Design dimensions of Digital Platform Ecosystems for Independent Living Services

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Abstract

This thesis summarizes the results of theoretical and empirical research, through a case-study approach, into a Framework for a Digital Platform Ecosystem (DPE) for Independent Living Services (ILS). A theoretical framework for a DPE is developed based on content analysis of selected articles from a literature review. This framework consists of seven design dimensions (building blocks): 'Network effects'; 'Governance'; 'Boundary resources'; 'Architecture'; 'Data governance'; 'Value-creating mechanisms'; 'Ecosystems and the wider environment', and at least two to six subdesign dimensions per design dimension. The framework is researched for the relevance of its subdesign dimensions, through a case-study approach, using an organization that qualified the research criteria for a DPE for ILS. Using Thematic Analysis (TA), the transcribed interviews of actor-participants were analyzed for themes. Participants also rated the subdesign dimensions for their relevance. This resulted in a final framework for a DPE for ILS for the case-organization. The framework can be by used by DPE's for ILS, which are at a developing stage, to gain an understanding of the design dimensions and subdesign dimensions of the DPE. It may also be used to establish a common understanding of the DPE between actors from a framework perspective as well as addressing responsibilities. Further validation of the framework should be undertaken contributing to triangulation of the results.

Key terms
Digital Platform Ecosystem, Design Dimension, Independent Living Services, Health Service Platform, Building Block, Framework.

Summary

Based on the main research question, three conclusions are drawn from this research:
1. The development of a theoretical framework that includes the design dimensions and subdesign dimensions for the Digital Platform Ecosystem (DPE) for Independent Living Services (ILS).
2. Empirical evidence for the relevance of this framework for the case-DPE that has been studied.
3. No alterations or changes by the study participants for the definitions used for the subdesign dimensions of this framework.

Starting from a theoretical background the thesis begins with an exploration of the DPE and its design dimensions (building blocks). The main focus is on DPE's and their design dimensions. As a broader understanding of what makes up a DPE and which elements it contains is still lacking this concludes in a problem statement and main research questions from the focus of ILS. Following this, a research approach was devised to address the available research literature between October 1st 2010 and October 1st 2020, applying a selected set of search terms through the digital library of the Open University. The resulting set of articles was reviewed in four phases, using 'EndNote', and concluded into a set of 14 articles which were included for the theoretical research. A theoretical framework for a DPE was then devised using the process of content analysis. This framework includes seven design dimensions and for each of these at least two and maximal six subdesign dimensions. This answers the first of the three sub-questions for the research.

The two remaining sub-questions were answered through the empirical stage of the research from chapter three of the thesis and onwards. This started with defining the research strategy concluding in the use of a case study strategy and defining the criteria for the case DPE. Also, a data collection approach including an interview protocol were devised. The qualitative research method of 'Thematic Analysis' (TA) was chosen to extract and identify codes from the interviews and to generate themes from these codes.
A Dutch based non-profit DPE for ILS was selected for interviews with the respective actor-participants, and over the course of seven months, eight interviews were performed. The interviews addressed the relevance of each of the subdesign dimensions of the framework. Firstly, using the method of TA, each interview was recorded and transcribed. Following this a process of coding relevant parts for each subdesign dimension (from each interview) and identification of themes (patterns) for all coded parts of the design dimensions was applied. Also, the mean numbered relevance for each subdesign dimension was calculated. Secondly, answering the third sub-question, the additions by the participants to the subdesign dimensions were identified and evaluated against the theoretical framework.

In chap. 4.1 the final framework a DPE for ILS for the case-organization is presented. This answers the main research question and its sub-questions outlined in chap. 1.4. This is followed by chap. 5, which discusses the main findings of the research and follows to its conclusions. Recommendations for practical application of the findings and further research are given in sections 5.3 and 5.4.

Contents

1. Introduction

1.1. Background

Independent Living Services (ILS) are an umbrella term for all kinds of ICT solutions that enable elderly people to live longer independently at home. ILS are "hindered by a lack of interoperability, leading to incompatible data exchange formats and protocol, expensive integration efforts, and lack of economies of scale as sensors and devices are typically dedicated to only one service offering" (de Reuver & Keijzer-Broers, 2015) (p.1). This makes it difficult for care service providers to share data and to bundle services and products from different device providers (Nikayin et al., 2013). It is likely that a platform can solve these issues, because a platform "brings together individuals and organizations so they can innovate or interact in ways not otherwise possible, with the potential for nonlinear increases in utility and value"(Cusumano et al., 2019) (p.22). A platform also gives care service providers a standard interface to connect to multiple assistive devices as well as customers' data. An increasing longevity of people is coupled with greater susceptibility to disease and disability, multimorbidity and chronicity of health conditions. These factors greatly influence the uptake and use of ILS. "There are no common platforms that independent living providers can utilize to bring their services to end-users"; a platform for ILS would provide a multisided platform connecting end-users of ILS with service and application providers (de Reuver & Keijzer-Broers, 2015) (p.1). Such an ICT platform would address the paradigm shift that takes place in healthcare systems, resulting in complexity for both users as well as providers of ILS: a transition to more localized care arrangements that are multidisciplinary, community-oriented, consisting of a mix of professional and informal care (de Reuver & Keijzer-Broers, 2015). To realize benefits of using a platform, one must first decide on its design dimensions (e.g., governance, architecture) (de Reuver and Lessard (2019). Design dimensions can be interpreted as the building blocks or design elements of a platform (Hein et al., 2020) (Otto & Jarke, 2019). These terms are often used interchangeable; in this thesis the term 'design dimensions' will be used. For Health Service Platforms (HSP's) an understanding of the contribution of their design dimensions such as governance and architecture and their interactions from a process perspective is emerging. Fürstenau et al. (2019) identify that research for a process perspective for digital HSP's is lacking which facilitates the development of the different area's of platform design and management in health care.

1.2. Exploration of topic

A Digital Platform Ecosystem (DPE) "comprises a platform owner that implements governance mechanisms to facilitate value- creating mechanisms on a digital platform between the platform owner, as well as an ecosystem of autonomous complementors and consumers" (Hein et al., 2020) (p.90). It is characterized by interdependencies between the platform and their agents (Hein et al., 2020). Well known examples of platforms are e.g. Facebook and Airbnb. DPE's are increasingly used for provision of health services e.g. through real-time monitoring of patients and preventive care (Fürstenau et al., 2019; Otto & Jarke, 2019). They contribute to the development of health areas such as disease prevention, remote patient care or self-management. Rather than only enabling product innovation or facilitating economic transactions, as is the case with literature on digital platforms, their focus is on the transformation of healthcare delivery with the goal to improve health outcomes (de Reuver & Lessard, 2019). Furthermore, several authors report on design dimensions of Digital Platform Ecosystems.

Three examples are given here. First, Hein et al., (2020) identify three design dimensions: 1. Status of platform ownership: the relationships among partners in the ecosystem; 2. Value creating mechanisms in the ecosystem; 3. Autonomy of complementors: the degree of freedom that complementors have when they co-create value with the digital platform. Second, 'governance' and 'architectural rules of platforms' are identified as design dimensions of DPE's, because they "balance the level of platform control with the necessary incentives for platform participants to engage with the platform and generate value for one another" (Constantinides et al., 2018) (p.381). Third, de

Reuver and Lessard (2019) identify two design dimensions for HSP's: networks of digital components (e.g. software) and liquefied resources (e.g. business rules) that provide an initial framework for describing health service platform architecture.

1.3. Problem statement

Although several authors report on design dimensions of DPE's, there is no clear agreement on what constitutes the definitive design dimensions. Due to the different views on design dimensions for DPE's, a more comprehensive view is required. To close this gap, this study will focus on identifying the design dimensions of a DPE, then evaluate the validity (correctness) and refinement (completeness) of the identified design dimensions in the practical context of ILS.

Fürstenau et al. (2019) identify three core functions of DPE's in healthcare: 1. Shared patient information repositories; 2. Service integration and interoperability; and 3. Service innovation. These functions can address two main problems in health care provision: the fragmentation of services and the lack of innovation. While the interest in the application of DPE's for ILS is increasing, there is no specific framework on design dimensions of DPE's which is being applied. This study will focus on identifying the design dimensions of a DPE as a foundation for the empirical research in the context of ILS.

A theoretical basis is required that outlines the design of digital platforms as an ecosystem before empirical research can undertaken addressing how platforms for health services are designed (de Reuver et al., 2018; Hein et al., 2020; Tura et al., 2018).

The main problem for this research is stated as: "*While there is an increasing body of research on the design dimensions for Digital Platform Ecosystems, due to the fragmented view, there is a lack of systematic understanding of what design dimensions constitute a Digital Platform Ecosystem for Independent Living Services*".

1.4. Research objective and questions

Based on the problem statement, the design dimensions of DPE's for ILS require further investigation. The objective of this research is therefore to identify the design dimensions of DPE's through a systematic literature review, and empirically validate these design dimensions for ILS by conducting a case study.

Main research question. The main research question that addresses this objective is: Which design dimensions determine the design of Digital Platform Ecosystems for Independent Living Services?

Sub-question 1: What are the design dimensions that characterize Digital Platform Ecosystems in the research literature? This will be the central question for the literature review.

Sub-question 2: Are the identified design dimensions of a DPE relevant and (correct) in a real-life context of Independent Living Services? This will be the question for the empirical study.

Sub-question 3: How can the identified design dimensions be refined with practical information? This will be the question for the empirical study.

1.5. Motivation/relevance

Two main arguments, one practical and one scientific, provide the motivation for the research questions.

First, DPE's are a rapidly emerging phenomenon that greatly affect consumers, service delivery organizations, and businesses. Changes in service delivery of ILS as well as changes in the health status of elderly people and/or people with chronic health conditions vastly challenge the way in which these platforms can be designed and used. For organizations participating in ILS platforms, it is essential to understand DPE's to evaluate the benefits and its effectiveness.

Second, while the scientific body of knowledge and theory development for DPE's is gradually developing (Gawer, 2014; Hein et al., 2019; Otto & Jarke, 2019), the amount of research for health services in relation to DPE's is still scarce. There is an increasing potential for service delivery to

people with needs for ILS, and effective and efficient provision of healthcare to improve health outcomes (de Reuver & Lessard, 2019)(p.1). Health care services are characterized by fragmentation of services and lacking innovation. Also the finance model for health services influences efforts to implement and scale digital health platforms (Fürstenau & Auschra, 2016; Fürstenau et al., 2019). Addressing the design dimensions for DPE's is likely to develop service delivery for elderly people and people with chronic health conditions, but also enhance the body of scientific knowledge.

1.6. Main lines of approach

This thesis is structured into five chapters. Chapter two outlines the theoretical framework that addresses the first research question. Chapter three presents a methodology that justifies the empirical research process and data analysis. The results of the empirical research are presented in chap. four. In chap. five, the conclusions relate the results with the research questions and theoretical framework. These are followed by recommendations for further research.

2. Theoretical framework

This chapter outlines the Systematic Literature Review as the research approach for addressing the research questions in chapter 1. In ch. 2.1 this approach will be explained and the outline of the review protocol. Chapter 2.2 describes the progression of the literature review, followed by the results in chap. 2.3. Chapter 2.4 states the objective for the empirical follow-up research.

2.1. Research approach

The objective for the theoretical part of this approach is to identify, bring together and synthesize relevant scientific literature that addresses sub-question one. The Systematic Literature Review (SLR), will be used because it serves two main purposes that fit the research objective of this thesis: a. identification and critical appraisal of relevant research and b. collection and analysis of data from this research (Snyder, 2019). The SLR-process has an iterative character, as the different activities that are employed during the different phases are repeated during the review, thereby contributing to a refinement during the review. An overview of the phases and stages of the SLR process is included in appendix 1. The review protocol that specifies the method that was used to undertake this review (Kitchenham & Charters, 2007) is shown in summary in figure 1 and detailed in appendix 2.

Review protocol of Systematic Literature Review

A. The background	Thesis section 1.1
B. The research questions	Thesis section 1.4
C. Search Process	Search performed in digital library of the Open Universiteit. Sources: formally published journals and conference papers since 2010. These are primary studies and secondary studies
D. Search Terms	Search terms are derived from the initial literature in Ch. 1: ((Digital Platform) OR (Multi-sided Platform) OR (Digital Ecosystem) OR (Digital Platform Ecosystem) OR (Platform Ecosystem)) AND ((Building blocks) OR (Design dimensions) OR (Design elements))
E. Inclusion criteria	• Setting for the studies: industries and businesses in general including health care. • Articles published between January 1st 2010 and November 1st 2020. • Articles published in a peer-reviewed (refereed) journal or conference proceedings. • Articles in the English language that are full-text available. • The main objective of the studies should be design dimensions of the digital platforms.
E. Exclusion criteria	• Studies whose focus is limited to the intra-organizational perspective. • Studies that do not address the first sub-question.
F. Article selection procedures	Thesis section 2.2
G. Study quality assessment and procedure	Thesis appendix 3
H. Data Extraction Strategy	1. Open coding: the article content that relates to the search terms is coded to summarize the meaning of the data. 2. Grouping on content: grouping similar coded data into categories. 3. Categorization: classification of categories into subdesign dimensions of a specific design dimension. When a category is specified as subdesign dimension the specific subcategories are outlined. 4. Abstraction: subcategories (subdesign dimensions) from phase three are summarized per design dimension in table one.
I. Data Synthesis	The information from the coding phase that relates to design dimensions is classified in the phase "Grouping on content". When this information is sufficiently specific to be categorized as subdesign dimension this is done in the categorization phase (Thesis appendix 13).
J. Reporting the review	This phase concerns the dissemination of the results, and will be applied when this thesis is finished.

Figure 1. Review protocol of Systematic Literature Review

2.2. Implementation

The literature review has progressed in four phases as shown in figure 2, based on the PRISMA guidelines for reporting items for systematic reviews and meta-analysis (Moher et al., 2009). For the eligibility phase, the criteria to assess the study quality, developed by Dyba et al. (2007), will be applied on the eligible articles. Each criterium will be graded by the researcher on a "yes" or "no" scale. The criteria as well as their application to the eligible articles are shown in appendix 3. Not included are additional comments made by the researcher with the application of the criteria. These are available for the thesis committee however. Appendix 4 presents a listing of the articles from the eligibility phase that have been included and excluded for the inclusion phase.
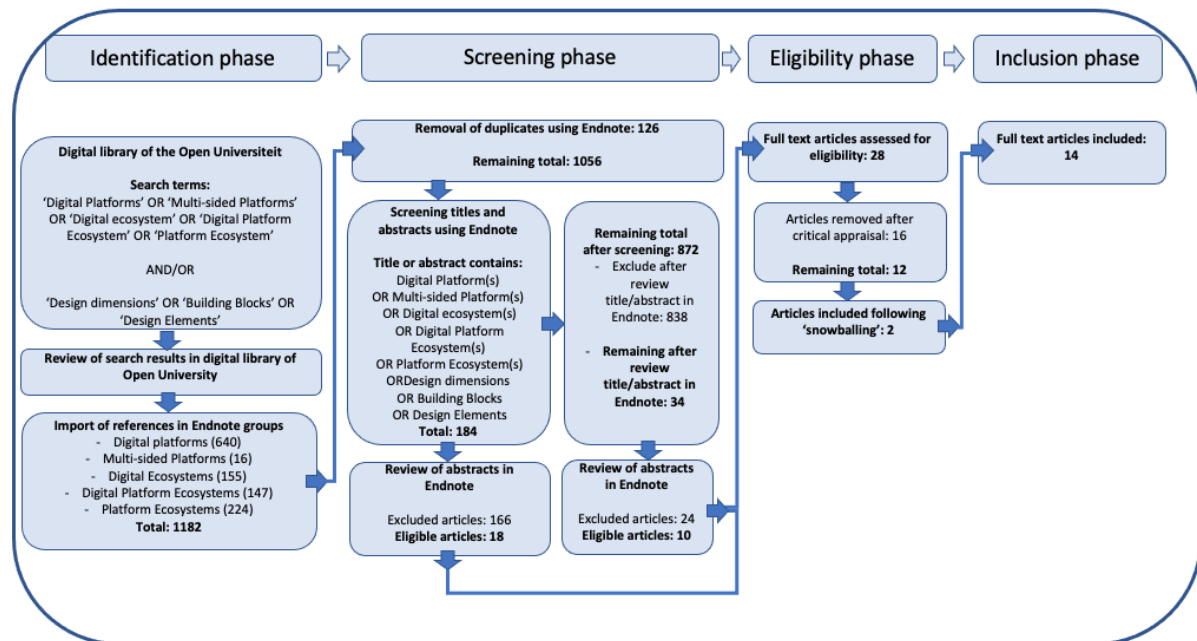
Figure 2 Flow of information during the different phases of the review

2.3. Results and conclusions

This section presents the results of the answer to sub-question 1 (section 1.4). It is based on the data extraction strategy (element H. in figure 1 and appendix 2) The content analysis indicates that design dimensions of DPE's support and enforce each other to develop a sociotechnical environment which together enable and stimulate cooperation and interaction. As such the DPE can be considered as a 'living and evolving ecosystem' in itself. The design dimensions **Architecture** and **Governance** provide the basis for a DPE. Without them it is not possible to establish and develop a DPE. This is in line with the finding that architecture and governance provide balance to the level of platform control and incentivize participation and engagement (Constantinides et al., 2018) (Jacobides et al., 2018). The design dimension **Data Governance** addresses several aspects of governance of data that is exchanged in the DPE. The design dimension **Boundary Resources** is made up of resources that facilitate technical and social interaction. The important relation between boundary resources and governance is stressed as a key problem of organization design: the balancing the trade-offs involved in controlling the core technology as one of the main goals of platform ecosystem governance (Jacobides et al., 2018) (p. 2259). The design dimension **Network Effects** are required for growth and development, by accelerating the effects of boundary resources. The design dimension **Ecosystem and the wider environment** establishes relationships with other DPE's. The combined effects of all the design dimensions accumulates in the design dimension **Value-creating mechanisms**. Each design dimension includes a number of subdesign dimensions. These can be interpreted as operational elements of design dimensions. They are operationalized in table 1. Appendix 13 provides the details of the content analysis.

2.4. Objective of the follow-up research

The empirical part of the follow-up research has the objective to identify whether the subdesign dimensions are actually relevant and being applied in the real-life context of a case study for ILS. This is relevant in order to test the validity of the theoretical findings from chap. 2.

Table 1. Design dimension and subdesign dimensions

Design dimension 1. Network effects - definition	Subdesign dimensions	Description	Reference
The effects of the presence of participants, products and services on a platform. An increase of one of these factors as well as more end-users stimulates an increase of the other factors. Network effects are fostered by business and operational dimensions (Fürstenau et al., 2019; Valdez-De-Leon, 2019) (Gawer & Cusumano, 2014)	1. Openness	"The platform allows access to platform resources (e.g., API's) enabling ecosystem participants to develop their own use cases"	(Valdez-De-Leon, 2019) p. 47
	2. Modularity	"Enables different organizations to build complementary products or services".	Valdez-De-Leon, 2019)p. 47
	3. Quality	"Features that enable high availability, reliability, and security, which can be highly valued by ecosystem participants".	Valdez-De-Leon, 2019)p. 47
	4. Facilitation of participation	"This aims for the enhancement of both a user and contributor base. Such a growing base can add to the creation of (cross-side) network effects".	(Fürstenau et al., 2019)p. 584
	5. Degree of innovation on complementary products	"The more innovation there is on complements, the more value it creates for the platform and its users (via network effects), creating a cumulative advantage for existing platforms".	(Gawer & Cusumano, 2014)p. 421
	6. User-base	The usefulness of technology on a platform increases with the increase of the user-base.	(de Reuver et al., 2018) (Gawer & Cusumano, 2014)

Design dimension 2. Governance - definition	Subdesign dimensions	Description	Reference
Addresses the ownership, coordination, regulation, decision rights, access rights, knowledge management and resource allocation of a platform (Foerderer et al., 2018) (Tura et al., 2018) (Tiwana et al., 2010)	1. Pricing	Decisions to subsidize and price complementors. E.g., complementor apps on software platforms can be priced or subsidized as an incentive mechanism to influence interaction.	(Song et al., 2018)
	2. Mechanisms to coordinate and control platform participants	Mechanisms to coordinate and control platform participants such as specification of decision-making rights and rules of control with regard to using the platform, services offering, and defining platform access rights.	(Song et al., 2018) (Otto & Jarke, 2019) (Fürstenau et al., 2019) (Tiwana et al., 2010)
	3. Decisions and policies	Decisions and policies about the platform's self-development, facilitation of collaboration and third party contributions.	(Song et al., 2018) (Fürstenau et al., 2019) (Hein et al., 2020)
	4. Leadership and ownership status	Leadership and ownership status and related decisions with regard to the ecosystem/ platform and it's complementors.	(Foerderer et al., 2018) (Tura et al., 2018) (Tiwana et al., 2010) Fürstenau et al., 2019)

Design dimension 3. Boundary resources - definition	Subdesign dimensions	Description	Reference
Resources that facilitate technical and social interaction, relationship development and innovation on a platform (Otto & Jarke, 2019) (de Reuver et al., 2018)	1. Technical boundary resources	Resources through which different agents/ complementors create relationships and interact with each other in order to co-create value. E.g., API's, SDK's, applications for end-users.	(Otto & Jarke, 2019; Valdez-De-Leon, 2019)
	2. Social boundary resources	Regulations and policies facilitating the relationship between platform provider and complementors, such as app developers. E.g., Intellectual Property Rights (IPR), documentation for software services and support services for complementors.	(Otto & Jarke, 2019) (de Reuver et al., 2018)

Design dimension 4. Architecture - definition	Subdesign dimensions	Description	Reference
Is concerned with the integration and interaction of (technical) components and modules. This facilitates and allows exchange between the demand and supply side on the platform (Tiwana et al., 2010) (Otto & Jarke, 2019).	1. Technical architecture	The selection, possibly creation and use of standards and "connectors", as well as a blueprint for the integration of the different technical components like reference architectures.	(Fürstenau et al., 2019; Otto & Jarke, 2019)
	2. Platform span	"The number of subsystems into which a platform or module can be partitioned".	(Tiwana et al., 2010)p. 678
	3. Modularity	"The degree to which changes within a subsystem do not create a ripple effect in the behavior of other parts of the ecosystem".	(Tiwana et al., 2010)p. 678
	4. Composability	"The resistance of modules to change".	(Hein et al., 2019)p.634 (Tiwana et al., 2010)
	5. Malleability	"The adoption of evolving user needs by enabling a flexible reconfiguration or extension of existing modules".	(Hein et al., 2019)p. 634 (Tiwana et al., 2010)
	6. Design rules	"The rules that platform owners expect module developers to obey to ensure interoperability with the rest of the ecosystem".	(Tiwana et al., 2010)p. 679

Design dimension 5. Data governance - definition	Subdesign dimensions	Description	Reference
Instruments that facilitate, stimulate, and control data sovereignty, trust, security and interoperability of data between user and providers (Otto & Jarke, 2019).	1. Trustworthiness of complementors	When data are exchanged these are key instruments regulating the adoption and use of the platform, sovereignty of data owners and data providers and trustworthiness are essential.	(Otto & Jarke, 2019)
	2. Data sovereignty	"The corporate entity's capability of being entirely self-determined with regard to its data".	(Otto & Jarke, 2019) (Otto, 2018)p. 7.
	3. Interoperability of data	"Is needed for standardized interaction of ecosystem actors (vocabularies play a key role in this task, as they facilitate the mapping of different data sources and the integration through linked-data presentations"	(Otto & Jarke, 2019)p. 570

	4. Secure exchange of data.	Secure exchange of data.	(Otto & Jarke, 2019)
	5. Metadata management	"Information about the data owner, data usage conditions and financial aspects (e.g., price of data)".	(Otto & Jarke, 2019)p. 572
	6. Data provenance	"Tracking the dataflow across multiple nodes of the network".	(Otto & Jarke, 2019)p. 572

Design dimension 6. Value-creating mechanisms- definition	Subdesign dimensions	Description	Reference
Mechanisms that are the result of transactions between participants on a platform, which lead to improved use value or exchange value (Hein et al., 2020; Tura et al., 2018).	1. The efficient and convenient facilitation of transactions	"Digital platforms help complementors and consumers locate and interact with each other and exchange value in a mutually beneficial manner"	(Hein et al., 2020)p. 91
	2. The provision of affordances	"The innovation capabilities of digital platforms that enable complementors to create solutions complementary to the platform core".	(Hein et al., 2020)p. 92
	3. Actor roles within the platform	Identification of possible beneficiaries to the value proposition of the platform and how their commitment is achieved.	(Tura et al., 2018)
	4. Value creation and capture	Consideration how value is created and captured/ appropriated through price structure and revenue model.	(Tura et al., 2018)

Design dimension 7. Ecosystem and the wider environment - definition	Subdesign dimensions	Description	Reference
The environment of a platform, be it other ecosystems (e.g. regulatory, financial or larger platforms) or industries (Fürstenau et al., 2019).	1. Management of regulatory issues and laws	Coping with regulations, laws and informal expectations regarding, for example, data security and quality control which can constrain but also enable platform development.	(Fürstenau et al., 2019)p. 584
	2. Dialogue with regulatory authorities	Dialogue with regulatory authorities.	(Fürstenau et al., 2019)
	3. Choice of partners	Forging alliances by adopting and endorsing existing standards or setting up proprietary standards.	(Fürstenau et al., 2019)
	4. Forging alliances with other platforms or whole industry actors	This implies technology and/or standard choices.	(Fürstenau et al., 2019)p. 583

3. Methodology

In this study two-phase research was followed. In the design phase, a framework for design dimensions of DPE was developed in chapter 2. In the evaluation phase, we will validate this framework empirically through an evaluation of its correctness (relevance) and reasoning for the relevance (to provide an in-depth understanding) and possibly refine the framework in practice.

3.1. Conceptual design: select the research method(s)

3.1.1. Research objective

The objective for the empirical research is to check the relevance, correctness and completeness of the design dimensions in the proposed framework through a case study of a Digital Platform Ecosystem for health services. The empirical part of the research addresses sub-questions two and three of chap. 1.4.

3.1.2. Research strategy

Different research strategies exist for answering the sub-questions two and three of this study:

- The Survey strategy addresses the collection of standardized data that can be analyzed quantitatively. This is associated with a deductive research approach and implies a theory-testing approach. (Saunders et al., 2019). For this thesis no theoretical propositions have been formulated that require testing. This excludes the use of this strategy.
- Archival and documentary research relies on the availability of data and archives, as well as access to these sources (Saunders et al., 2019). As the research questions address the real-life situation of a DPE, this is not likely to be reflected through this strategy. Also, substantive access to sources is likely to be difficult due to commercial or competitive motives. Therefore, this strategy is not used either.
- The Case study strategy is considered the most appropriate strategy for addressing our research questions because it has the capacity to generate insights and leads to empirical descriptions (Saunders et al., 2019). The case study strategy allows "an in-depth inquiry into a topic or phenomenon within its real-life setting" (Saunders et al., 2019) (p.196). The use of experts is not applicable because understanding of the DPE is essential: participants are therefore part of the same DPE.

Concerns regarding the case study approach focus on:

a.) the need for rigor; this can be addressed by following systematic procedures; b.) confusion with non-research case studies; this is addressed by using methodological procedures; c.) the inability to generalize from a single case study; a case study is generalizable to theoretical propositions and should not be confused with generalizability to populations; d.) the length of time to execute and lengthiness of report; this can be addressed by the composition and the method of data collection; e.) the comparative advantage with regard to other research methods; case studies can result in insights that are not provided by other methods, or function as adjuncts (Yin, 2018)(p. 50-54).

3.2. Technical design: elaboration of the method

3.2.1. Research method

1. Definition of the case and determination of the scope of the data collection.

Risks involved with using a case study strategy are the lack of analytic benefits, e.g. the ability for replication with two cases, and the inability producing a stronger effect and vulnerability as 'all eggs are in one basket' (Yin, 2018). Because the limited scope of the research, these risks are addressed through applying sufficiently robust selection criteria for the single-case that is used for this research:

1. a Digital Platform Ecosystem for Independent Living Services that is based in the EU which has been operational for more than two years and is not for profit.

2. The DPE for ILS consists of three main actors (Hein et al., 2020) (Tiwana et al., 2010) which are active on this platform: a.) The platform provider. b.) A complementor that has been active for at least one year. c.) An end-user-organization that has been active for at least one year.

3. Each of these actors provides access to three different informant-roles (totaling 9 participants) representing distinctive practices that focus on key design and management choices for a DPE (Fürstenau et al., 2019): 1. Founder/CEO/CIO; 2. Technology knowledge advisor and 3. Project leader/manager.

The **data collection approach** involves a qualitative approach by information gathering through semi-structured interviews. This is a type of non-standardised interview that includes a predetermined list of themes and key questions referring to these themes to structure the interview (Saunders et al., 2019). The structure of the interview is shown in figure 3.
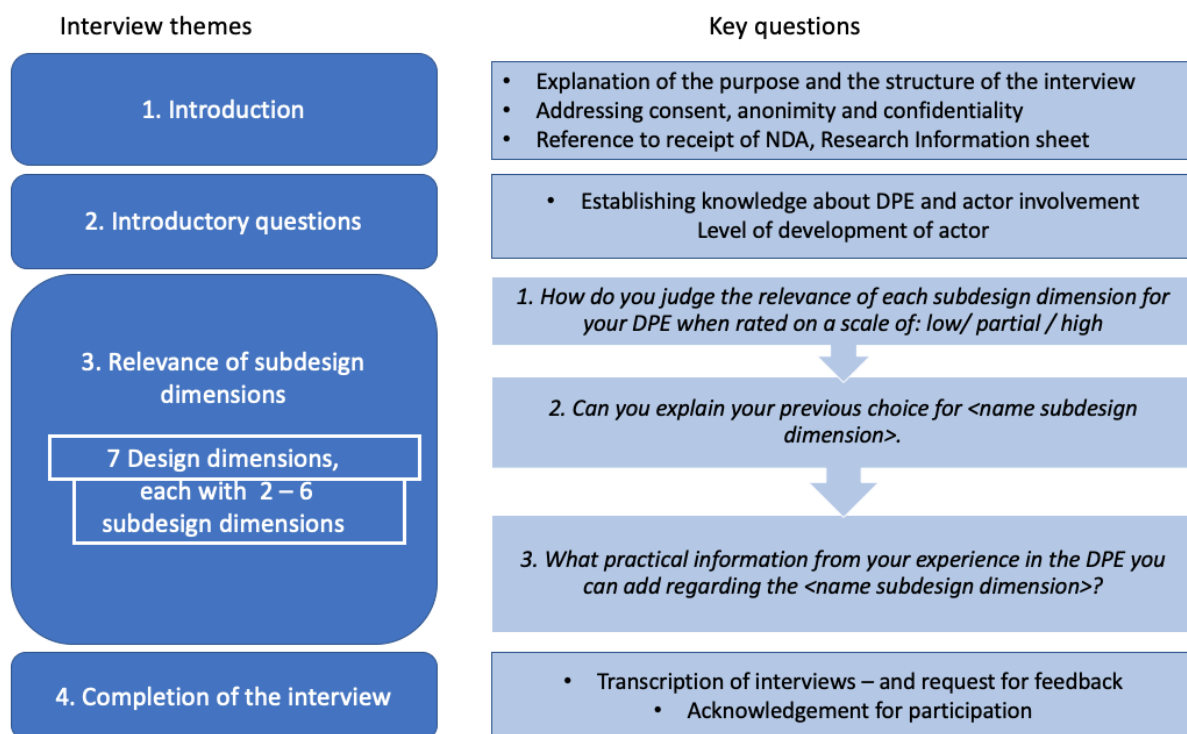
Figure 3. Interview structure

2. Clarification of the nature of the study questions. By collecting data through the interviews the sub-questions two and three are adressed and the subdimensions of the design dimensions from the framework in table 1 are validated. An interview protocol provides structure and assure that the relevant themes are adressed. Also, the Interview Protocol Refinement (IPR) framework (Castillo-Montoya, 2016) is used to design the interview protocol (appendix 5 and 6). The interview questions adress for each design dimension the subdesign dimensions that have been identified. The participants will receive a research information sheet (appendix 7), a Non-Disclosure Agreement (appendix 9) and an informationsheet on the identified design dimensions (appendix 8) at least seven days prior to the interview.

3.3. Data analysis

In this section the analysis of the collected data will be addressed, as well as the advantages and disadvantages of the selecte method. Each recording of the interview will be transcribed anonimously and will be sent to the participant for validation. This will corroborate the accuracy of the findings. The interviews will be performed in English; participants will also be requested to answer in English. If this is not possible, and they only speak Dutch, their answers will be translated into English.

Thematic Analysis (TA) will be used for analysing the transcribed data: "a method for identifying, analysing, and reporting patterns (themes) within data" (Braun & Clarke, 2006)(p. 79).The flexibility of TA is an advantage. TA does not apply precise analytical procedures and allows for a generic approach to qualitative data analysis (Braun & Clarke, 2006) (Nowell et al., 2017) (Saunders et al., 2019). A disadvantage of TA is the lack of substantial literature which can guide the conduct of this method. The flexibility can also lead to inconsistency and a lack of coherence in the development of themes that result from the data (Nowell et al., 2017). The different phases used in TA are outlined in figure 4. and specified in appendix 11.

The data from the interviews will be collected in tables for data analysis, shown in appendix 10. For each interview segment that addresses a subdesign dimension, 'items of interest', are identified which are then coded. This 'selective coding' allows for identification of analytical concepts that the researcher is looking for, in contrast with complete coding, which identifies anything and everything of interest or relevance. It also requires existing theoretical and analytical knowledge, giving the researcher the ability to identify analytical concepts (Braun & Clarke, 2013). From the codes for the subdesign dimensions and the associated data, themes are identified for each subdesign dimension. A theme "has a central organizing concept, which tells us something about the content of the data that's meaningful" (Braun & Clarke, 2013), p. 224. The themes of the design dimensions are then derived from the themes for the subdesign dimensions and the associated data. To address the flexibility of TA and to guide the quality of the analysis process, the checklist of Criteria for Good Thematic Analysis (Braun & Clarke, 2006), (appendix 12), will be used.
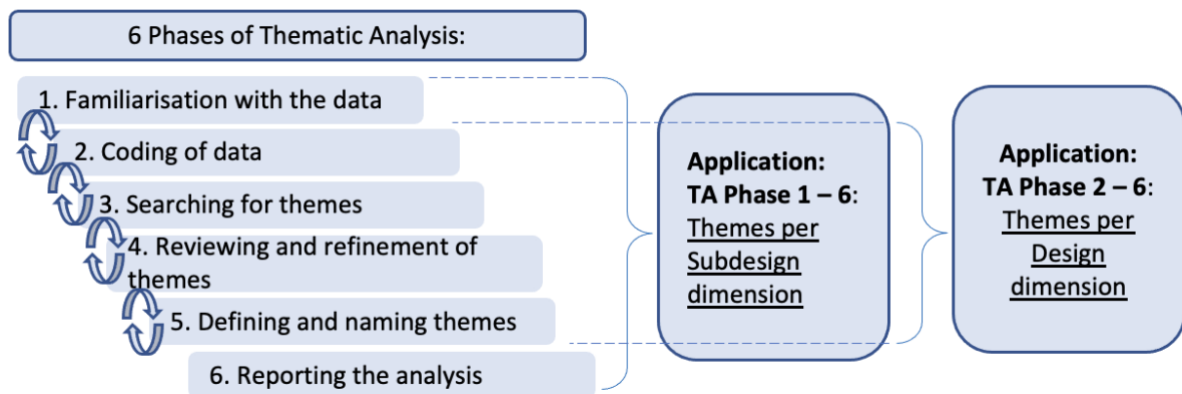
Figure 4. Phases of Thematic Analysis (Braun & Clarke, 2006) and their application

3.4. Reflection regarding validity, reliability, quality and ethics

The evidence for the quality of the research design and research method will take place through a discussion of validity and reliability as quality measurements. These interpret the strengths of the findings from the research. The ethics involved with this research will also be addressed.

3.4.1.Validity

Validity is the extent to which any measuring instrument measures what it is intended to measure" (Carmines, 1979) (p. 17).

Internal validity adresses whether what you actually measure is also what you intend to measure (Saunders et al., 2019). This concerns the degree to which the participants properly identify subdesign dimensions within the context of the design dimensions. Internal validity addresses two aspects: 1. *Content validity* addresses whether the interview questions provide sufficient coverage of the research question and the related topics (Saunders et al., 2019). This is answered through the methodology of the SLR and the content analysis (chap. 2.1). The accuracy of the findings and evidence presented is corroborated by the review of the interviews by the participants (Yin, 2018) (Saunders et al., 2019).

Construct validity addresses whether the measurement actually represent the constructs (subdesign dimensions) that were intended to be measured (Carmines, 1979; Saunders et al., 2019). This is addressed through the interview protocol which ensures that data are collected in a systematical way (chap. 3.2). Also phase four of the Thematic Analysis (chap. 3.3) considers if the themes that have been devised in relation to the dataset are sufficiently representative for the meanings that are evident in the whole dataset. (Braun & Clarke, 2006). By adressing the relevance of the subdesign dimensions through a rating followed by an open question asking to explain this choice, different methods are applied to measure the relevance. This is a way of establishing the **convergent validity** of this construct (Saunders et al., 2019).

External validity concerns the generalization of the findings to other relevant contexts (Saunders et al., 2019)(p. 21) As the research is based on a single case study the results can provide insights that contribute to further evidence for the understanding of design dimensions for a DPE for ILS.

3.4.2. Reliability

Reliability concerns the extent to which an experiment, test, or any measuring procedure yields the same results on repeated trials (Carmines, 1979) (p. 11). A different researcher that applies the same approach should get the same results within a certain acceptable level of random error. Random error is unsystematic and involves chance factors that influence measurement of phenomena, e.g. bias by the researcher or misunderstanding by the participant. To safeguard consistent understanding of the questions an interview protocol is piloted and used for all participants. Participants also receive the same information and instructions prior to the interview. This addresses participant error by reducing the factors that may inadversely affect their performance.

3.4.3. Quality of thematic analysis

Braun and Clarke (2006) advocate the use of the checklist of Criteria for Good Thematic Analysis (appendix 12) to determine whether a proper thematic analysis is provided.

3.4.4. Ethical aspects

The participants are informed of the interview process, the transcription and recording of their responses and the usage of these transcriptions and the opportunity to review the draft case study. Participants are also informed in writing and verbally, prior to the interview, that data and reporting will be anonymized. Before requesting their informed consent to participate they will receive a research information sheet outlining the main points addressed in this paragraph and chap. 3.2 (Saunders et al., 2019). Participants will not be coerced in any way (e.g. through financial incentives) to participate in the research or to supply information that they are not comfortable with.

4. Results

The results of the case study are presented in this section, starting with the implementation of the research and deviations from the research method. Following this, the results to sub-questions two and three from chap. 1.4 are outlined. This leads to a final framework that is applicable to the DPE for ILS which was subject to the case study.

4.1. Research Implementation

Eight participants, specified in figure 5, from the DPE were interviewed through sessions of approximately 1 ¾ hours.
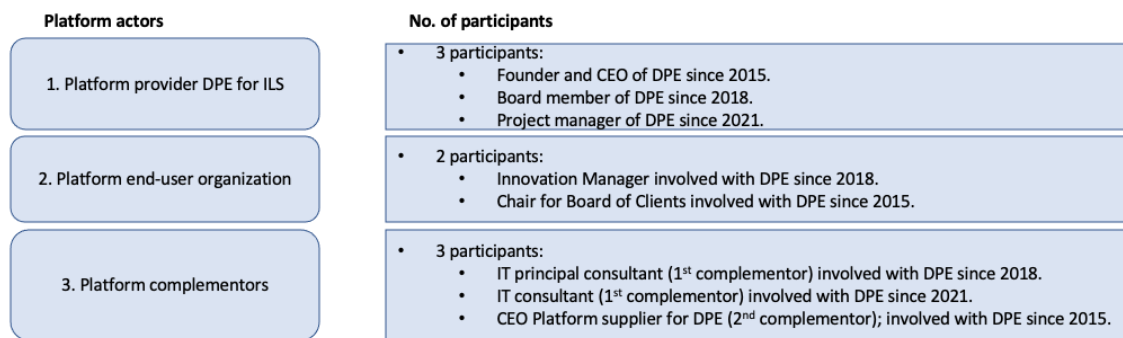

Figure 5. Platform actors and participants

The expected technical level of information of the subdesign dimensions and the lack of examples for the subdesign dimensions would make it difficult for respondents to respond during the interview without prior information. Following the first interview, and after consultation with the platform CEO the decision was made to provide participants subsequently with initial information prior to the interview and commence the interviews in Dutch. Therefore, an interview package (in Dutch) was provided with an explanation about the research and research questions. The package included an appendix with the (sub)design dimensions, their definitions and examples for each subdesign dimension. All remaining participants were briefed about the research and their participation and received the interview package one week prior to the interview. They were requested to review the information and keep the appendix at hand during the interview. Therefore the "Open introductory questions", as listed in the research method chap. 3.2.1.; figure 3 were skipped as participants would otherwise have been biased by the information send to them in advance.

4.1.1. Results sub-question 2

In answering the question 'are the identified design dimensions of a DPE relevant and (correct) in a real-life context of Independent Living Services?' a two-step approach has been taken

Step 1. The themes for each subdesign dimension (of a design dimension) have been derived from results of the TA coding process and associated data which was outlined in section 3.3. These themes are derived from the participants' interviews through the identification of 'items of interest' and their coding. In these interviews participants were asked to explain their choice for judging the relevance of each subdesign dimension. The themes therefore address the relevance of the subdesign dimensions in the context of the case-organization.

Step 2. The TA process from step 1 is repeated, and here the themes of the subdesign dimensions and their originating coding processes have been revisited to arrive at the themes for each design dimension. There is however no hierarchical relationship between the themes of the subdesign dimensions and the themes of the design dimension. On an overarching level, the themes address the relevance and correctness of their design dimension in the context of the case-organization and "capture the most salient patterns in the data relevant to answer the research question" (Braun & Clarke, 2013), p. 225. The flow of information for this process is displayed in figure 11, appendix 17.

The themes for the subdesign dimensions and design dimensions are presented together in appendix 17, and they are presented with the design dimensions in table 2. The relevance of each subdesign dimension, as rated by the participants, resulted in a mean relevance for each design dimension. The minimum mean rate for a subdesign dimension was 1,9 and the maximum mean rate was 3,0 on a scale of low (1) /partial (2) /high (3); therefore all subdesign dimensions were classified as 'partial' to 'highly relevant' for their respective design dimensions. These ratings are summarized per design dimension in table 2. and specified in appendix 14. Applying the TA analysis, figure 6 shows coding examples for a subdesign dimension of each design dimension. These display examples of 'items of interest' identified from the participant interviews and the codes applied to these. The complete coding for all interviews of each subdesign dimension is presented in appendix 16. This includes coding examples for each design dimension. The full interview transcripts have not been included in this thesis; the anonymized data remain however available for the thesis committee.

Table 2. Themes and mean relevance per design dimension (chap. 4.1.1)

Design dimension	Mean relevance score per design dimension (1)	Theme 1	Theme 2
1. Network effects	2,6	**Level of development of the platform**: the stadium of development of the platform is prescriptive for the level to which the subdesign dimension will be developed. All participants indicate that the platform is in an initial stage of development. Therefore, they did have insufficient insight in the effect of and experience with the subdesign dimension.	**Perspective with regard to the platform function**: the participants identified that the subdesign dimensions could be positioned in the perspective of platform development.
2. Governance	2,4	**Taking ownership / positioning**: platform owner and complementor assume a leading position for the platform owner. Specific in relationship to the societal role of the platform and also aimed at the platform users. The strategic and visionary rol of the platform CEO is mentioned as an important factor.	**Role taking and responsibility**: apart from assuming ownership is also taking a specific role and responsibility narrowly connected. The question that can be asked is whether and at what moment the user should take responsibility for it's role in the platform.
3. Boundary resources	2,3	**Mutual dependency of platform actors**: network boundaries require a mutual dependency of platform actors in order to create agreement on the resources at a social and technological level. This creates opportunities for the use of uniform norms and standards and optimalisation of solutions.	
4. Architecture	2,3	**Mutual dependency of technical components**: a functional architecture is strongly dependent of the technical components from which it is built as well as the way in which these cooperate with eachother.	**Interaction with complementors and facilitation of users**: in the design and layout of the architecture, interaction with complementors is an important element. The architecture should facilitate its users.
5. Data governance	2,6	**Ownership**: data governance requires ownership by all parties; the creators and users. Ownership is underpinned by principles such as vision and autonomy.	**Responsibility for data**: taking responsibility for data which are being created and used lies at the heart of data governance. As different parties are involved this is subject to aspects

			such as data quality, mutual solidarity and trust.
6. Value-creating mechanisms	2,3	**Developmental perspective**: the application of value creation is strongly dependent of the developmental stage of the platform and its facilitation. Potentially, monetary value plays a less important role because the platform does not have a commercial basis.	**Contracts**: value creation requires agreement between actors. On the one side between platform and complementors ('commercial contracts') and on the other side between platform and users ('social contracts').
7. Ecosystem and the wider environment	2,3	**Cooperation**: for the development and continued existence of an ecosystem, cooperation is an overarching theme. The cooperation assumes compliance with laws and rules and a level of openness towards each other as well as reliability of partners.	

4.1.2. Results sub-question 3

The third sub-question that was addressed in this study covered the refinement of the definitions of the subdesign dimensions with practical information. These additions and comments are specified in appendix 15.

4.1. Final framework for a Digital Platform Ecosystem for ILS

The conclusion of the foregoing analysis is a final framework of design dimensions that is applicable for the case-Digital Platform Ecosystem for Independent Living Services. The framework is presented in figure 7. This framework is made up of seven design dimensions, each with two or more subdesign dimensions. All ratings for the design dimensions vary between 'partial' and 'high relevance; therefore all design dimensions and subdesign dimensions from table 1, chapter 2.3 are included in this framework. Each design dimension is subject to one or two themes, which are derived from the subdesign dimensions. These theme(s) reflects the relevance of each design dimension for the case DPE. They are the result of the thematic analysis, outlined in chapters 4.1.1. and 4.1.2

Design dimension 1. Network Effects - Subdesign dimension 1. Openness

Items of Interest e.g.:"That 'open', that we should do this. Yes, because that was the basis of our platform." (P1). "Yes, in fact, to improve their own development actually and there it goes to develop in that area, and they have to find something for that and then this could be a nice tool for that." (P5). "Yes, the thing is with <Case-organization>, at the moment it is right that in this, this phase they often use open, other open ecosystems so. It is mainly a consumer of APIs and it is not really a publisher of APIs yet, but of course it could be. Ehm it does make it, but it makes use of that openness at its core, so."(P7).

Coding: "Openness as facilitator" ; "Future perspective to use"(P1); "Development" (P5); "Stage of development determining the use of open ecosystems" (P7).

Design dimension 2. Governance - Subdesign dimension 4. Leadership and ownership status and related decisions with regard to the ecosystem/ platform and it's complementors

Items of Interest e.g.: "because as the owner of a platform, have a responsibility towards <user organization>" (P5). "Because I don't know who that owner is or where that ... I think the board is the owner in the sense that they manage the cash flows. But I think <CEO case-organization> does have a kind of Mark Zuckerberg function, or a Steve Jobs function in the sense of intellectual leadership"(P6)." But that you are already involved in the development of that question and the decision of which questions, on which functionality do we go now, is now relevant to work out, to give attention to."(P7)

Coding: "Responsibility towards the user"(P5); "Knowledge about owner structure"(P6); "Form of leadership and ownership"(P7).

Design dimension 3. Boundary resources - Subdesign dimension 2. Social boundary resources

Items of Interest e.g: "These social boundary resources are essential to be able to execute the technical boundary resources and perhaps vice versa. That reinforces each other or influences each other." (P1). "They want a good, working system and they assume that they have chosen parties that are able to determine whether IPRs are good or security is well organized, etc."(P5). "Well, for me on the medical side... <case-organization> does not yet have medical data, but on the medical side it is also high, because I cannot exist without certifications and without a well-documented platform."(P8).

Coding: "Reinforcing effect of the platform."(P1); "Relevance" (P5); "Determining product in relation to this type of platform" (P8).

Design dimension 4. Architecture - Subdesign dimension 5. Malleability

Items of Interest e.g.: "So then that is constantly in a kind of ping pong story with the architects with developers of what things... and then I would also like to hear back from well, how many hours would you spend on it? Is this something that still fits into our timeline? Does it provide a very great convenience? Then I am willing to make a different choice within us, our design sprints." (P1). "We have already thought about this in architecture, in the past. And also in the choices we make, we are already trying to make choices that make it possible to use other reconfigurations in the future. So if you design that well, you can later reuse the same components for other things, for example."(P6).

Coding: "Customer and architecture dependency" (P1); "Architecture platform determines importance subdesign dimensions."(P6).

Design dimension 5. Data governance - Subdesign dimension 6. Data provenance

Items of Interest e.g: "For example, if it is about information, doctor's information or something, then you want the users, they also get certain information that is 'authoritative', I do not know if the Dutch word is even, so it comes from a certain authority, so to speak. So there will be important to say: well, for example, this comes from doctors site or I know a lot of what, so that you can see the user: okay, this is not just something, this is important or something." (P6). "I think that's it: accountability. And then combine on the core of <case-organization> that yes, you have to, you have to be accountable to such a. If you, if you're working on medical data and then that's really relevant." (P7). We say: we make the technology available and <case-organization> figure it out with the data." (P8).

Coding: "Authority of the data is decisive" (P6); "Information and accountability about the movement of data through the platform" (P7). "Technical angle determines complementor" (P8)

Design dimension 6. Value-creating mechanisms - Subdesign dimension 2. The provision of affordances

Items of Interest e.g: "The collaboration and co-creation must lead to a win-win. So as far as we are concerned, everyone has their own business model and everyone is also allowed to make money, but not on the platform, but because of the platform, so that is actually an unwritten rule in the design of <case-organization>." (P1). "We are still really in the creative phase in which we want to keep a bit of a grip ourselves, which we want to do in consultation with end users." (P3). "if you say: I actually want to keep the user inside, then you actually have to do the entire service of products and services supplier again, or something, or integrate or well, whatever." (P6).

Coding:Coding: "Co-creation" (P1); "Development" (P3); "Future vision for the design of the platform" (P6).

Design dimension 7. Ecosystem and the wider environment - Subdesign dimension 3. Choice of partners

Items of Interest e.g.: "I think the partners with whom we develop the idea and the reliability that they radiate, that is of great importance." (P3). "Again, we make as open as it can be, so we try to be as open as possible so that you are clear where you can, to prevent you from getting a kind of secrecy story in which everyone dies at some point." (P5). "An essential role for the platform,<case organization>. If she didn't, there would be nothing. So I can't judge the importance high enough, say for her as far as she's concerned, but that's not our role in that." (P6).

Coding: "Reliability" (P3); "Openness" (P5); "Leadership platform owner" (P6).

Figure 6. Coding examples for subdesign dimensions of all design dimensions

Design dimension 1	Theme 1		Theme 2	
Network Effects	**Level of development of the platform**: initial platform development.		**Perspective with regard to the platform function**: position subdesign dimensions in relation to the stage of platform development.	
Definition Network effects	**Subdesign dimensions**		**Description**	
The effects of the presence of participants, products and services on a platform. An increase of one of these factors as well as more end-users stimulates an increase of the other factors. Network effects are fostered by business and operational dimensions.	1. Openness		The platform allows access to platform resources (e.g. API's) enabling ecosystem participants to develop their own use cases.	
	2. Modularity		Enables different organizations to build complementary products or services.	
	3. Quality		Features that enable high availability, reliability, and security, which can be highly valued by ecosystem participants.	
	4. Facilitation of participation		This aims for the enhancement of both a user and contributor base. Such a growing base can add to the creation of (cross-side) network effects.	
	5. Degree of innovation on complementary products		The more innovation there is on complements, the more value it creates for the platform and its users (via network effects), creating a cumulative advantage for existing platforms.	
	6. User-base		The usefulness of technology on a platform increases with the increase of the user-base.	

Design dimension 2	Theme 1		Theme 2	
Governance	**Taking ownership / positioning**: platform owner and complementor are assuming a leading position. For the platform owner, the platform CEO assumes a key strategic and visionary role.		**Role taking and responsibility**: active and specific.	
Definition Governance	**Subdesign dimensions**		**Description**	
Addresses the ownership, coordination, regulation, decision rights, access rights, knowledge management and resource allocation of a platform.	1. Pricing		Decisions to subsidize and price complementors. E.g. complementor apps on software platforms can be priced or subsidized as an incentive mechanism to influence interaction.	
	2. Mechanisms to coordinate and control platform participants		Mechanisms to coordinate and control platform participants such as specification of decision-making rights and rules of control with regard to using the platform, services offering, and defining platform access rights.	
	3. Decisions and policies		Decisions and policies about the platform's self-development, facilitation of collaboration and third party contributions.	
	4. Leadership and ownership status		Leadership and ownership status and related decisions with regard to the ecosystem/ platform and it's complementors.	

Design dimension 3	Theme 1	
Boundary resources	**Mutual dependency of platform actors**: mutual dependency of platform actors in order to create agreement on the resources at a social and technological level.	
Definition boundary resources	**Subdesign dimensions**	**Description**
Resources that facilitate technical and social interaction, relationship development and innovation on a platform.	1. Technical boundary resources	Resources through which different agents/ complementors create relationships and interact with each other in order to co-create value. E.g. API's, SDK's, applications for end-users.
	2. Social boundary resources	Regulations and policies facilitating the relationship between platform provider and complementors, such as app developers. E.g. Intellectual Property Rights (IPR), documentation for software services and support services for complementors.

Design dimension 4	Theme 1		Theme 2	
Architecture	**Mutual dependency of technical components**: strong dependence and interdependence.		**Interaction with complementors and facilitation of users**: important with a focus on facilitation of it's users.	
Definition Architecture	**Subdesign dimensions**		**Description**	
Is concerned with the integration and interaction of (technical) components and modules. This facilitates and allows exchange between the demand and supply side on the platform.	1. Technical architecture		The selection, possibly creation and use of standards and "connectors", as well as a blueprint for the integration of the different technical components like reference architectures.	
	2. Platform span		The number of subsystems into which a platform or module can be partitioned.	
	3. Modularity		The degree to which changes within a subsystem do not create a ripple effect in the behavior of other parts of the ecosystem.	
	4. Composability		The resistance of modules to change.	
	5. Malleability		The adoption of evolving user needs by enabling a flexible reconfiguration or extension of existing modules.	
	6. Design rules		The rules that platform owners expect module developers to obey to ensure interoperability with the rest of the ecosystem.	

Design dimension 5	Theme 1		Theme 2	
Data governance	**Ownership**: by all parties; the creators and users. Ownership is underpinned by principles such as vision and autonomy.		**Responsibility for data**: active responsibility. This is subject to aspects such as data quality, mutual solidarity and trust.	
Definition Data governance	**Subdesign dimensions**		**Description**	
Instruments that facilitate, stimulate, and control data sovereignty, trust, security and interoperability of data between user and providers.	1. Trustworthiness of complementors		When data are exchanged these are key instruments regulating the adoption and use of the platform, sovereignty of data owners and data providers and trustworthiness are essential.	
	2. Data sovereignty		The corporate entity's capability of being entirely self-determined with regard to its data.	
	3. Interoperability of data		Is needed for standardized interaction of ecosystem actors (vocabularies play a key role in this task, as they facilitate the mapping of different data sources and the integration through linked-data presentations.	
	4. Secure exchange of data.		Secure exchange of data.	
	5. Metadata management		Information about the data owner, data usage conditions and financial aspects (e.g. price of data).	
	6. Data provenance		Tracking the dataflow across multiple nodes of the network.	

Design dimension 6	Theme 1		Theme 2
Value-creating mechanisms	**Developmental perspective**: Value creation is strongly dependent of the developmental stage of the platform and it's facilitation. The non-commercial aspect of the platform may influence development.		**Contracts**: Requirement for agreement between actors; business to business and business to consumers.

Definition Value-creating mechanisms	**Subdesign dimensions**	**Description**
Mechanisms that are the result of transactions between participants on a platform, which lead to improved use value or exchange value.	1. The efficient and convenient facilitation of transactions	Digital platforms help complementors and consumers locate and interact with each other and exchange value in a mutually beneficial manner.
	2. The provision of affordances	The innovation capabilities of digital platforms that enable complementors to create solutions complementary to the platform core.
	3. Actor roles within the platform	Identification of possible beneficiaries to the value proposition of the platform and how their commitment is achieved.
	4. Value creation and capture	Consideration how value is created and captured/ appropriated through price structure and revenue model.

Design dimension 7	Theme 1
Ecosystem and the wider environment	**Cooperation**: necessary requirement for the development and continued existence of an ecosystem, cooperation is an overarching theme. The cooperation assumes compliance with laws and rules and a level of openness towards each other as well as reliability of partners.

Definition Ecosystem and the wider environment	**Subdesign dimensions**	**Description**
The environment of a platform, be it other ecosystems (e.g. regulatory, financial or larger platforms) or industries.	1. Management of regulatory issues and laws	Coping with regulations, laws and informal expectations regarding, for example, data security and quality control which can constrain but also enable platform development.
	2. Dialogue with regulatory authorities	Dialogue with regulatory authorities.
	3. Choice of partners	Forging alliances by adopting and endorsing existing standards or setting up proprietary standards.
	4. Forging alliances with other platforms or whole industry actors	This implies technology and/or standard choices.

Figure 7. Final framework for the case-organization of a Digital Platform Ecosystem for ILS

5. Discussion, conclusions and recommendations

5.1. Discussion – reflection

5.1.1. Reflection on the empirical results

The exploratory phase of this thesis as outlined in chap. two states that there is no clear agreement on what constitutes the definitive design dimensions, and that a more comprehensive view is required. Three observations can be made that connect the literature with the empirical observations.

First, study participants partly confirm the view of Constantinides et al. (2018) that the design dimensions Governance and Architecture function as a balancing factor for platform engagement and value generation. This is reflected in the themes for the design dimension Governance ("taking ownership/ positioning" and "role taking and responsibility") and the theme "interaction with complementors and facilitation of users" (Architecture) (chap. 4.1.1., table two). The themes identified for their subdesign dimensions substantiate this; for Governance this is demonstrated through subdesign dimension (subdes. dim.) two (theme: "determining for autonomy"); subdes. dim. three (theme: "role and responsibility development") and subdes. dim. four (themes: "interdependence of participants on the platform" and "platform ownership"). For Architecture this is demonstrated through subdes. dim. five (theme: "positioning of the customer") and subdes. dim. six ("positioning of complementors vis-à-vis platform owners") (appendix 16 and 17). All design dimensions with their corresponding subdesign dimensions were analyzed independently from each other, therefore relationships between design dimensions such as mentioned by Constantinides et al. (2018) were not part of the research.

Second, Hein et al. (2020) identify three different building blocks that characterize DPE's. For the first building block, Governance, the relationships among partners and distribution of power is translated through the ownership model of the platform according to Hein et al. (2020). The results of the empirical research substantiate this. The themes for the design dimension Governance ("taking ownership/ positioning" and "role taking and responsibility") substantiate these relationships among partners and the distribution of power. Also, the themes for all its subdesign dimensions substantiate this; subdes. dim. one: (theme: "interpretation of ownership"); subdes. dim. two: (theme: "determining for autonomy"); subdes. dim. three: (theme: "role and responsibility development") and subdes. dim. four: (themes: "interdependence of participants on the platform" and "platform ownership"). Hein et al., (2020) distinguishes for the second building block between value-creating mechanisms that allow the platform to function as intermediary between supply and demand and use its innovative capabilities. The themes belonging to the design dimension Value-creating mechanisms: "contracts" and "development perspective", confirm these functions (chap. 4.1.1., table two). These are substantiated by the themes for subdes. dim. one ("platform as intermediary between actor"); subdes. dim. two ("development perspective"); subdes. dim. three ("agreement on value creation") and subdes. dim. four ("role of actors" and "development perspective") (appendix 16 and 17). The third building block "degree of complementor autonomy" that Hein et al. (2020) identifies relates to the autonomy of complementors when co- creating value with the platform. While this building block is not directly related with a specific design dimension from the research framework, themes from all design dimensions can be connected with this building block; Network effects ("level of development of the platform" and "perspective with regard to the platform function"; Governance ("taking ownership/ positioning"); Boundary resources (mutual dependency of platform owners"); Architecture ("interaction with complementors and facilitation of users"); Data governance ("responsibility for data"); Value-creating mechanisms ("developmental perspective" and "contracts") and Ecosystem and the wider environment ("Cooperation"). This could suggest that a building block that emerge from the literature, but cannot directly be linked to the design dimensions of this framework, may not necessarily qualify as a building block when applied to the themes of this empirical framework but can still be addressed

from a relevance-perspective through the themes that have emerged for this framework. However, being based on a case-study, this framework addresses a non-commercial DPE that is in a developing stage, so the future development of the framework may lead to new themes or a different operationalization of these themes.

Third, the view of a DPE by de Reuver and Lessard (2019) characterizes a platform as enabler which facilitates the creation and access of resources for value cocreation through the exchange of services. The design dimensions which facilitate this, networks of digital components (e.g., software) and liquefied resources (e.g., business rules), are substantiated through the design dimensions Boundary Resources (theme: "mutual dependency of actors") and Value-creating mechanisms (themes: "developmental perspective" and "contracts") of the framework (chap. 4.1.1., table two and appendix 17). The use of these themes, identified in the empirical research allows a perspective that moves beyond a traditional view of 'static' design dimensions or building blocks by focusing on the relevance of the design dimensions for the platform. Through the application of themes, this does support the view by de Reuver and Lessard (2019) that the perceived value of services that are delivered to end users and their integration with existing resources and activities is more important than the services itself. This conclusion aligns with the author's focus of health based digital platforms on transforming healthcare delivery to improve health outcomes. Value creation from the stakeholder's perspective is a key characteristic, rather than a functional approach based on architecture de Reuver and Lessard (2019).

No additions of changes were made in the definitions and descriptions of de design dimensions and subdesign dimensions that were identified by answering sub-question 1. Several comments were made about subdesign dimensions, all of which were evaluated by the researcher. None of these however lead to changes in the definitions. Two comments require explanation; 1. the use of the concept 'modularity' in two different design dimensions (Network effects and Architecture). Because they are derived from the literature they won't be changed. 2. The term 'Complementor' was not explained in the work package, however this was done during the interview and did not lead to further questions.

5.1.2. Reflections on the research set-up

Validity. The case-organization is considered to be at a developing stage as a DPE. Within the Dutch context the case organization is considered to be one of the few, if not the only DPE for ILS with a non-profit orientation. In cooperation with the CEO of the DPE all participants were approached through her reference. This meant that the intended representation as outlined in 3.2.1 could not always be followed, due to availability or ability/willingness of participants to cooperate. Also, knowledge regarding the different design dimensions varied according to the roles of the participants in respect to the design dimensions. This may influence the content validity of the answers. This may be addressed in future research by researching design dimensions with specific participants with content knowledge of specific design dimensions.

The chosen method of TA may also have limited the necessary depth of analysis, affecting construct validity, because 32 subdesign dimensions needed to be discussed within an acceptable 90- to 105-minute timeframe, in line with recommendations for a virtual interview (Braun & Clarke, 2013) (appendix 16).

Quality of TA analysis. Also, the outbreak of the coronavirus disease (COVID-19), early in 2020 and the subsequent measures to prevent spread of the virus resulted in interviews by video with all participants. A video-interview lacks 'physical' interaction, the ability to read body language and can limit interpretation of voice characteristics or facial expressions. It has however also positively affected the availability and accessibility of participants and contributed to a convenient setting, as participation was possible from participant's homes or work locations (Braun & Clarke, 2013). With regard to the limitations of the research that have already been mentioned above, the analysis and results have not been reviewed independently by other researchers. This is due to constraints in time and availability of other researchers. These factors may also affect on the reliability of the

research. A mitigation strategy for this was the use of the "Checklist of good criteria for TA" in appendix 12 and use of the textbook by Braun and Clarke (2013).

Reliability. The interview protocol, together with the initial meeting and accompanying work package about the research that included the definitions and examples of the subdesign dimensions and subsequent interview for all participants were consistently used. Only for the first interview a different work package was used that did not include examples; after evaluation with the platform CEO this approach was further implemented. This is expected to have positively affected the reliability of the research. Due to the experience and (assumed) level of knowledge of the first participant it is not likely that this has negatively impacted on the interview.

Ethics. Participants and data have been treated according to chap. 3.4.4.

5.2. Conclusions

The motivation for this research is based on an increasing longevity of people, coupled with greater susceptibility to disease and disability, multimorbidity and chronicity of health conditions. These factors greatly influence the uptake and use of ILS. There are no common platforms that independent living providers can utilize to bring their services to end-users (de Reuver & Keijzer-Broers, 2015). This lead to the following problem statement "*While there is an increasing body of research on the design dimensions for Digital Platform Ecosystems, due to the fragmented view, there is a lack of systematic understanding of what design dimensions constitute a Digital Platform Ecosystem for Independent Living Services*"(chap. 1.3).

The three main conclusions from the research, based on the research questions, derived from this problem statement are:

1. Sub-question 1: What are the design dimensions that characterize Digital Platform Ecosystems in the research literature?
   Conclusion: A theoretical framework that includes design dimensions and subdesign dimensions has been developed that addresses the subdesign dimensions for each design dimension for the DPE for ILS. This is outlined in chap. 2.3.

2. Sub-question 2: Are the identified design dimensions of a DPE relevant and (correct) in a real-life context of Independent Living Services?
   Conclusion: The empirical evidence for this framework, using a case-study approach, confirms the relevance of the framework for the case-DPE. Through the themes derived for the subdesign dimensions the final themes for the design dimensions have been established. These demonstrate the relevance for each design dimension, together with the relevance scores. This is outlined in chap. 4.1.

3. Sub-question 3: How can the identified design dimensions be refined with practical information?
   Conclusion: The empirical research has identified separate subdesign dimensions for each design dimension of the framework. Participants have reflected on the definitions of the subdesign dimensions. This did not result in a change of a definition of any of the subdesign dimensions. This is outlined in chap. 4.2.

This case study has contributed to the validation design dimension that were identified from the literature review. This has resulted in a partial to high relevance for all design dimensions, and maximum two themes per design dimension outlining its relevance from the perspective of the DPE. No additions of changes were made in the definitions and descriptions of de design dimensions and subdesign dimensions that were identified by answering sub-question one.

5.3. Recommendations for practice

The practical application of this research is two-fold. For a (future) actor in a DPE, the actors can use the framework to gain an (initial) understanding of the different roles in a DPE and the design dimensions and subdesign dimensions that make up the framework from the perspective of a developing DPE. Actors can also assess which design dimensions may bear relevance for its own actor role in a DPE as well as for the other actors. This may be used to establish a common

understanding of the DPE between different actors from a framework perspective as well as addressing responsibilities for the different design dimensions by the platform actors.

Secondly, design dimensions and related concepts that emerge from the literature can be assessed for convergence with the framework against the themes of the subdesign dimensions and design dimensions.

5.4. Recommendations for further research

As a single-case study, the interpretation of the results requires caution due to the inability to generalize (Yin, 2018). Therefore, further validation of the framework through other non-profit DPE's for ILS should be undertaken contributing to triangulation of the results. This should also address the different stages of development of a non-profit DPE. Other research opportunities exist with regard to the relationships of the individual subdesign dimensions relative to each other and the contribution to their design dimension. Also, the current design dimensions have been operationalized into specific subdesign dimensions. Future research opportunities could address whether the framework design dimensions could be developed as a criterium for industry standards. A similar research opportunity is assessing the suitability of specific design dimensions to evaluate the strategy of a DPE, e.g., with regard to governance or ecosystem.

7. References

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