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

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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	Output
2013/02/04	Keep up a diary to track iterative design steps of the research project	Logbook (with 700+ notes)
2013/02/16	Arrange an expert group for the research project	Expert team
2013/02/18	Describe first hunch of the platform project	Conceptual model
2013/03/01	Labeling interview conversations about Smart Living and possible solutions	Coded interviews
2013/03/04	Look into design theory as a research method	Action Design Research
2013/03/06	Literature review: Platform theory, Stakeholder management/Smart Homes	Kernel theories
2013/03/08	Summarize and code 59 interviews	Analysis of interview data
2013/03/25	Description of who is collaborating in the project	Stakeholder road map
2013/03/26	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 and preliminary outputs, all decision steps are traceable for the Action Design Researcher.

The remainder of this paper presents the theoretical framework (section 2) followed by the first ADR stage based on two series of exploratory interviews with stakeholders and two rounds of focus group meetings (section 3). 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 4, 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 5 provides the discussion. As in Section 6 the lessons learned and recommendations for future work are described.

2. Theoretical framework

As this research focuses on service providers and end-user issues in establishing and governing a business ecosystem for smart living, we base the theoretical framework on concepts of platform theory from a multi-sided market perspective, i.e., different 'independent' providers provide complementary products and services on the platform [17]. A service platform is an IT platform that enables, shapes and supports the business processes needed for delivering products and services and for improving the value proposition [18]. Technically a platform can be viewed as 'a hardware configuration, an operating system, a software framework or any other common entity on which a number of associated components or services run. Economically, platforms and their providers mediate and coordinate between various stakeholders, for instance between two or more groups of agents [19]. In 2009 Gawer [20] created a typology of platforms, to organize and categorize the distinct meanings of internal platforms, supply chain platforms, industry platforms and multi-sided markets or platforms.

Platforms typically consist of features such as search functionality, payment administration, authentication, security, data-access and identity management. As stated by Gawer and Cusumano [21] a platform should bring value to the overall system: 'it should be easy to connect to or to build upon to expand the system of use as well as to allow new and even unintended end-uses.' Most of the theoretical and empirical research on multi-sided platforms has focused on mature platforms [20, 22] and less attention has been given to issues in starting up a new platform [23]. These issues include strategies for attracting different user groups of a platform and attaining a critical mass. From an economic point of view such a platform creates a multi-sided market and generally faces a critical mass constraint that must be satisfied if the business wants to be viable [22]. Therefore, the challenge is to figure out if a health and wellbeing platform is a viable solution and generates value from bringing end-users and members of different stakeholder groups together.

Platform theory is relevant because it provides insights in 1) how service platforms come to exist and develop, 2) how to identify potential and patterns for collaboration and 3) how to organize users and form a foundation for their interactions. Next to that, platform theory enables us to clarify

what has to be done when designing a service platform and how to involve different stakeholder groups in an early stage.

3. 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 [24] 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.

3.1 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 [25]. 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.

3.2 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 [26]. Focus groups are informal group discussions among a small group of individuals in which different views and experiences are explored through group interaction [27]. 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 [28]. For example, a Persona like Annie (See figure 1), who likes to age-in-place, has her own pains and gains to achieve this.

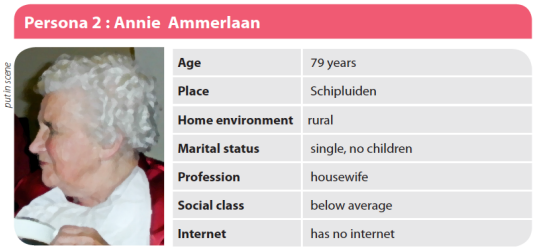

Fig. 1. Example of a Persona used in the study (fragment).

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 set the generic scope and functional requirements for the platform, the next step was to instantiate the design in real-life. To do so, we managed to establish a Living Lab in a metropolitan area in the Netherlands and embedded the ADR team (i.e., researcher, design team, providers, end-users and the municipality) in a real-life setting.

4. 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 [29]. 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 [30]. 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 [31]. 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 [32, 33]. 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.

4.1 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 [34]. 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. At the same time we arranged three different workshops with the Living Lab partners. See table IV.

Table IV. Workshops with Living Lab partners.

Date	Workshop goal	Output
Jan. 2015	Evaluation main features of the platform	List of requirements
Febr. 2015	Specifying technical architecture of the platform	Project Start Architecture
March 2015	Elaborating on critical design issues	Definition critical design issues
April 2015	Developing mock-ups for the platform	First prototype of the platform

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 [35]. 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 [36].

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 [37]. 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 Care plan "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.

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

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

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

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).

5. 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* [38]. 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, and can be seen as backup 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 will be taken into account in the next iterative design steps to improve the usability of the platform.

6. 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 and to come up with design guidelines. 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. As a follow-up a second survey is sent out to 1100 LinkedIn contacts from the Action Design Researcher (N = 500) and this convenient sample will be analyzed in the next research phase.

Theoretically, this paper provides the empirical basis for creating a design theory [39] on digital multisided platforms, which is currently still lacking in literature. While digital platform literature is often concerned with evaluating profitability for platform providers or the generative potential for app developers, our study is concerned with how platform functionalities affect the capabilities of elderly people. As such, our design theory will provide prescriptive statements on how to design and implement a multisided digital platform to improve the capabilities of elderly. Our starting point is the situated living lab context rather than theoretical propositions on how to design the platform, thus resembling the type-2 strategy as posited by Iivari [40]. For this reason, the present paper is limited to the building, intervention and evaluation steps in the first cycle of our ADR approach. As a next step, we will distill design guidelines on how to set up multisided platforms for health and wellbeing based on the lessons learned in the case, framed in theoretical notions of platforms and capabilities.

Our approach is design oriented, constructing a prescriptive artifact (i.e., a service platform) to an identified problem (i.e., service need in het smart living domain) and the artifact is subsequently taken through several specified phases in which it is constantly evaluated.

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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