and friends	○	○

Something else: _____

Comfortable life

Question 18
Which aspects in daily life are difficult for the one you are taking care of?

	No influence	A lot of influence
Enjoy food and drinks	○	○
Go outside	○	○
Social life (contacts)	○	○
Safety in and around the house	○	○
Mobility in and around the house	○	○
Leasure (hobbies, sports)	○	○
Traveling	○	○
Memory	○	○
Cooking	○	○
Washing and getting dressed	○	○
Household	○	○
Gardening and maintenance tasks	○	○

Something else: _____

Question 19
How does the one you are taking care of act upon these changes?
☐ Did not do anything, yet

☐ Asked for advice for help with daily activities
☐ Arranged help from friends and family
☐ Bought products that will help them
☐ Arranged services like help in household, grocery services etc.
☐ Made adjustments to the house
☐ Arranged alarm system to relatives/neighbors etc.
☐ Arranged alarm systems to call center

Question 20
What was the last product/service you arranged for health and wellbeing?

_____

_____

_____

_____ ○ N/A

Question 21
Where did you buy this product/service

_____

_____

_____

_____ ○ N/A

Digital platform

What if.....there was a digital platform that could help you (or the one you take care of) to live comfortably and independently in your own home

Question 22
What should you expect to find on a digital platform for health and wellbeing called 'So Near'?

_____

_____

_____

_____

Question 23
See the mock-up of the digital platform 'So Near'. Can you describe what the platform is about

_____

_____

_____

_____

Home page of the platform is shown (see Figure 9: Zo-Dichtbij home

Question 24

Who will benefit from a health and wellbeing platform?

	Totally not helpful	Very helpful
Citizens in general	○	○
Young elderly (55 - 75 years old)	○	○
Elderly (75+)	○	○
People with physical disabilities	○	○
People with mental disabilities	○	○
Product providers	○	○
Service providers	○	○
Voluntary caretakers (relatives included)	○	○
Volunteers	○	○
Municipality (Social Act Care)	○	○

Someone else: _____

Question 25

Which elements would be important on the platform?

	Not important at all	Very important
Marketplace products and services	○	○
Careplan (medical information and insurances)	○	○
Agenda for social and medical activities	○	○
Personal profile	○	○
Review possibilities product and services	○	○
Finding local activities	○	○
News about health and wellbeing	○	○
Diary (to share with relatives and caretakers)	○	○

Something else: _____

Question 26

How important are the next possibilities on the platform?

	Not important at all	Very important
Anonymous use	○	○
Available for different devices (mobile, tablets)	○	○
Private and secured	○	○
Search based on keywords	○	○
Local search (postal codes)	○	○
Multilingual	○	○
Helpdesk online	○	○
Telephone helpline	○	○

Something else: _____

Question 27

Which functionalities would you like to use (now or in the future)?

	Not at all	For sure
Residential products (safety, security, home automation)	○	○
Care products	○	○
Products for wellbeing (entertainment, convenience)	○	○
Residential services (installer, builder)	○	○
Care services (household, personal care)	○	○

Wellbeing services (hairdresser, grocery service)	○	○
Contact with others	○	○
Marketplace (local supply and demand)	○	○
Information about health and wellbeing	○	○
Agenda with local activities	○	○
Integration local platforms (caretakers, volunteers)	○	○
Integration national platforms (healthcare)	○	○
Careplan, agenda and diary (share with relatives)	○	○

Explanation: _____

Question 28

I assume the platform will help me (or the one I take care of) to .....

	Not useful at all	Very useful
Be social involved	○	○
Add extra comfort at home	○	○
Improve interaction with others	○	○
Unburden myself or others	○	○
Arrange daily schedule	○	○
Find information about health and wellbeing	○	○
Filter local demand and supply	○	○
Help others in an easy way	○	○
Share a care plan with others	○	○
Live in a comfortable way	○	○
Avoid moving to another place	○	○
Age in place	○	○
Stay independent as long as possible	○	○
monitor my relatives	○	○

Something else: _____

Conclusion

Question 29

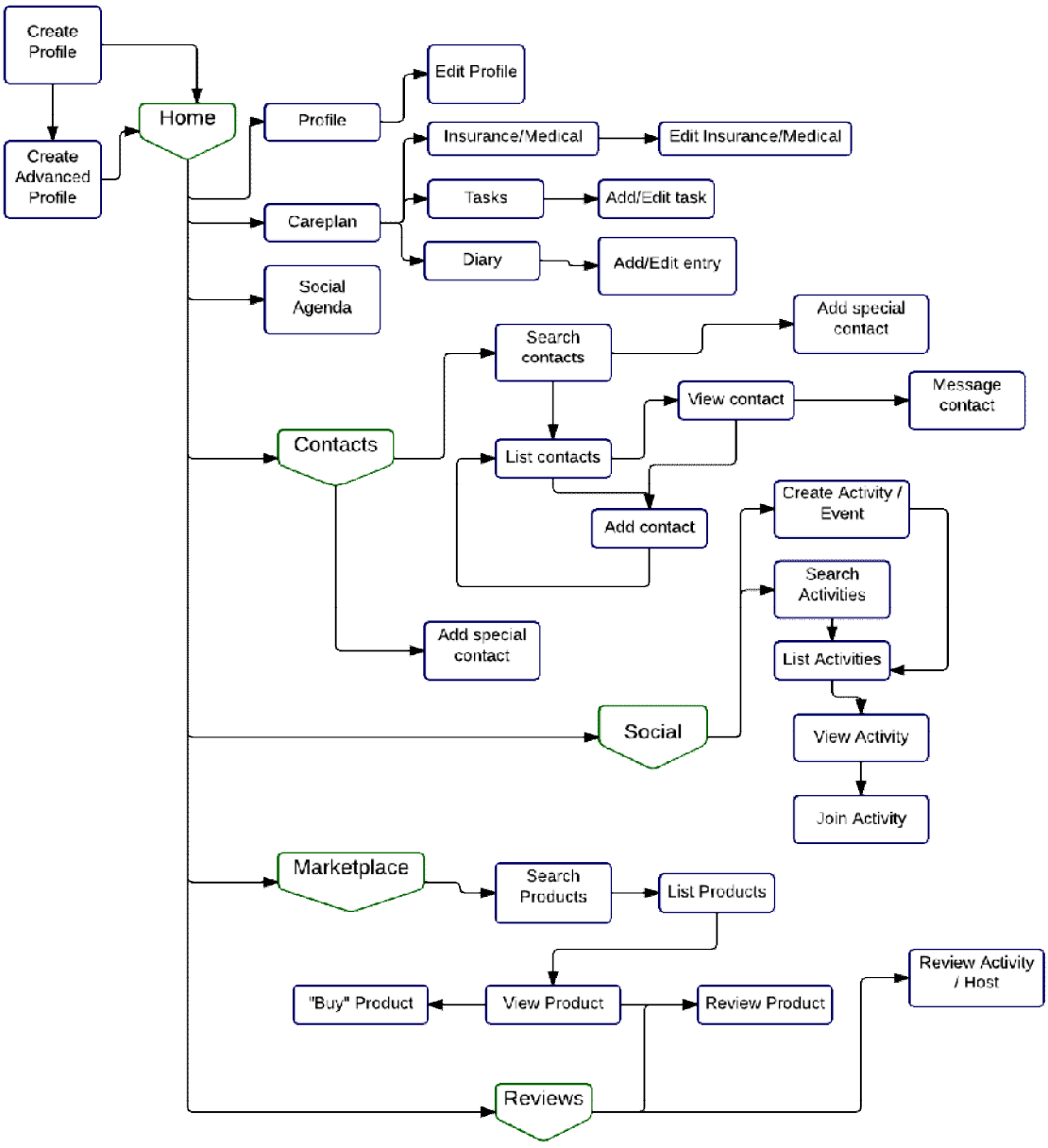
If interested in the results of the research please fill in your e-mail address

_____

8.3 Appendix C: Mockups

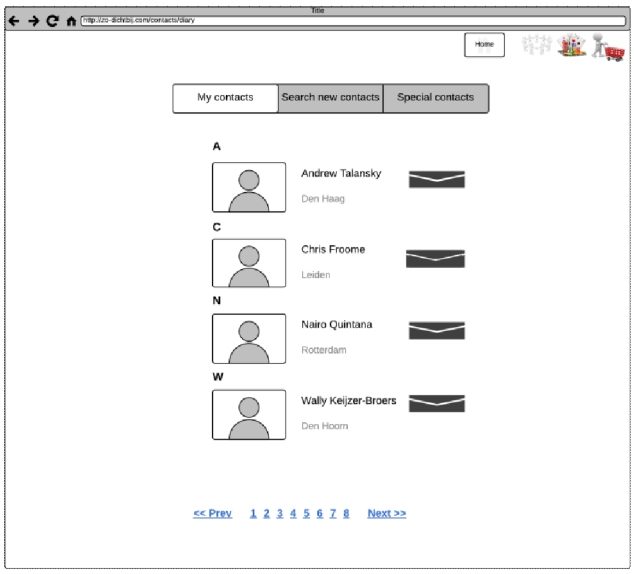
The following mockups were part of the design of the artifact and usability test in the form of a clickable model.

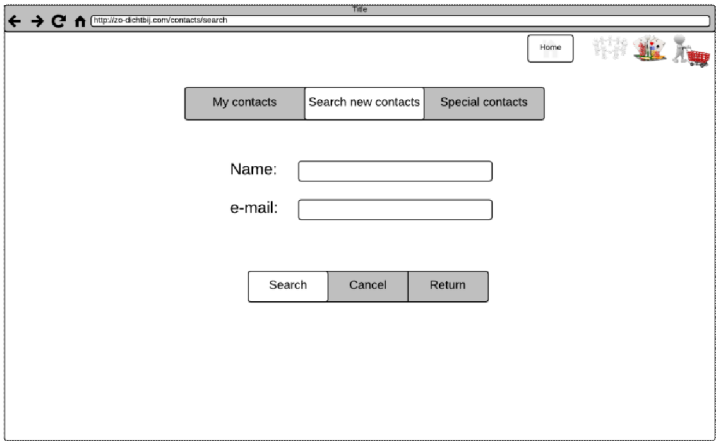
8.3.1 Navigation map Zo-dichtbij

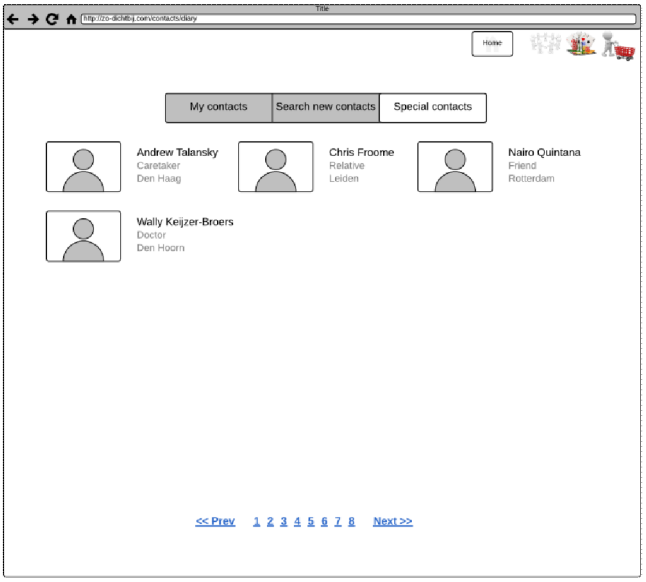


8.3.2 Zo-dichtbij home

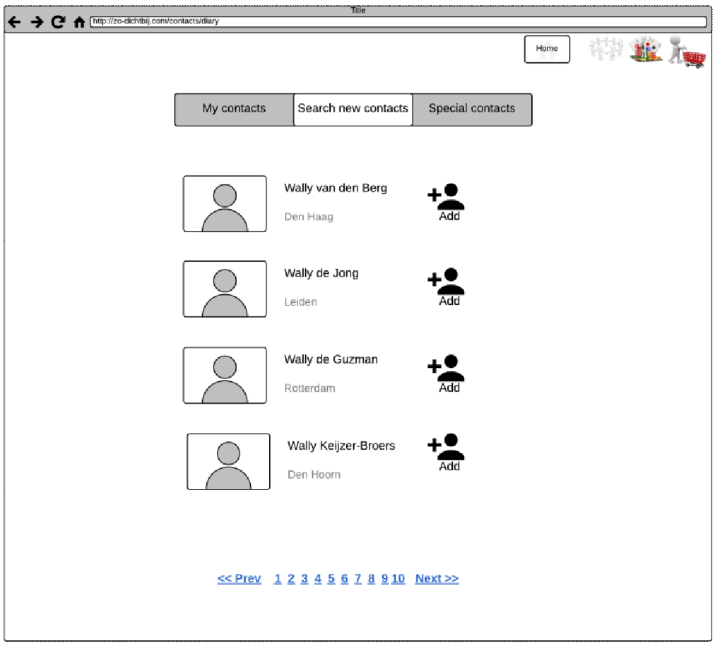
8.3.3 Contacts section 1 (my Contacts, Search new contacts, special contacts)

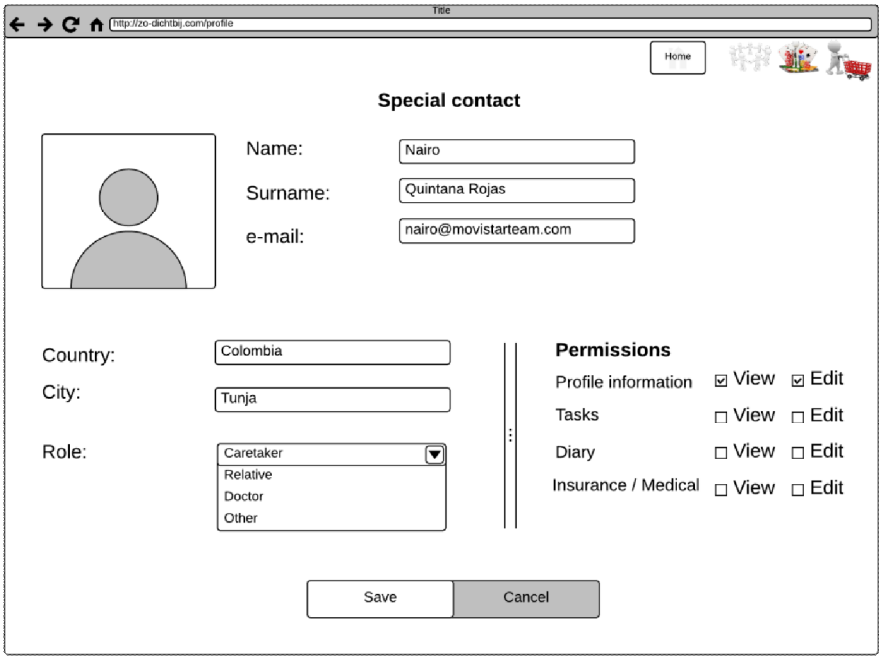




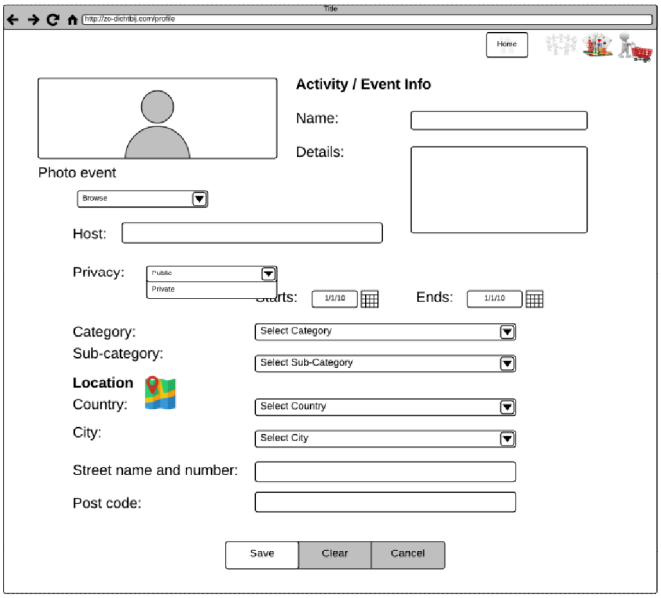


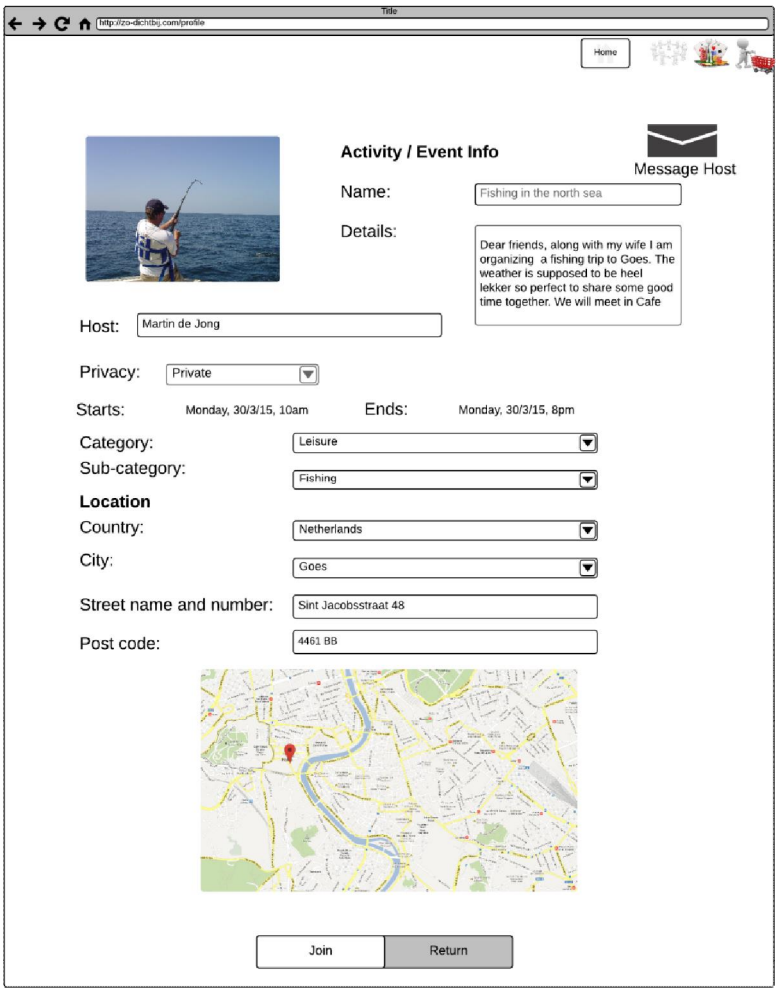
8.3.4 Contacts section 2 (List contacts – key word “wally”, add special contact)



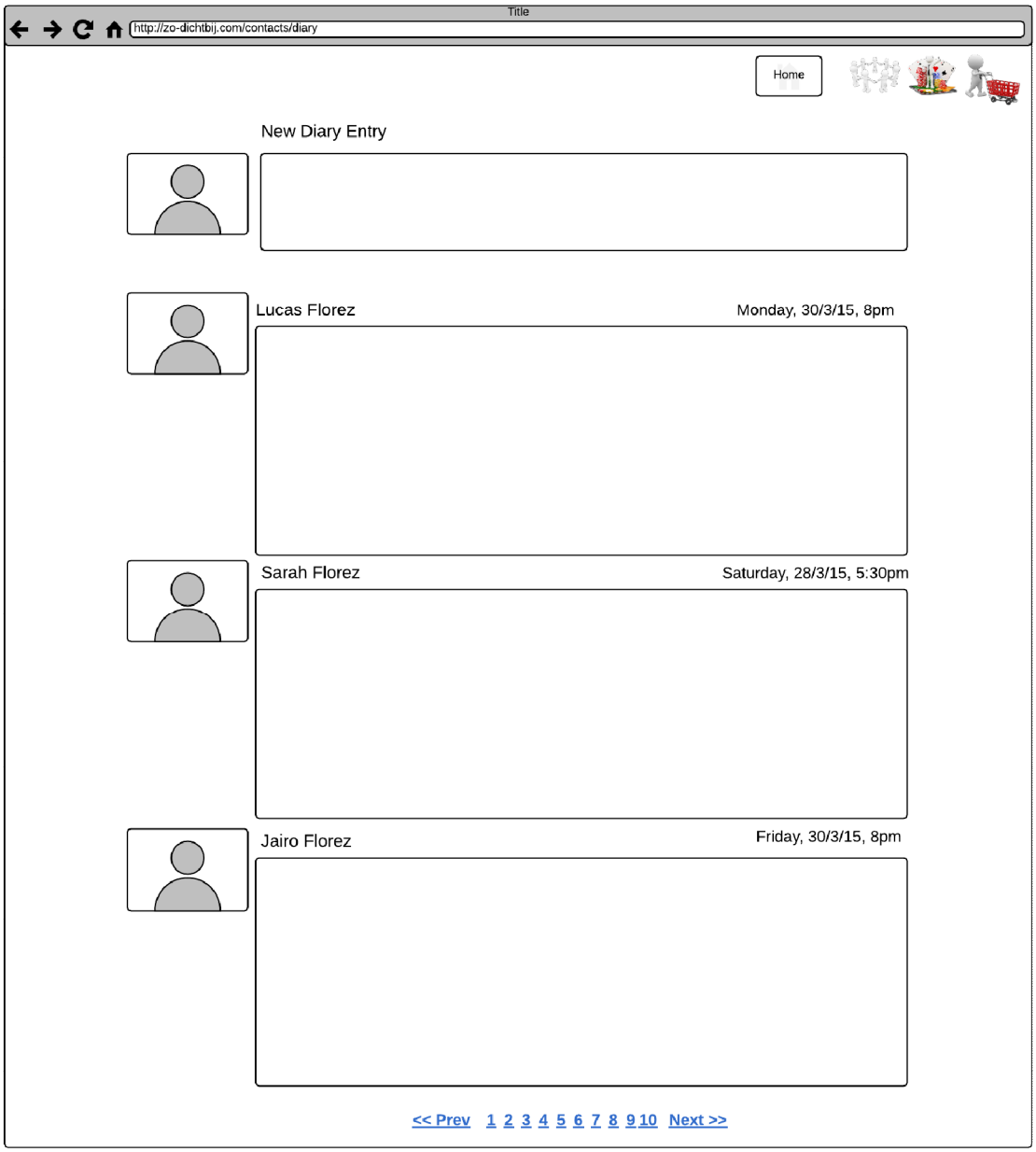


8.3.5 Activities section (Create activities/events, view activity)

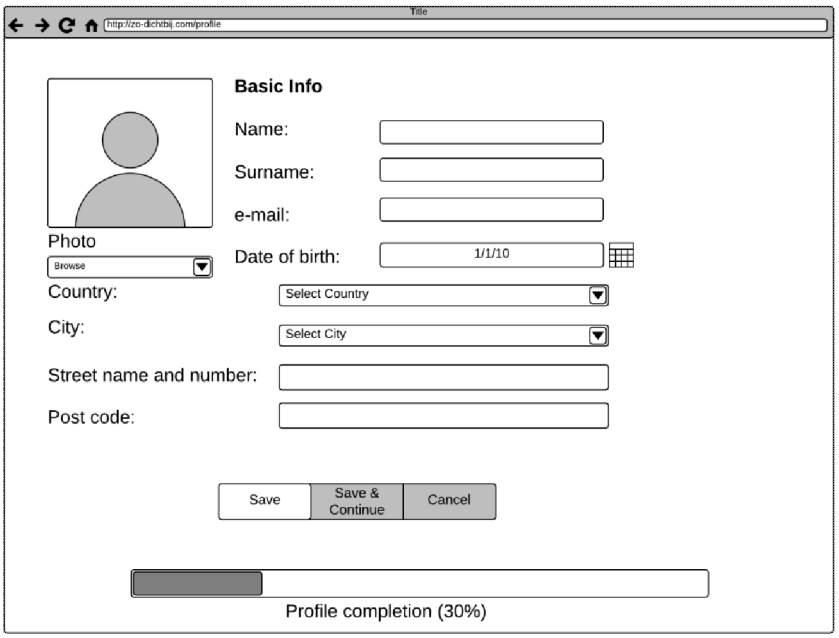


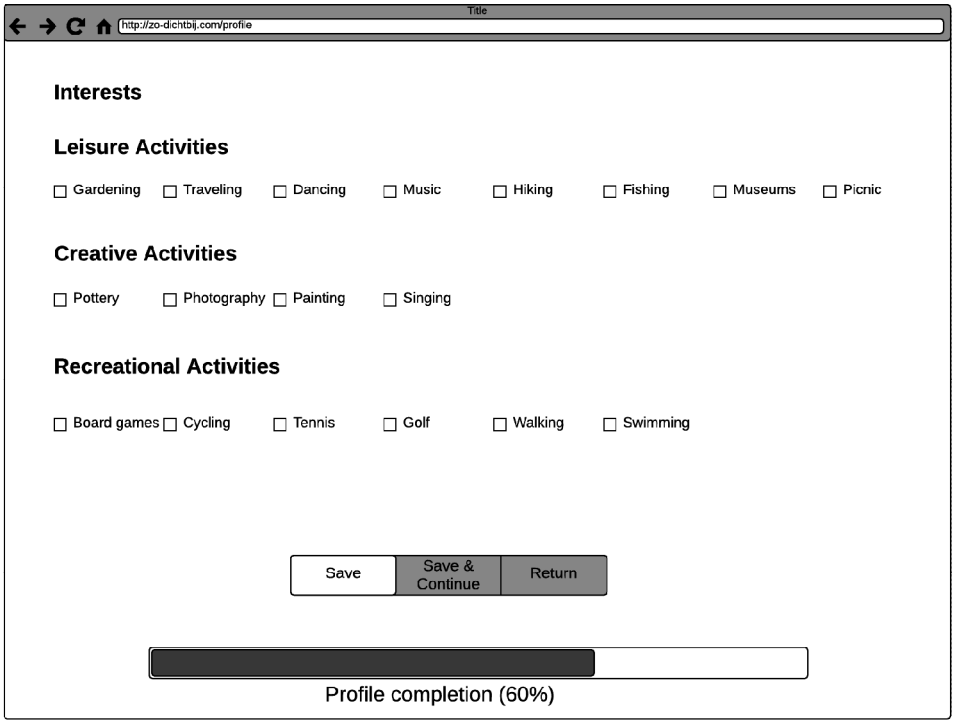


8.3.6 Diary section (outside the home page)



8.3.7 Profile creation basic and advanced





8.4 Appendix D: Papers

The following three conference papers have been co-authored throughout the execution of this project research. In order of appearance they are:

1. Developing a Health and Wellbeing Platform in a Living Lab Setting: An Action Design Research Study – prepared for the Tenth International Conference on Design Science Research in Information Systems and Technology. 21-22 May, Clontarf Castle, Dublin, Ireland. Paper already published. My contribution to this paper was in partly the section of design workshops (3.1); I prepared the section Critical Design Issues (3.2) and contributed to the conclusions.
2. Developing a Health and Wellbeing Platform in a Living Lab Setting – prepared for 24th International Conference On Information Systems Development that will take place in Harbin, China in August of 2015. Paper already accepted. My contribution to this paper was more substantial than in the first one: I mostly developed section 3 (Building the alpha version of the prototype), same with section 4 (Evaluation of the alpha version of the platform) and contributed to the discussion and conclusions.
3. Prototyping a Health and Wellbeing Platform: an Action Design Research Approach – prepared for the 49th Hawaii International Conference on System Sciences (HICSS) that will take place in January 2016. Paper under submission. My contribution to this paper was partly in section 3.1, substantially in section 3.2 and also contributed to the discussion and conclusions.

Developing a Health and Wellbeing Platform in a Living Lab Setting: An Action Design Research Study

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Abstract. The world's population is rapidly aging, which affects healthcare budgets, resources, pensions and social security systems. Although most older adults prefer to live independently in their own home as long as possible, smart living solutions to support elderly people at home did not reach mass adoption, yet. To support people age-in-place a Living Lab is established in one of the metropolitan areas in the Netherlands. The main goal of the Living Lab is to develop an online health and wellbeing platform that matches service providers, caretakers and users and to implement that platform in one particular city district. In this paper we describe the narrative of the action design research process that will give researchers insight how to deal with complex multi-stakeholder design projects as well as cooperation issues to develop an artifact in a real-life setting.

Keywords: aging-in-place, platform, action design research, smart living

1 Introduction

An aging population can be explained by the increasing life expectancy due to improved public health and a declining fertility rate. Both trends are expected to continue the coming decades. Life expectancy at birth will increase globally with ten years, to reach an average of 76 years by 2045 – 2050. In the same timespan the average global fertility rate will drop to the replacement level. Next to that, the United Nations predict that within thirty years the older adults will even outnumber children under the age of 15 [1]. One policy to reduce healthcare expenditures is to encourage people to live longer at home (i.e., aging-in-place) [2]. While, most elderly prefer aging-in-place instead of living in an institution [3], to maintain a certain quality of life [4], it is a challenge to make this happen. Declines in cognitive and functional abilities, social exclusion, digital divide as well as time pressure on the caregivers, are typical hurdles. Besides these general difficulties end-users are not aware of what products and services are available to fulfill their needs at a certain point of time. To assist the elderly, considerations need to be given to housing, transportation, social interaction, cultural engagement and activities [5]. Aging-in-place also implies that elderly maintain social connections to the neighborhood and the community, as well as in socio-cultural contexts [6].

The focus of this paper is on how aging-in-place can be supported by ICT-enabled solutions. For instance solutions related to smart living involve connecting our daily

activities at home, along the way, or anywhere else, through integrated ICT. Although smart living has been on the agenda of policymakers for quite a long time, smart-living services have not reached the diffusion phase and did not make it into the mass market, yet [7]. Creating awareness among end-users about existing solutions to support them age-in-place is challenging. We propose that such awareness may be increased, by offering an online service platform to find all relevant applications within the smart living domain [8, 9]. How to design, implement and roll-out such platforms is unclear as existing literature on digitals platforms is merely based on ex-post studies of successful platforms [10]. Therefore, the objective of this paper is to describe a narrative how to develop, a health and wellbeing platform within a real-life setting, in an agile iterative way.

Designing such a health and wellbeing platform is highly complex as many stakeholders are involved. We draw on Action Design Research (ADR), which has been suggested by Sein, Henfridsson [11]. ADR is particularly appropriate 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. Action Design Research should generate knowledge that can be applied to a class of problems that the specific problem exemplifies. Next to that, ADR is based on an artifact and emphasizes the interdependence of building, intervention and evaluation. As a result, the research activity is problem-inspired and combines thinking with doing [12, 13]. To use ADR in practice, we develop an artifact in a real-life context while constantly reflecting on the process. To track the iterative design steps, the action design researcher kept a logbook on a daily basis over the period 2013 – 2015 amounting up to 650 pages.

2 Earlier work on designing the artifact

In earlier research [14] we elicited three main features of an online platform for health and wellbeing based on 59 interviews with stakeholders 1) an **online community** for contact, social wellbeing and interaction with the neighborhood (consumer to consumer) driven by the need for social cohesion; and 2) a **portal** for bundled smart living services and solutions (business to consumer), driven by the one-stop-shop philosophy for 'aging in place' and 3) an **intervention instrument** for the municipality (government to consumer) to interact with citizens about needs for services and questions about the different health care arrangements. Ultimately, such a platform should enable end-users to enhance self-management (i.e., independency) by the provision of relevant information and support in matchmaking between different stakeholder groups (i.e., consumers, providers and government). Eventually the platform has to enhance the quality of life of end-users. While the initial phase sets the generic scope and functional requirements for the platform, the next step is to instantiate the design in a municipal setting.

To elaborate on the main features we arranged four focus group sessions and introduced personas as vivid descriptions of the potential platform user [15]. The aim of the focus group sessions was to assess whether using personas, as a user-centered

design tool, would lead to a better understanding of the end-user [16]. During two expert meetings these personas were further improved and applied as an input for scenario descriptions. For instance, frail elderly people like Annie (See fig. 1), who have no kids and are not *tech-savvy*, need an intermediary that can guide them through the complexities of the Dutch health and social care system. The goal of the personas and their associated task scenarios is to describe what the current customer journey looks like from different perspectives and, next to that, if and how a platform could help to support people age-in-place.

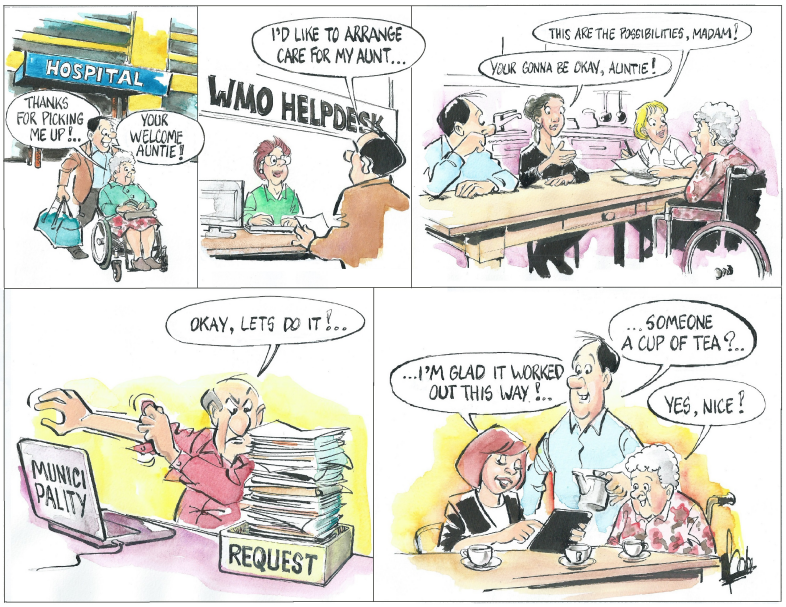

Fig. 1. One of the scenarios, according to Persona 2: elderly person called Annie. (The WMO helpdesk is the Dutch Social Support Act).

Both tools (i.e., personas and scenarios) are used to focus attention on problems and opportunities of a specific target audience.

3 Action Design Research Project

In a Living Lab, research and development moves from a pure academic environment into a real-life setting, with a multi-disciplinary network of people and organizations. We argue that designing a multi-sided platform can only done by addressing end-users' as well as external stakeholder needs in concert. It demands collaboration of stakeholders from multiple sectors to contribute to the required resources. Since the municipality is our launching customer, it was important to assemble the Living Lab according to a local community setting. To acquire commitment from stakeholders establishing a Living Lab required a lot of effort and resilience of the research team. After several attempts and initial failures, we managed to assemble a consortium with

multiple stakeholders from different disciplines (i.e., municipality, multinationals, SMEs and end-users). Based on a short questionnaire and additional interviews, the functions, roles and expected gains were elicited from the stakeholders. See table 1.

Table 1. Description of functions, roles and value propositions from a stakeholder perspective.

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

Important drivers for the stakeholders to invest in the Living Lab are related to 1) market access to the health and care domain 2) competitive advantage and 3) business opportunities. Importantly, the stakeholders in the Living Lab do not receive subsidies or other monetary compensation for their efforts.

3.1 Design workshops

The project draws on a set of reference platforms for inspiration and practical guidance. Next to that, the architecture is based on existing, successful online platforms, recognizing their value, the tensions and dilemmas around trust, privacy and security, that users encounter every day. In order to track real-time problems during the design process we are using the agile scrum method based on flexibility, adaptability and productivity [17]. To do so, we arranged three workshops with the Living Lab stakeholders to elaborate on efforts prepared in different scrum teams in parallel.
In a first workshop a list of main features were set to specify the critical design issues (CDIs) of the platform that were already gathered during previous research iterations [14, 16] See table 2. Table 2 illustrates the multiplicity of requirements for platform functions, ranging from basic information exchange towards active recommendations for services and matchmaking, and from pure focus on transactions towards interactive communication with end-users. Based on the aforementioned features, the plat-

form would 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) integration of successful, existing platforms in the health and wellbeing domain.

Table 2. List of main features for the platform.

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

In a second workshop, the technical architecture was further specified, by designing a Project Start Architecture (PSA) based on NORA, which is an acronym for the Dutch government reference architecture [18]. The reason to use this framework is to embark on a growth curve in maturity and to take the scalability potential of the platform into account. The PSA contains ten basic principles that relate to the provision of public services, and includes all activities by or through which service-providers carry out public tasks. The PSA is meant to ensure an adequate and sustainable solution for services that comply with 40 architecting principles, regarding technologies, service orientation and roles and responsibilities for providing digital services from the Dutch government.

3.2 Critical design issues

In a third workshop the Living Lab stakeholders elaborated on the critical design issues. Next to that two new CDIs were identified as the discussion moved towards ensuring adoption of the platform by end-users. The first CDI is *trust*; it 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 consumers and providers of products. In further discussion during the workshop the participants translated this CDI into two requirements for the platform. The first requirement is a *rating/review* mechanism for products and services offered in 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 in the platform) to

present the feedback to other users in order to reduce the customer's 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 offered; this requirement also enhances confidence in the platform by supporting dispute resolution and mediation services between consumers and providers. The second CDI is *user data privacy*; there should be a clear separation between 'social' data in the context of the platform and the data (e.g., medical) that must remain private to the user or those who are authorized (i.e., care takers, relatives). Next to that, the data privacy policy of the platform should be concise and transparent to create trust related to the platform. The proposed platform is a multi-sided platform offering services to individuals and to providers who offer services to the individuals. Such platforms require special attention to privacy because each transaction within the platform is somehow related to personal data of the individual. The platform will be compliant with privacy-by-design principles throughout all the development phases and the entire lifecycle. Consideration of appropriate use of existing Privacy Enhancing Technologies (PETs), as well as the EU Data Protection Directive (Directive 95/46/EC) will be made. In a multi-sided platform, one user contract for all the different types of services offered by all the different service providers will not be enough. In fact, one has to decide to implement a system based on approval for each single transaction within a general overall contract. Systems based on this design scheme like OpenPDS take care of the technical implementation, but the legal aspects should be taken in consideration in the design as well. For instance, approval for the delivery of personal data for each transaction, between a service provider and an individual, requires special software comparable with banking software for financial transaction (which can be considered as a subset of personal data).

To make sure the ADR team was on the right track with the proposed artifact, eight potential end-users were involved in the development phase of the mock-up and the first clickable model. Based on their recommendations, a mock-up of the design could be included in a widespread survey (i.e., elderly and informal caretakers) for further data gathering on the subject. In parallel with the data-analysis of the survey, field tests of the clickable model of the platform are foreseen with different groups of informal caretakers, district nurses and potential end-users (age group 55 – 75). These evaluation moments are part of the iterative design steps of the overall ADR project.

In the same workshop, we developed a first template to get an initial idea of the platform architecture. The proposed platform should contain an Application Programming Interface (API) as well as an Application (APP) store, and the emphasis is on a web-based application as the main interaction point with the users. Because compliance with rules on data protection and security is vital for healthcare applications, the platform will be compliant with the highest available Dutch standards for data security on a database level (i.e., NEN 7510) to share medical information. All authenticated pages must be exclusively accessed secured HTTP (i.e., HTTPS). Therefore all data throughout the platform send via the Internet will have Transport Layer Protection through the Transport Layer Security (TLS).

4 Reflection of the design process

Most of the theoretical and empirical research on multi-sided platforms has focused on mature platforms and less attention has been given to issues starting up a new platform. Therefore, the challenge is how to deal with the small iterative design steps, going back and forth in a rather complex design project. We formulate the following tentative propositions on the process of setting up and realizing a Living Lab setting, based on our smart living case experiences:

1. *Maintain a logbook on a daily basis to track actions of the design process.*
2. *Interview essential stakeholders from different disciplines related to your initial ideas about the artifact and include end-users as one of the stakeholder groups as well.*
3. *Use different methods of data collection (e.g., interviews, focus groups, survey) to get to the core of the design problem.*
4. *Include the goal of the user of the artifact: for example develop personas and scenarios to keep grip of the customer journey and use this during the whole project.*
5. *Select stakeholders from different disciplines with realization power and empower them to create a Living Lab or a similar case setting (e.g., multidisciplinary team with a launching customer, industry, end-user group and academy).*
6. *Develop a project plan to back up the artifact and the roles, functions and tasks of stakeholders.*
7. *Collect requirements for the artifact and prioritize the critical design issues.*
8. *Define the scope of the project and set up boundaries to develop a minimal viable product to test in real life.*
9. *Work in different groups in parallel, to get things done in small iterative design steps, according the agile scrum methodology.*
10. *Involve the end-user in the design process to validate and evaluate the artifact from the very beginning.*

5 Conclusion

Our design project contributes to current research on how ICT can support end-users aging-in-place. We are following an Action Design Research approach, with a focus on the understanding of the stakeholders and their needs in relation to a health and wellbeing platform. We are using the Living Lab setting to place the values of the stakeholders into a real-life context. This paper proposes a way of using ADR in design science to bridge the gap between theoretical propositions and successful adaptation of smart living platforms in daily practice. Accordingly, ADR gives us the opportunity to get a close look at the complexity of the design process when multiple stakeholders including end-users with different value propositions are involved. This understanding contributes to the design knowledge that is generalizable to other design projects. Based on our study, we propose a first practical guideline how to develop an artifact (i.e., an online platform) in a complex environment using ADR: in this specific case related to a highly sensitive health and wellbeing environment.

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Developing a Health and Wellbeing Platform in a Living Lab Setting

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Abstract

A key challenge older adults face is the ability to live independently. Losing their everyday independence is a major concern for older adults. Partly, because they fear this could lead to an involuntary move to an assisted living facility instead of living independently. Since 2015, the Dutch government encourages their citizens to age-in-place, but at the same time struggles how to implement new healthcare regulations. To support both the government and the citizens, we propose an online platform to match supply and demand in the health and wellbeing domain. Such a platform should not only enable end-users to enhance self-management, but also support them to find solutions for everyday problems related to aging-in-place. To illustrate our action design research we established a Living Lab in a metropolitan area in the Netherlands, and developed a prototype of the proposed platform in a real-life setting. The usability of the alpha version of the platform is evaluated with six potential end-users. Their comments are input for next iterations where the ADR team will constantly observe the effects of the platform in a complex social process within the Living Lab setting.

Keywords: Smart living, Living Lab, Health and wellbeing platform, Action Design Research

1. Introduction

The worldôs population is growing older and, as many other countries in Europe, the Dutch government is aiming for better integration of health and social care to support older adults and patients with chronic conditions in the community [1]. An aging population can be explained by the increasing life expectancy due to improved public health and a declining fertility rate. Both trends are expected to continue the coming decades. Life expectancy at birth will increase globally with ten years, to reach an average of 76 years by 2045 ï 2050. In the same timespan the average global fertility rate will drop to the replacement level. Next to that, the United Nations predict that within thirty years the older adults will even outnumber children under the age of 15 [2]. One policy to reduce healthcare expenditures is to encourage people to live longer at home (i.e., aging-in-place) [3]. While, most elderly prefer aging-in-place instead of living in an institution [4] and to maintain a certain quality of life [5], it is a challenge to make this happen. Declines in cognitive and functional abilities, social exclusion, digital divide as well as time pressure on the caregivers, are typical hurdles. Besides these general difficulties end-users are not aware of what products and services are available to fulfill their needs at a certain point of time.

Societal issues related to health, wellbeing and comfort come together in the home-environment of people, but if elderly become more vulnerable, it becomes harder to take responsibility themselves. This requires solidarity from society and especially from voluntary caretakers, friends and family to support active aging [6]. To assist the elderly, considerations need to be given to housing, transportation, social interaction, cultural engagement and

activities [7]. Aging-in-place also implies that elderly maintain social connections to the neighborhood and the community, as well as in socio-cultural contexts [8].

Next to that, ICT solutions can help to arrange daily activities in a smarter way. It is not about a smart home per se (i.e., with advanced automated appliances) but how to integrate smart solutions in our daily life. This is related to the concept of smart living defined as an integrated design of our homes and neighborhoods in which functional and non-functional requirements come together in an integrated value-sensitive design. Smart living is related to the quality of life [9] and involves connecting our daily activities at home, along the way, or anywhere else, that can be supported by integrated ICT. Smart Living services are related to the Internet of Things (IOT) that can be interpreted as ó a worldwide network of interconnected objects uniquely addressable, based on standard protocolsô [10]. Because of advanced sensor technologies and integrating sensors, devices are transforming into smart objects [11]. Next to that, smart living services can be seen as mediator between providers and customers in the process of value creation [12].

Therefore, we propose an online platform for health and wellbeing to match supply and demand in the smart living domain. This service platform should not only create awareness among end-users about what services and technologies can help them, but also assist in matchmaking between (latent) needs and (yet unknown) services. Ultimately, such a platform should enable end-users to enhance self-management (i.e., independency) by the provision of relevant information and support in matchmaking between different stakeholder groups (i.e., consumers, providers and government). Eventually the platform has to enhance the quality of life of end-users.

This paper describes the prototyping phase of a health and wellbeing platform in a real-life setting. In section 2 the Action Design Research method is explained and how this is integrated in a Living Lab environment. Section 3 gives insight in the prototyping phase of the health and wellbeing platform. Finally, before the conclusion and future work is discussed, the first usability test of the platform is described in Section 4.

2. Action Design Research method

Our research falls in the design research tradition, which is a well-established sub-branch of information systems e.g., [13, 14]. To be more precise, we draw on Action Design Research (ADR) that stresses the relevance circle of Hevner [15] by providing guidance for combining building, intervention and evaluation of an IT artifact in a concerted research effort [16]. Fundamentally, ADR is a study of change and particularly appropriate for our research 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 (See Figure 1).

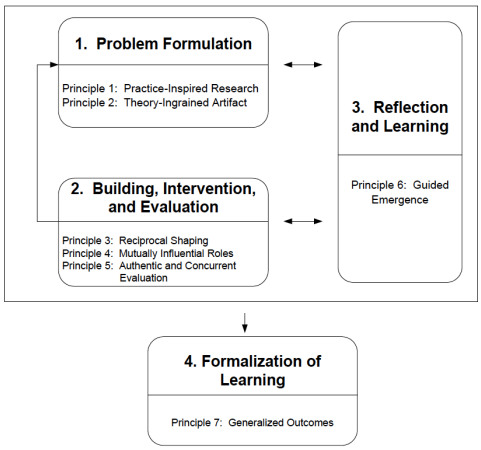

Fig. 1. ADR design stages and related principles according to Sein, Henfridsson [16] page 41.

Action Design Research should generate knowledge that can be applied to a class of problems that the specific problem exemplifies. As a result, the research activity is problem-inspired and combines thinking with doing [17, 18]. We assume that complex social processes are best studied by introducing change into this processes and observing their effects. Therefore, we illustrate ADR in a real-life context, developing an online health and wellbeing platform (i.e., the IT artifact). The ADR method contains four stages: 1) Problem Formulation, 2) Building, Intervention and Evaluation (BIE), 3) Reflection and Learning, and 4) Formalization of Learning. Each stage anchored by principles that captures the underlying assumptions, beliefs and values. To reflect on the ADR process and to track the iterative design steps, the action design researcher kept an observation log on a daily basis over the period 2013 ï 2015 amounting up to 700 pages. Next to that, the logbook is used as a scientific record [19] and contains the decision steps related to the design process.

2.1. Earlier research on the platform

Earlier research on the health and wellbeing platform covered the first stage of the ADR design cycle: ópproblem formulationô ([20-23]. In this part of the research we structured the problem and identified the solution possibilities to guide the design [24]. As a result of the first design stage, we categorized the suggested features extracted from 70 interviews and 2 focus groups for the health and wellbeing platform before moving to the second stage: the óBuilding, Intervention and Evaluationô phase. See table 1.

Table 1. List of main features for the platform.

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

Table 1 illustrates the multiplicity of requirements for platform functions, ranging from basic information exchange towards active recommendations for services and matchmaking, and from pure focus on transactions towards inter-active communication with end-users. Based on the aforementioned features, the platform would be a first mover in the Netherlands to combine and offer; 1) matchmaking between providers of smart living products and services and end-users, 2) finding local activities, 3) connecting with others (e.g., family, caretakers), 4) information about aging-in-place and, 5) integration of successful, existing platforms in the health and wellbeing domain.

2.2. Living lab setting

To enter the stage of óBuilding, intervention and evaluationô we moved from a pure academic environment to a Living Lab setting. The Living Lab approach represents a research methodology for sensing, prototyping and validating complex solutions in real-life contexts. Studying behavior in a real-life context allows researchers to gain a better understanding how the creation of artifacts fit into the complexity of daily life [25]. Living Labs thus can be

considered as user-centric environments providing open collaborative innovation. For a successful societal deployment of the proposed platform we needed to address end-usersô as well as external stakeholder needs in concert. Feedback from end-users in an early stage of the technology development phase, on elements like relevance and usability are crucial to give a boost to both utilization and delivered value of the application [26]. Understanding the (potential) user can help minimizing risks of a technology introduction.

To acquire commitment from stakeholders, to enter a Living Lab, required a lot of effort and resilience of the ADR team. Healthcare related systems are extremely complex and it takes a lot of time to gain understanding, especially when there is no subsidy or monetized compensation involved related to the stakeholdersô efforts. After several attempts and initial failures related to time, money and priority constraints, we managed to assemble a consortium with multiple stakeholders from eight different disciplines (i.e., municipality, multinationals, SMEs and end-users) that committed themselves to the Living Lab. Important drivers for the stakeholders to invest in this 10 month pilot are related to 1) market access to the health and care domain 2) competitive advantage and 3) business opportunities (*nn* DESRIST 2015).

Our Living Lab can be described as a Quadruple Helix: a co-operation between large and small-medium enterprises, the university, public organizations and end-users [27]. In most Living Labs end-users are often consulted óafter the arrow has left the bowô, but there are clear benefits to the inclusion of, for instance, citizens in a preliminary stage of the design [28, 29]. The focus of our public sector-centered Living Lab is on the development of public services, so that the municipality can function better and offer new and better products and services to the citizens. To do so, we incorporated user-centered design (UCD), an approach that involves end-users (i.e. elderly and caretakers) throughout the development process, to ensure that the proposed platform technology meets their needs.

2.3. Building Intervention and Evaluation phase

The second stage of ADR uses the problem framing and theoretical premises adopted in stage one carried out as an iterative process in a Living Lab setting. This phase interweaves the **B**uilding of the IT artifact, the **I**ntervention in a real-life setting and the **E**valuation of the IT artifact (BIE). See Fig. 2. During the first BIE iteration, the ADR team challenges participantsô existing ideas and assumptions about the platformôs specific use context in order to create an alpha version of the prototype.

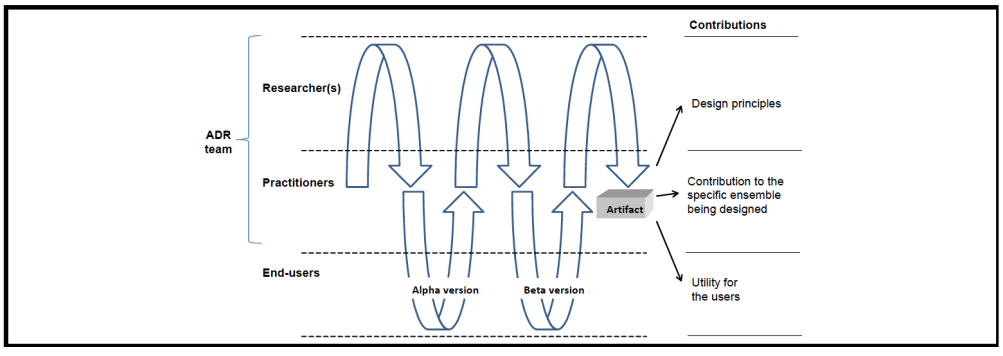

Fig. 2. BIE iterations according to Sein, Henfridsson [16] page 43.

3. Building the alpha version of the prototype

In order to track real-time problems during the design process we are using the agile scrum method based on flexibility, adaptability and productivity [30].

As a first step, the ADR team elaborated on the main features (i.e., marketplace products and services, contacts, local activities, information exchange and integrating existing platforms) for the prototype (See paragraph 2.1) and translated these features into a navigation map from an end-user perspective (Fig. 3).

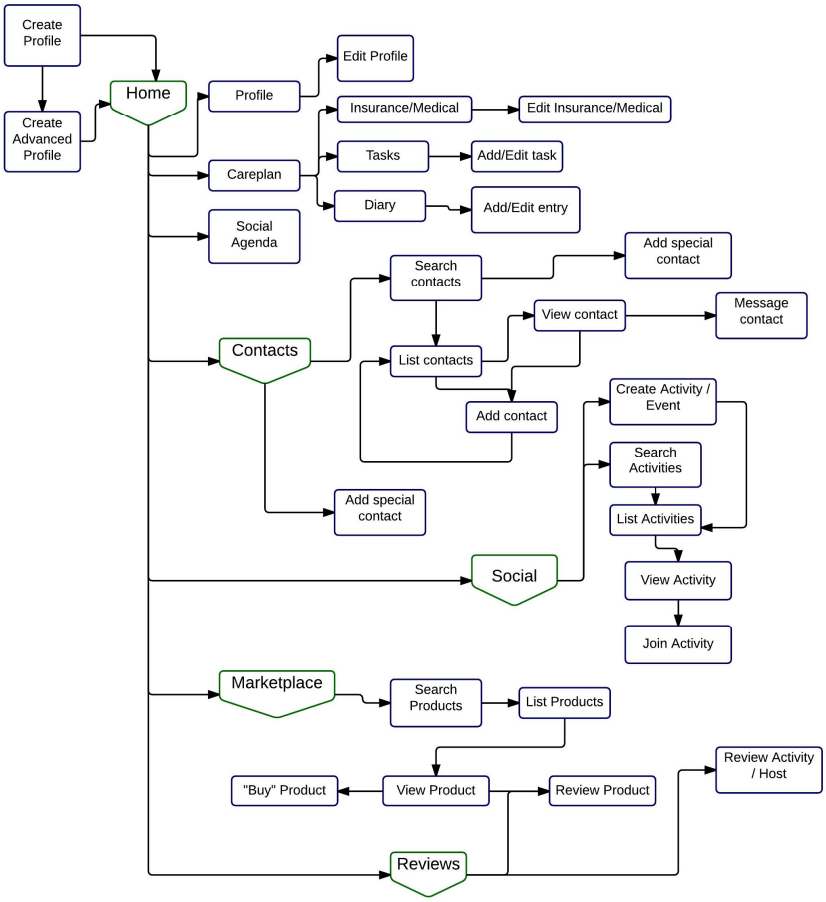

Fig. 3. Navigation map of the Alpha version of the platform.

Based on the main features, the Alpha version of the platform 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 health and wellbeing profile which can be extended with a personal Care Plan. The rationale behind the Care Plan is that people themselves can be the center of action-taking related to 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 the end-user perspective.

3.1. Building the mockups

As a second step, the ADR team elaborated further on the suggested features to visually represent them in mockups from the perspective of an end-user (Fig. 4 presents the mockup of the Care Plan). Several user-centric design principles were considered in this effort such as visual hierarchy, simplicity and usage of familiar patterns from successful IT artifacts (e.g., Facebook, google calendar) during the design of the mockups.

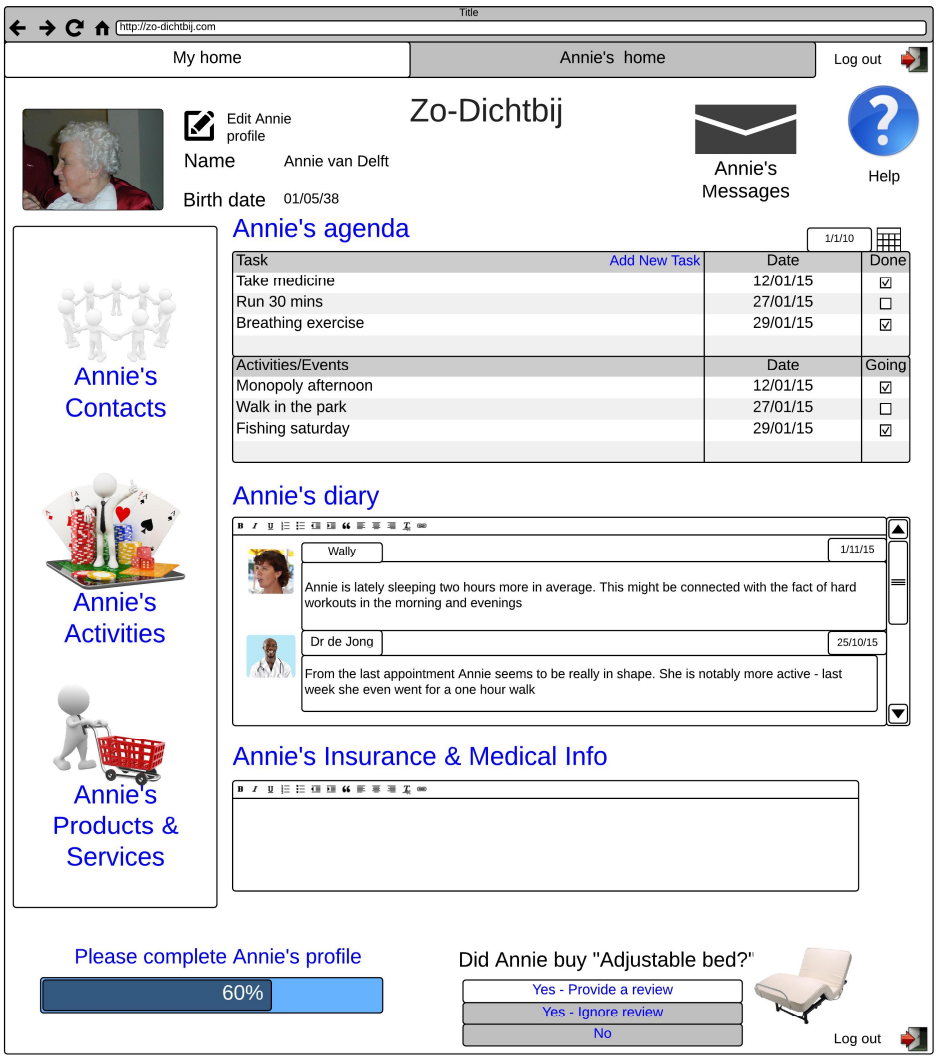

Fig. 4. Mockup of the Care Plan.

Figure 4 is the mockup that represents the view of an informal caretaker responsible for an older person (i.e., Annie). This is illustrated in the top bar of the mockup where it is shown on whose profile the user is acting, self (My home) or some elseôs (Annieôs home).
There are five key elements on the Care Plan:

(1) The left menu gives access to the three main features earlier identified as requirements, such as contacts, activities and smart living products and services.
(2) The agenda; this contains the tasks assigned to the user (i.e., Annie) given by a doctor, caretaker or relative (or any other user with the permission) related to Annieôs 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 left menu) as part of her social agenda.
(3) The diary; this keeps a record of events, observations and experiences of Annie so others can have a traceable log of Annieôs health and wellbeing.
(4) Insurance and medical info; this contains the insurance policy file of Annie and other medical information that is important for Annie and those surrounding her.
(5) The bottom notification section; this reminds the user to complete the profile (so relevant social activities can be suggested for Annie) and to review products and services acquired (in order to present the feedback to other users and to reduce the customerôs perception of risk with 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 if the profile owner allows this. 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 in the context of health and wellbeing. In other words, this functionality allows efficient handling of information for those involved in the care of others.

The proposed platform is a multi-sided platform offering services to individuals and to providers who offer services to the individuals. Such platforms require special attention to privacy because each transaction within the platform is somehow related to personal data of the individual. The platform will be compliant with privacy-by-design principles throughout all the development phases and the entire lifecycle. Consideration of appropriate use of existing Privacy Enhancing Technologies (PETs), as well as the EU Data Protection Directive (Directive 95/46/EC) will be made.

4. Evaluation of the alpha version of the platform

To assess whether the ADR team was on the right track, a usability test was conducted almost immediately after the first clickable model of the platform was developed. Two important considerations when conducting usability testing are (1) to conduct a test where representative participants interact with representative scenarios and (2) to ensure that an iterative approach is used [31]. In the test, data on the time that the participants took to complete the given tasks, as well as the satisfaction with the experience has to be collected. This data is both quantitative and qualitative and will be incorporated in a detailed report that can be used by designers, to make changes and test the artifact again. Leavitt and Shneiderman [31] suggest that usability testing should be performed early in the design process with a small number of users (approximately six) in order to identify problems with the navigation and overall design issues. Once the navigation, basic content, and display features are in place, quantitative performance testing (e.g., measuring time, wrong pathways, failure to find content) can be conducted to ensure that usability objectives are met. Besides providing valuable input for the evolution of the artifact towards a *usable tool*, the role of the usability test is to measure the artifact acceptance in the early stages of the design.

The first usability test was in a physical environment, which means the tester and the participants were in the same physical location. The test was intended to determine the extent to which the userôs interface facilitates the userôs ability to complete key tasks. This was conducted with a group of six potential end-users (i.e., elderly, voluntary caretakers and professional caretakers) that were asked to complete a series of tasks with an end goal. Sessions were recorded and minutes were taken to identify critical areas for improvement of the artifact. Table 2 summarizes the usability test tasks along with the criteria set.

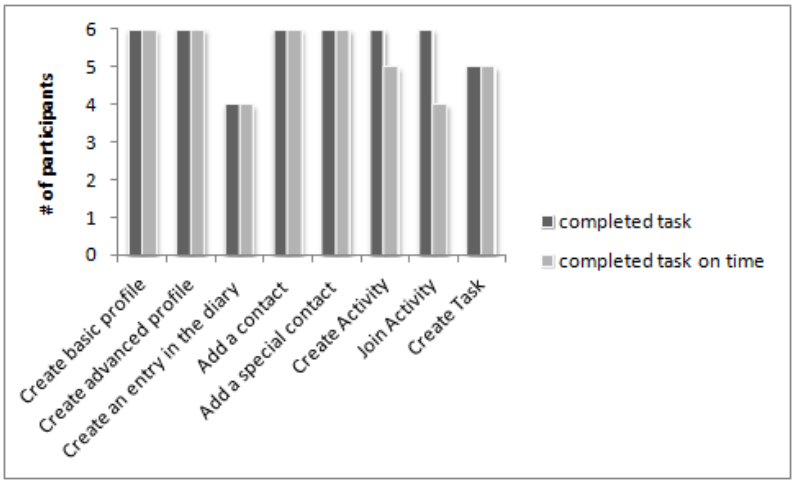

Table. 2. Usability test tasks and criteria (N=6)

These tasks are related to the three functionalities described in the mockup for which a clickable model was developed in this first iteration. Our benchmarking norm is 5 out 6 successful tasks by the participants as suggested by Leavitt and Shneiderman [31]. As a result only one task (ócreate an entry in the diaryô) didnôt fulfill the completion criteria, and two (ócreate an entry in the diaryô and ójoin activityô) the time criteria. The diary concept/functionality in the artifact was not clear for everyone and needs to be revisited and enhanced; participants were unfamiliar with the type of text input that we offered.
In a post-test survey participants were asked whether they would use/recommend the platform as well as their satisfaction with their experience; all the participants (6/6) agreed that they would use or recommend the platform if available and 4 out of 6 participants rated 4 or 5 in a scale of 1 to 5 the user experience of the artifact. The prototype tested was a simple HTML model with no efforts on visual design as yet. Participants also provided qualitative input during the usability test. Font and images size, simplicity and structure of the artifact were praised; whereas specific functionalities as the diary were suggested for improvement.

5. Discussion and conclusions

Early acceptance of the platform is critical in this research; therefore the results given by the usability test suggest that the right steps are being taken during design stage. Using familiar patterns when designing a prototype helps potential users to feel more acquainted with the artifact. Preparing a clickable interactive model for a usability test is a much smaller effort compared to the one when a fully functional artifact is provided, however we consider that the effects of testing could be comparable. Although the participants are not provided yet with a full experience, the usability test can be designed in a way that really evaluates critical elements of the artifact based on specific tasks and goals given to the participants as a controlled setting, creating the *feeling* a finalized artifact. Therefore, the approach taken in this iteration for the evaluation of the design of the platform is suggested for next iterations. Based on the recommendations of the first testers, we will include the mock-up of the design in a large-scale survey (i.e., elderly and informal caretakers) for further data gathering on the subject. In parallel with the data-analysis of the survey, field tests of the clickable model of the platform are foreseen with different groups of informal caretakers, district nurses and potential end-users (age group 55 ï 75). These evaluation moments, that ensure effective participation of end-users, are part of the iterative design steps of the overall ADR project.

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Prototyping a Health and Wellbeing Platform: an Action Design Research Approach

Abstract

At present, healthcare providers are offering an overwhelming range of smart living products and services to support elderly in their daily routine and enhance their independent lifestyle. However, even smart living services that are technologically feasible and acceptable have not reached the mass-market yet, as end-users cannot find them in today's fragmented marketplace with an overload of information. Basically there is a mismatch between demand and supply. We argue that a multi-sided platform for health and wellbeing is required to help end-users search for smart living services and simultaneously supports service providers promoting their products. In this paper, we present the first prototype for such a platform that is developed in a Living Lab setting in the Netherlands. Next to that, this paper illustrates our Action Design Research (ADR) journey and the iterations and evaluation moments to support people age-in-place. Besides platform design, the project also delivers process knowledge on how to implement ADR in a real-life setting.

1. Introduction

Technologies, like mobile devices, wearable and sensors combined with advances in data analytics, are increasingly enabling elderly people to stay as independent as possible and at the same time enhancing their quality of life. Quality of life is related to the smart living concept and emphasizes a safe home environment, good health conditions and social cohesion of the individual [1]. Smart living allows us to connect our daily activities at home, along the way, or anywhere else, supported by integrated ICT [2]. It encourages us to look outside our homes, and involves the neighborhood as well [3]. 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.

Although feasible smart living products and services to support independent living are widely available in Western countries, bringing them to market is challenging due to the lack of viable business models [4]. One of the major issues is that there are no common platforms in the health and wellbeing domain that providers can utilize to bring their products and services to end-users [5]. Such platforms should not only integrate various health services (e-Health included) but also convenience and entertainment services. Most research on independent living and e-health focuses on technological issues and ignores social and organizational issues [6]. Only recently, research is shifting towards issues of strategy, organizational change and technical platforms [7]. Academic work on how to bring independent living and e-health services to market is scarce with only a few earlier published studies [8-10].

Due to various reasons end-users are often unaware of how technology can help them. At the same time, service providers are unaware of the specific needs of end-users. In other words, a bridge is needed between the technology-focused smart living solutions and the demands in everyday life of end-users. This paper presents the results of a Living Lab study addressing this gap in the smart living domain that has been conducted over the period 2013-2015. Within the study, a conceptual design of a multi-sided health and wellbeing platform was created and evaluated in a living lab environment, which was initiated by the present authors. Besides content-related insights into the platform itself, the project also delivers process knowledge on how to set up and conduct Living Lab environments for smart living.

Although related work on Living Labs related to elderly [11, 12] is available, the combination of platform development for the elderly in a Living Lab setting is not appropriately addressed elsewhere. For instance, in the European Network of Living Labs (ENoLL) a few Living Labs like CareVille and InnovAge focus on user-centred innovation for elderly care, but they do not involve platform development as a tool for the elderly. Our Living Lab approach is based on Action Design Research (ADR), which has been suggested by Sein, Henfridsson [13]. ADR is particularly appropriate for living lab environments 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. Action Design Research should generate knowledge that can be applied to a class of problems that the specific problem exemplifies. Next to that, ADR is based on an artifact and emphasizes the interdependence of building, intervention and evaluation. As a result, the research activity is problem-inspired and combines thinking with doing

[14, 15]. The ADR method contains four stages: 1) Problem Formulation, 2) Building, Intervention and Evaluation (BIE), 3) Reflection and Learning, and 4) Formalization of Learning. Each stage anchored by principles that captures the underlying assumptions, beliefs and values. To use ADR in practice, we developed an artifact in a Living Lab context while constantly reflecting on the process.

To track the iterative design steps, the author (i.e., Action Design Researcher) kept a logbook on a daily basis over the period 2013 – 2015 amounting up to 700 pages. Next to that, the logbook is used as a scientific record and contains the decision steps related to the research process [16].

Table I. Decision steps from daily logbook (fragment Feb – March 2013).

Date	Decision step	Milestone
4/2/2013	Keep up a diary to track iterative design steps of the research project	Logbook (with 700+ notes)
16/2/2013	Arrange an expert group for the research project	Expert team
18/2/2013	Describe first hunch of the platform project	Conceptual model
1/3/2013	Labeling interview conversations about Smart Living and possible solutions	Coded interviews
4/3/2013	Look into design theory as a research method	Action Design Research
6/3/2013	Literature review: Platform theory, Stakeholder management/Smart Homes	Kernel theories
8/3/2013	Summarize and code 59 interviews	Analysis of interview data
25/3/2013	Description of who is collaborating in the project	Stakeholder road map
26/3/2013	Involve stakeholders and end-user groups (i.e., elderly)	Part of Living Lab Setting

Although, the recorded decision steps sometimes just led to miniature milestones, all decision steps are traceable for the Action Design Researcher.

The remainder of this paper presents the first ADR stage based on two series of exploratory interviews with stakeholders, subsequently followed by two rounds of focus group meetings. This is the first step in a research project in which such a platform will be designed, prototyped, implemented and evaluated in reality. In section 3, the second ADR stage is described based on a Living Lab setting and how agile scrum is used to design the platform in small iterative design steps. Section 4 provides the discussion. As in Section 5 the lessons learned and recommendations for future work are described.

2. First ADR stage: problem formulation

Our goal is to design, prototype, implement, and evaluate a smart living platform in a Living Lab environment. To do so, we used mixed research methods: combining qualitative and quantitative research in one single case study to get to the core of the research problem [17] and properly address rigor and relevance of the research. For the first ADR stage (i.e., problem formulation), 70 stakeholder interviews were conducted (See 2.1) and two focus group rounds were arranged (See 2.2). While the primary aim of this ADR stage was to unravel the conceptual design of the platform, a secondary aim was to engage potential stakeholders who could be partner in a Living Lab setting.

2.1 70 Interviews with stakeholders

First, we explored why smart living services do not take off, yet. Through eleven exploratory interviews with different stakeholders (i.e. installer, opinion leaders and manufacturers), we found that end-users lack awareness of what smart living solutions are available and how these solutions could fulfill their needs. These interviewees had a track record in the smart living field. At the same time, we discovered that service providers had problems to reach end-users and to market and promote their products and services. According to the interviewees a solution was required to solve this mismatch between demand and supply.

After that, we arranged 59 semi-structured interviews with potential user groups and various stakeholders, to develop a solution for the problem elicited and to address the mismatch between demand and supply *[NN, ICOST 2014]*. Interviewees were selected in three stakeholder groups that each represent a different side of the platform: Two external stakeholder groups, like 23 strategic level stakeholders (i.e., knowledge institutes, government and funding partners), 17 affiliate level stakeholders (i.e., service and technology providers) and 19 potential end-users (i.e., care providers and citizens). The rationale behind these interviews was to explore the problem statement and to identify the willingness of the stakeholders to enter a Living Lab setting. Based on the interviews we elicited 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; and 2) a *portal* for bundled smart living services and solutions (business to consumer), driven by the one-stop-shop philosophy for aging-in-place and 3) an *intervention instrument* for the municipality (government to consumer) to interact with citizens about needs for services and questions

about the different health care arrangements. Ultimately, such a platform should enable end-users to enhance self-management (i.e., independency) by the provision of relevant information and support in matchmaking between different stakeholder groups (i.e., consumers, providers and government). Eventually the platform has to enhance the quality of life of end-users.

2.2 Two focus group rounds

To evaluate our first ideas, and in order to explore different requirements for the platform, we arranged two rounds of focus group meetings, with in total 28 participants [*NN, ACIS 2014*]. Focus groups are informal group discussions among a small group of individuals in which different views and experiences are explored through group interaction [18]. They can be considered as group interviews, whose purpose is to collect qualitative data. We used the focus group method as a secondary research goal to: 1) validate the basic platform features (i.e., online community, portal and intervention instrument), 2) to elicit the first functional and non-functional requirements of the platform, and 3) to shape the outline of the tentative design of the platform. During the focus group meetings we discussed 13 basic requirements for the digital platform (See table II and III).

Table II. Requirements of the platform according to the participant itself (n =13)

	Mean ($\bar{X}$)	**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

Although the average score for all requirements in this 7 points scale was between beneficial and very beneficial ($\bar{x}$ between 4.23 and 6.39), there is a difference in perception if the participants (n = 27) take themselves into account for the platform (n = 13) (See table II), or if they refer to parents or grandparents (n = 14) (See table III). For instance if the younger participants (age < 55) took themselves into account, it was clear that the participant was not ready to use a matchmaking platform for health and wellbeing. The rationale behind this assumption is that younger participants do not see themselves as the target group, yet. Nevertheless, all participants in this age group were sure that a health and wellbeing platform could help them in the (near) future.

Table III. Requirements of the platform referring to parents or grandparents (n =14)

	Mean ($\bar{X}$)	**Standard Deviation (SD)**
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

Participants that refer to themselves as potential users for the platform mentioned *Information about local activities* ($\bar{x}$ 6.39), *Contact with others* ($\bar{x}$ 6.08), and *Integration of local platforms* (($\bar{x}$ 6.08) as most beneficial requirements. Also the *Integration of local* ($\bar{x}$ 6.08) and *National platforms* ($\bar{x}$ 5.46) for health and wellbeing in the platform is pointed out as beneficial, mainly to avoid that developers 'invent the wheel' again. Most participants prefer the integration of existing, trustworthy and well-known web applications for health and wellbeing. Participants below 55 (n = 6) that refer to themselves, have no specific need for products and services that are related to healthcare, 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), by means that it can directly add something to their comfortable lifestyle.

The main target group for the platform is foreseen for the young elderly (i.e., 55 to 75 years old). According to the participants of the focus groups, the rationale behind this assumption is that 1) this group of people is used to live a comfortable life and want to continue their lifestyle in the (near) future, and 2) they take care of their relatives and can function as an intermediary between the platform and their relatives.

To elaborate on the main features we introduced personas as vivid descriptions of the potential platform user [19]. For example, personas like Annie and Kees (See figure 1), who like to age-in-place, have their own pains and gains to achieve this.

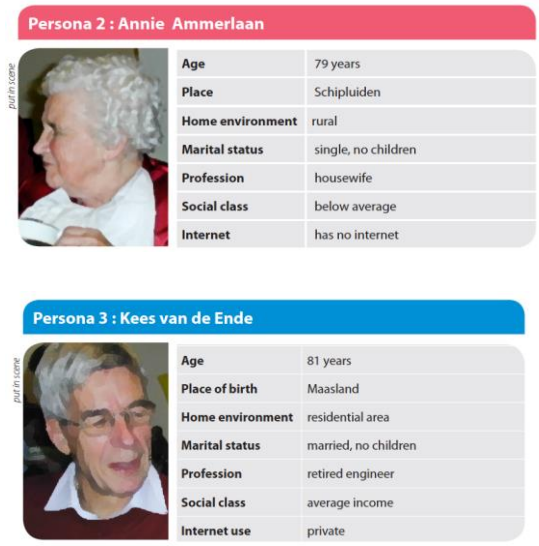

Fig. 1. Two examples of Personas used in the study (fragment).

The aim of the focus group sessions was to assess whether using personas, as a user-centered design tool, would lead to a better understanding of the end-user. During two expert meetings these personas were further improved and applied as an input for scenario descriptions. For instance, frail elderly like Annie who have no kids and are not tech-savvy, need an intermediary that can guide them through the complexities of the Dutch health and social care system. The goal of the personas and their associated task scenarios is to describe what the current customer journey looks like from different perspectives and, next to that, if and how a platform could support potential end-users to age-in-place. Both tools are used to focus attention on problems and opportunities of a specific target audience. While the initial phase sets the generic scope and functional requirements for the platform, the next step was to instantiate the design in a real-life setting. To do so, we managed to establish a Living Lab in a metropolitan area in the Netherlands with eight different stakeholders.

3. Second ADR stage: Building, Intervention and Evaluation

The second stage of ADR uses the problem framing and theoretical premises adopted in stage one, carried out as an iterative process in a Living Lab setting. In a Living Lab, research and development moves from a pure academic environment into a real-life setting, with a multi-disciplinary network of people and organizations. Living Labs are emerging Public Private Partnership (PPP) concepts in which different stakeholders from the public and private sector work together to create, prototype, validate and test artifacts in real-life contexts [20]. We argue that designing a multi-sided platform can only done by addressing end-users' as well as external stakeholder needs in concert. It demands collaboration of stakeholders from multiple sectors to contribute to the required resources [21]. Since the municipality is our launching customer, it was important to assemble the Living Lab according to a local community setting. To acquire commitment from stakeholders, establishing a Living Lab, required a lot of effort and resilience of the research team. Healthcare related systems are extremely complex and it takes a lot of time to gain understanding. Especially when there is no subsidy or monetized compensation involved related to the stakeholders' efforts. After several attempts and initial failures, we managed to assemble a consortium with multiple stakeholders from eight different disciplines (i.e., municipality, multinationals, SMEs and end-users). Important drivers for the stakeholders to invest in the Living Lab are related to 1) market access to the health and care domain 2) competitive advantage and 3) business opportunities. All partners committed themselves to a ten months pilot project as part of the Living Lab. Our Living Lab can be described as a Quadruple Helix: a co-operation between large and small-medium enterprises, the university, public organizations and end-users [22]. In most Living Labs end-users are often consulted 'after the arrow has left the bow', but there are clear benefits to the inclusion of, for instance, citizens in a preliminary stage of the design [23, 24]. The focus of our public sector-centred Living Lab is on the development of public services, so that the municipality can function better and offer new and better products and services to the citizens. To do so, we involved end-users direct from the start of the design process.

3.1 Architecture design

The project draws on a set of reference platforms for inspiration and practical guidance. Next to that, the architecture is based on existing, successful online platforms, recognizing their value, the tensions and dilemmas around trust, privacy and security, that users encounter every day. In order to track real-time problems during the design process we are using the agile scrum method based on flexibility, adaptability and productivity [25]. To do so, we worked in different scrum teams in parallel: 1) specifying the critical design issues of the platform, 2) establishing a project plan, 3) developing a first template of the platform architecture, and 4) designing mock-ups as basic input for the platform prototype.

In a first workshop round within the Living Lab the list of main features of the platform (See table II and III) were evaluated. This evaluation step verified the multiplicity of requirements for platform functions, ranging from basic information exchange towards active recommendations for services and matchmaking, and from pure focus on transactions towards inter-active communication with end-users and even sharing a Care Plan. Based on the aforementioned features, the platform would be a first mover in the Netherlands to combine and offer 1) matchmaking between providers of smart living products and services and potential end-users 2) finding local activities 3) connecting with others (e.g., family, caretakers) via a Care Plan 4) information about aging-in-place and 5) integration of successful, existing platforms in the health and wellbeing domain.

In a second workshop, the technical architecture was further specified, by designing a Project Start Architecture (PSA) based on NORA, which is an acronym for the Dutch government reference architecture [26]. The reason to use this framework is to embark on a growth curve in maturity and to take the scalability potential of the platform into account. The PSA contains ten basic principles that relate to the provision of public services, and includes all activities through which service-providers carry out public tasks. Next to that, we developed a template to get an initial idea of the platform architecture. For example, the platform contains an Application Programming Interface (API) as well as an Application (APP) store, and the emphasis is on a web-based application as the main interaction point with the users. Because compliance with rules on data protection and security is vital for healthcare applications, the platform will be compliant with the highest available Dutch standards for data security on a database level (i.e., NEN 7510) to share medical information. To reflect on the design process we proposed a first practical guideline how to develop an artifact in a complex environment using ADR *(NN DESRIST 2015).*

In a third workshop the Living Lab stakeholders elaborated on the critical design issues that were extracted from earlier research and zoomed in on *trust* and *user data privacy*.

As a next step, all input gathered during the workshops, are translated into twenty mock-ups as a basis for the alpha version of the artifact. To make sure every small iterative design step was validated from the beginning, we included potential end-users in the whole design process as well and conducted a first usability test with a first group of end-users *(NN ISD 2015 under submission).* Early acceptance of the platform is critical in this research. Using familiar patterns when designing a prototype helps potential users to feel more acquainted with the artifact. This is also applicable for the consistency in the navigation and other elements of the interface. Preparing a clickable interactive model for a usability test is a much smaller effort compared to the one when a fully functional artifact is provided, however the effects of testing can be comparable. Although the participants of the usability test were not provided with a full experience, the test was designed in such a way that it evaluated critical elements of the artifact based on the tasks and goals given to the participant creating the *feeling* a finalized artifact. Therefore, the approach taken in this iteration for the evaluation of the design of the platform is suggested for next iterations. Based on the input extracted from the first usability test the mock-ups are translated in a prototype of the platform for the Dutch market. See Figure 2.

Figure 2. Prototype of the homepage "Zo-Dichtbij" from Annie (for the Dutch market).

Figure 2 is a representation of the Care Plan of Annie, with contains five key elements.

(1) The left menu gives access to all the main features earlier identified as requirements, such as contacts, activities, smart living products and services, and information about aging-in-place.

(2) The agenda; this contains the tasks assigned to the user (i.e., Annie) given by a doctor, caretaker or relative (or any other user with the 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 left menu) as part of her social agenda.

(3) The diary; this keeps a record of events, observations and experiences of Annie so others can have a traceable log of Annie's health and wellbeing.

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

(5) Next to that, there is a possibility to review products and services acquired (in order to present the feedback to other users and to reduce the customer's perception of risk with the platform when purchasing products and services).

The Care Plan can be used by the elderly end-user, or shared with relatives, a district nurse or even a care broker, but only if the profile owner allows this. 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 in the context of health and wellbeing. In other words, this functionality allows efficient handling of information for those involved in the care of others.

3.2 Survey sample

Based on the recommendations of the first usability testers, we included the homepage of the design in a widespread end-user survey. The first of the four stakeholder groups that received the survey (April 2015) was a panel of 400 voluntary caretakers from the Tympaan institute in the western part of Holland. This research institute focuses on the *quality of life* in the social domain, ranging from youth and culture to care and voluntary participation. Within two weeks we received a total response of 152 (38% response rate), 82 female (54%) and 68 male (64%). 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 voluntary caretakers (25% > 9 hours a week), matches the main target group for the platform. One of the questions was: *Who will benefit from the platform?* See table IV. In a 7-points scale the average of all items got a score above 4. The one sample t-test with 95% confidence interval shows that all suggested end-user groups would somehow benefit from the platform.

Table IV. Descriptive statistics and one sample t-test for "Who will benefit from the platform?"

Statistics				Test value = 4		Test value = 5	
Variable	N	Mean	Std. Deviation	Sig. (2-tailed)	Mean Difference	Sig. (2-tailed)	Mean Difference
Citizens in general	128	4.71	1.883	.000	.711	.085	-.289
Young elderly (age 55 - 75)	128	5.17	1.517	.000	1.172	.202	.172
Elderly (75+)	126	5.22	1.971	.000	1.222	.208	.222
People with physical disabilities	123	5.44	1.685	.000	1.439	.005	.439
People with mental disabilities	125	4.90	1.932	.000	.904	.580	-.096
Product providers	120	4.67	1.853	.000	.667	.051	-.333
Service providers	120	4.90	1.826	.000	.900	.550	-.100
Voluntary caretakers (relatives included)	133	5.94	1.353	.000	1.940	.000	.940
Volunteers	124	5.81	1.480	.000	1.806	.000	.806
Municipality (Social Act Care)	122	5.41	1.840	.000	1.410	.015	.410

However if we consider anything above 5 (test value = 5) to be of 'strong' benefit, *People with physical disabilities, Voluntary caretakers (relatives included), Volunteers, Municipality (Social Act Care)* would benefit the most. *Citizens in general* and *service providers* are seen as the group of people who would 'slightly' benefit from the artifact. Nevertheless the respondents confirmed that the design of the platform meets the criteria of targeting its main group of end users (i.e., elderly and those that surround them).

Table V. One sample t-test for "Which elements of the platform would be important?"

Statistics				Test value = 4		Test value = 5	
Variable	N	Mean	Std. Deviation	Sig. (2-tailed)	Mean Difference	Sig. (2-tailed)	Mean Difference
Marketplace products and services	115	4.34	1.942	.064	.339	.000	-.661
Careplan (medical information and insurances)	124	5.48	1.679	.000	1.476	.002	.476
Agenda for social and medical activities	122	5.27	1.505	.000	1.270	.049	.270
Personal profile	118	4.64	1.856	.000	0.644	.039	-.356
Review possibilities product and services	116	4.70	1.761	.000	.698	.067	-.302
Finding local activities	122	5.44	1.455	.000	1.443	.001	.443
News about health and wellbeing	122	5.58	1.425	.000	1.582	.000	.582
Diary (to share with relatives and caretakers)	125	4.78	1.899	.000	0.784	.206	-.216
Anonymous use	125	5.31	1.977	.000	1.312	.080	.312
Available for different devices (mobile, tablets)	125	5.27	1.948	.000	1.272	.121	.272
Private and secured	126	6.39	1.277	.000	2.389	.000	1.389
Search based on keywords	123	6.06	1.308	.000	2.057	.000	1.057
Local search (postal codes)	124	5.26	1.724	.000	1.258	.098	.258
Multilingual	121	4.31	2.058	.096	.314	.000	-.686
Helpdesk online	122	5.46	1.745	.000	1.459	.004	.459
Telephone helpline	122	5.63	1.697	.000	1.631	.000	.631

Another question was: *Which elements of the platform would be important?* See table V.

Again the average of all items got a score above 4. The one sample t-test (95% confidence interval) for value 4 shows that all features, except '*marketplace products and services'* with ($\bar{x}$ 4.34), are important features in the platform. The most important features for this group of voluntary caretakers is: *News about health and wellbeing* ($\bar{x}$ 5.58); *the Care plan* ($\bar{x}$ 5.48); *finding local activities* ($\bar{x}$ 5.44), the *Agenda for social and medical activities* ($\bar{x}$ 5.27) and the *Diary* (($\bar{x}$ 5.44). Extra functionalities that are of importance are *privacy and security* ($\bar{x}$ 6.39); search based on keywords ($\bar{x}$ 6.06) and the availability of a *helpdesk by telephone* ($\bar{x}$ 5.63) or *online* ($\bar{x}$ 5.46).

4. Discussion

Agile development relies heavily on user feedback. That is why the ADR team integrated an inclusive design into the platform application as early as possible. The best way to describe the agile developing process is based on *adaptability*, *simplicity* and *communication* [27]. Our general motivation to include the end-user in the ADR process is the adaptability to new obstacles as soon as they pop up. Accordingly, the ADR team adjusted the goal-setting procedures, confided to what the end-user states in a simple platform solution. Furthermore, communication with our target groups is crucial to understand the abilities, morals and mindsets of the elderly people. Therefore, the ADR team included end-users (i.e., elderly, voluntary and professional caretakers, service-providers and representatives of the municipality) in every iteration step. Not only as part of interviews and focus groups but also in the usability tests and the surveys.

Reflecting on the process, the multiple iteration steps supported the robustness of the study. To use multiple viewpoints (i.e. interviews, focus groups and surveys) to evaluate the artifact, we were able to improve the platform before moving to the next design step.

From the first survey analysis related to the Tympaan panel of voluntary caretakers, we learned that:

1) Although the average age of the respondents is above 71, they are perfectly capable to see the benefits to integrate platform technology as one of the instruments to support aging-in-place.
2) People in the age between 55 and 75 can be seen as an intermediary for those who need help aging-in-place. Technology-wise there are no real hurdles.
3) Privacy and security of the platform is an issue related to the trustworthiness of the system.
4) A helpdesk (online or by telephone) is a crucial functionality, as back-up for the end-user of the platform.
5) Simple and seamless navigation, like searching based on keywords is core.

What was not totally clear to respondents was:

1) In order to use a *diary* or a *medical and social agenda*, you need to fill in a *personal profile*.
2) The link between seamless access to products and services for aging-in-place and the benefits for the users. A reason could be that respondents are not aware of products and services that could help them in the first place.
3) *Multi-lingual* features could be of importance for Non-Dutch speaking citizens.

These observations should be taken into account in the next research steps.

5. Conclusion and future work

The proposed online platform is a groundbreaking concept 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) finding local activities 3) connecting with others (e.g., family, caretakers) 4) information about aging-in-place and 5) integration of successful, existing platforms in the health and wellbeing domain.

We used the Living Lab setting to place the values of the stakeholders in the healthcare domain into a real-life context. This context both stimulates and challenges research and development, as public authorities and citizens will not only participate in the Living Lab, but also contribute to the whole innovation process.

This paper proposes a way of using ADR in design science to bridge the gap between theoretical propositions and successful adaptation of smart living platforms in daily practice, supporting people age-in-place. Accordingly, the ADR method gives us the opportunity to get a close look at the complexity of the design process when multiple stakeholders with different value propositions are involved. This understanding contributes to the design knowledge that is generalizable to other design projects. By maintaining a logbook the Action Design Researcher can track and trace the decision steps in the whole design process and this improves transparency, validity and reliability of the

research. Hence, researchers can use this method to create their own design science research studies.

In the next research step, the survey will be sent to at least three other stakeholder panels, like the Dutch patient bond, elderly bonds and the Dutch branch organization of voluntary caretakers for cross case analysis. As part of the iterative design steps of the overall ADR project, usability tests with different groups of informal caretakers, district nurses and potential end-users (age group 55 – 75) are foreseen, before implementing the prototype of the health and wellbeing platform in a real-life test setting.

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