Common Platform Dilemmas
Collective Action and the Internet of Things

The term "Internet of Things" (IoT) is used to conceptualize networks of interconnected sensors, devices and appliances on the internet, which are enabling a wide range of application areas, including Smart Living (i.e., a wide range of ICT-enabled services such as e-healthcare and home energy management). Despite the considerable potential of IoT applications, technical issues such as interoperability of devices, as well as the rise of proprietary service platforms for services offered are the main bottlenecks in enabling progress of IoT.

While common service platforms are suggested to solve technical issues, several collaboration issues need to be dealt with. From an organisational perspective, establishing common service platforms requires resources and expertise across disparate sectors of consumer electronics, IT, telecommunications, energy, healthcare and construction. Since organisations from distinct sectors have different ways of doing business, different roles, expectations and motives arise, as well as several potential sources of conflicts.

This PhD research provides insight into why and how collective action for establishing common service platforms arises among organisations in the Smart Living domain. Building on theories of collective action, platforms and business ecosystems, eight propositions are developed on the impact of platform and ecosystem characteristics on the decision of organisations for collective action. The propositions are tested in three qualitative case studies in the domains of e-healthcare and home energy management. Finally, the importance of factors in the propositions is prioritized by a quantitative survey among practitioners in the domains of e-healthcare and home energy management.

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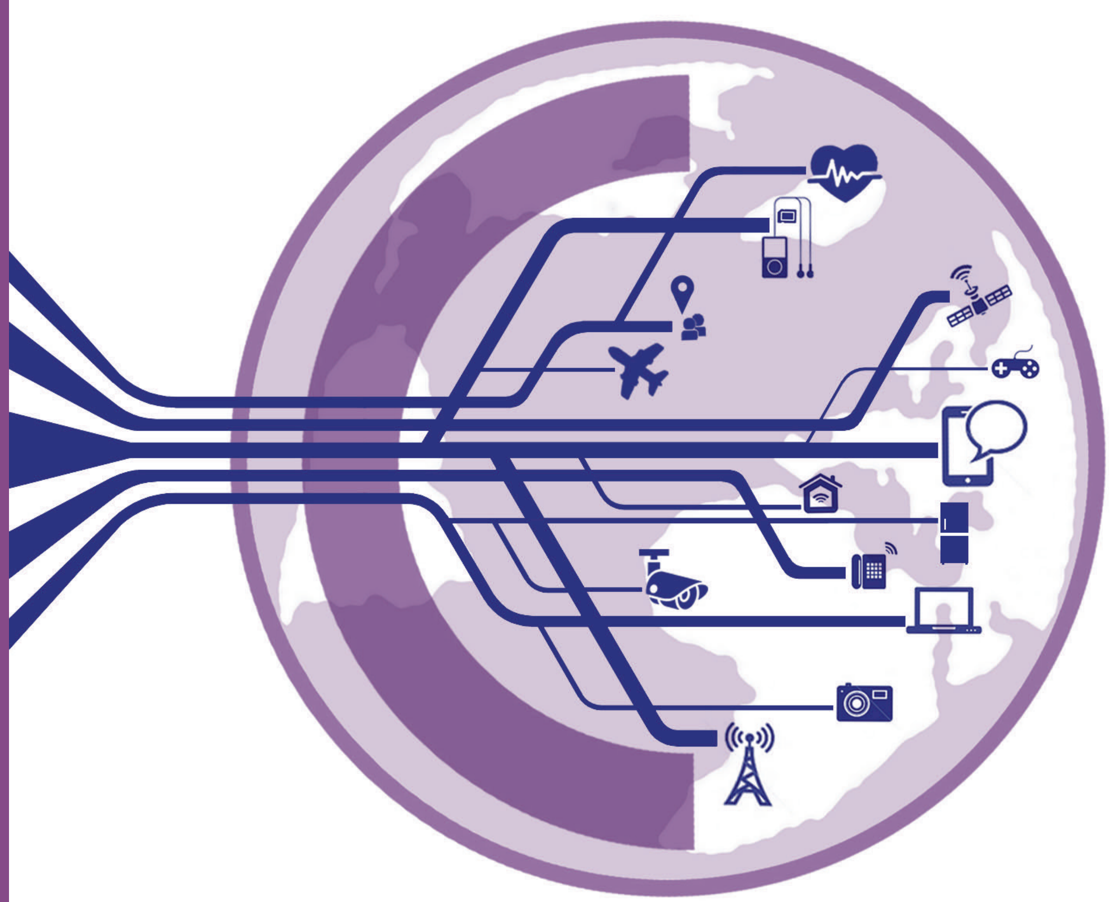

Fatemeh Nikayin

Common Platform Dilemmas
Collective Action and the Internet of Things

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Invitation

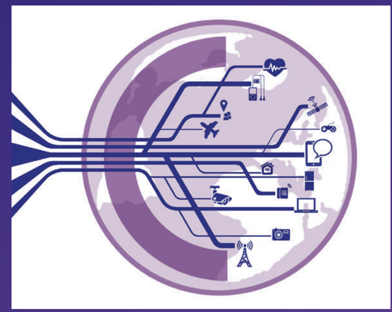
You are cordially invited to attend the public defense of the PhD dissertation:

Common Platform Dilemmas

Collective Action and the Internet of Things

by

Fatemeh Nikayin



The defense will take place
on Tuesday April 8,
2014 at 10:00
in the Senaatszaal of the Aula
of Delft University of Technology
Mekelweg 5, Delft

At 9:30, there is a short
Introductory presentation

After the defense,
there will be a reception

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COMMON PLATFORM DILEMMAS

Collective Action and the Internet of Things

Proefschrift

ter verkrijging van de graad van doctor
aan de Technische Universiteit Delft;
op gezag van de Rector Magnificus prof. ir. K.C.A.M. Luyben,
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A note about the cover: The picture on the cover symbolizes significance of collaboration in two different contexts: 1) Internet of Things: when several objects, communication lines and a common platform “C” connecting objects to each other create opportunities for several service offerings; 2) Music composition: when musical lines and notes on each line together create a musical piece. The lines continue outside the “C” and the globe to show that our vision of future possibilities is limited to the time and space in which we are living in.

“So much is asked of parents, and so little is given”
Virginia Satir

To my parents, Nasrin & Ghasem,

&

to Masoud

with love.

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Fatemeh Nikayin
March 2014

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1 Introduction

1.1 *Research Background*

We are entering an era of *Smart Living* in which advancements in Information Technology (IT) and ubiquity of mobile communication are changing a typical home into a smart environment. Such smart environment, driven by an Internet of Things, are equipped with several connected devices, sensors and appliances to support people's daily routines. Ever since the 1960s, the use of Information and Communication Technology (ICT) to support people in their home environment has received much attention (Aldrich, 2003). From simple home automation, the field is moving to increasingly advanced (mobile) internet-based services that are assisting people inside and outside their domestic environments.

Obviously, what is 'smart' depends on time (Weiser, 1996). In the 1980s, the 'smartness' of smart homes merely involved predefined automation of appliances' tasks (e.g., turning on/off appliances at certain time). Since the year 2000, smartness involves much more flexible task automation, adapting to the situation based on past usage data, user preferences and interaction with other devices and/or services. In addition, the internet makes smart home services accessible regardless of the device and location of the user (Barlow & Venables, 2003; Rohracher, 2002). For example, users are increasingly able to remotely access and control appliances and devices inside the home through their mobile phones.

As a result of ICT advancements, a number of actors from different sectors, including consumer electronics, telecommunications, healthcare and energy, have become interested to offer various internet-based services to people at home (Barlow & Venables, 2003). Examples of such services are home energy management services to help households to manage energy consumption and reduce their electricity bill (Fensel et al., 2013; Kamilaris et al., 2013) or healthcare services to enable elderly and disabled people to live independently at their homes while being remotely monitored for safety and healthcare purposes (Charlon et al., 2013; Fatima et al., 2013; Pommeranz, 2012).

These advanced types of internet-based services are thus no longer limited to controlling home appliances and are accessible beyond the confines of the home, thanks to mobile technologies. Therefore, the common term of ‘smart home’ no longer fits and we propose the term of ‘Smart Living’. Smart Living is about using ICT in the home environment to solve the grand challenges of healthcare and energy. We define Smart Living as ‘a bundle of internet-based services offered to households, accessible within and outside the house that combine value drivers of health, energy, safety and entertainment services to facilitate comfort living for households’.

1.2 *Problem Statement*

Currently, there is a huge growth in terms of wireless sensor technologies, internet-connected appliances and devices, all collecting and communicating real-time information and enabling the vision of Smart Living. For example, wearable assistive devices (e.g., watches and necklaces) with integrated sensors are used to remotely monitor body vital signs of the elderly or patients for safety and healthcare services. There are also sensors and devices that measure temperature, motion, and power consumption, enabling households to control and manage their homes energy consumption. This increasing number of interconnected devices and sensors, enabled by communication technology, is creating an ‘Internet of Things’.

The term Internet of Things (IoT) is used to envision networks of interconnected sensors, devices and appliances on the internet which are enabling a wide range of application areas, including Smart Living (Domingo, 2012; Gubbi et al., 2013a; Miorandi et al., 2012). Despite the considerable potential of IoT applications, technical issues make it difficult to capture potential opportunities of IoT with regard to Smart Living services. Typical examples of technical issues are inconsistent semantics of data produced by heterogeneous devices and sensors along with the lack of interoperability among different devices and applications (Barnaghi et al., 2012; Miorandi et al., 2012; Zeng et al., 2011)

Although a lot of attention is paid to standardizing technologies to solve interoperability issues between devices and services, there is a lack of attention to using shared platforms to run Smart Living services (Nikayin & De Reuver, 2013; Peine, 2009). Recently, there is a trend towards modularization and platformization (i.e., to use a platform architecture to provide various services to customers) in the ICT industry (Ballon, 2009a). 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’

(Ballon, 2009b). Mobile handsets, app stores, marketplaces and operating systems are examples of platforms in the mobile industry that enable various service providers to offer services to customers. Although platformization has also been started in the Smart Living domain, existing Smart Living service platforms, each addressing a niche in the market, are often non-interoperable (Jones et al., 2006; Martín et al., 2009a; Nikayin & De Reuver, 2013; Perumal et al., 2008). This fragmented nature of the market with non-interoperable service platforms not only makes it difficult for Smart Living service providers to share data and to bundle services and products from different device or service providers, it also increases the time and costs to develop and implement new services.

A service platform provides a set of technical and operational functions. On a technology level, a service platform gives access to a range of (non) interoperable sensors and devices and also stores, shares and maintains data. Furthermore, a service platform provides a communication infrastructure, a user interface and authorization services to access manage and personalize services on the internet. On an operational level, a service platform should include a billing process and a help desk for customer support.

Recent studies in the Smart Living domain suggest that generic technical and operational functions can be shared on common service platforms, so called open systems or open platforms, to offer a wide range of Smart Living services to households (Fagerberg et al., 2010; Peine, 2008; Viswanathan et al., 2009). In our view, a common service platform for Smart Living services includes generic technical and operational functions to mediate between a wide range of devices and services that operate in homes. Moreover, the common service platform is being developed and offered by multiple actors. Such a common service platform may solve interoperability issues and foster service innovation by enabling service providers to develop new services reusing existing functions. Furthermore, a common service platform may make it simpler for users to access different services from different service providers.

Establishing common service platforms for Smart Living services involves technological and organisational challenges. Technological challenges of developing service platforms for Smart Living services involve: 1) difficulties in designing a flexible architecture to add new devices or services and ensure an acceptable performance regarding response time, service quality, service coverage and effectiveness (e.g., Cabrer et al., 2006; Nussbaum & Miesenberger, 2004; Valtchev & Frankov, 2002; Yu et al., 2012); 2) designing attractive interfaces that enable developing new applications and services and enhance user experience (e.g., Portet et al., 2013; B. Zhang et al., 2009) and 3) setting appropriate standards to ensure interoperability and compatibility among various devices (e.g., M. Lee & Gatton, 2010; Zoref et al., 2009).

While many scholars study technological issues regarding common service platforms, organisational issues are typically overlooked (Peine, 2008; Solaimani et al., 2013). From an organisational point of view, establishing common service platforms for Smart Living services requires resources and expertise across disparate sectors of consumer electronics, telecommunications, energy and healthcare. For instance, enabling a common service platform for offering energy management services requires telecommunication infrastructure from telecom companies, smart metering systems from energy companies and expertise on system architecture from IT companies. Since organisations from distinct sectors have different ways of doing business, different roles, expectations and motives arise, as well as several potential sources of conflicts. Thus, the first and foremost organisational issue is how collaboration for establishing common service platforms for Smart Living services may arise. It is important to understand the motivation and criteria, which organisations take into account when deciding to join a collaborative project for establishing a common service platform. Moreover, organisations collaborating for setting up a common service platform may later compete with each other in offering services on the platform. Therefore, equally important is to strike a balance between collaboration and competition (Brandenburger & Nalebuff, 1997) and build up trust and commitment between those parties to maintain collaboration and deal with power struggles (De Reuver, 2009; Hoffmann et al., 2010; Volz et al., 2011).

Practical Problem:
The issue of interoperability with regard to the Internet of Things as well as the rise of proprietary service platforms for service offerings are the main bottlenecks in enabling the vision of Smart Living. While common service platforms are suggested to solve technical issues, several collaboration issues need to be dealt with to establish common service platforms.

1.3 *Theoretical Background*

Theoretically, this study builds upon concepts from theory on collective action, (digital) platforms, and business ecosystems.

1.3.1 Collective Action Theory

Collaboration for setting up a common service platform can be considered as a collective action problem since 1) it requires several organisations to collaborate to realize a common goal (i.e., to establish a common service platform) (Oliver et al., 1985; Poteete & Ostrom, 2004) and 2) the common goal cannot be achieved individually (Keohane, 1984). The classical theory of *collective action*, first developed by the economist and social scientist Olson in 1965, has been extensively used within economics, sociology and political disciplines to explain how groups of individuals collaborate to pursue a common goal, especially when it is not possible to achieve the common goal through individual action (Keohane, 1984). Generally, the theory focuses on the conditions required for collaboration towards a common goal (Markus et al., 2006).

Despite the advantage of collective action in realizing a common goal, many obstacles may stop individuals from becoming engaged in collective action. According to Olson (1971), the dilemma of collective action occurs when benefits of the common goal cannot be excluded from non-contributors. Then, rational individuals will not contribute to the common goal and they tend to free ride on contributions of others. Several concepts including critical mass, group size, network structure, motivations and selective incentives have been widely studied, in different contexts of economics (e.g., Justino, 2006; King, 2008; Myatt & Wallace, 2008), sociology (Gould, 1993; Heckathorn, 1993, 1996; Van Zomeren et al., 2011; Wright, 2009) and political sciences (e.g., Duncan, 1999; Esteban & Ray, 2001; Scholz et al., 2008), to explain why collective action arises in one group and not in another group. The theory has been also applied in studying management of natural resources (referred to as common pool resources), in which several individuals need to collaborate for utilizing a common natural resource (e.g., a grazing land for cows) and preventing overexploitation (i.e., the free-rider dilemma) (e.g., Agrawal, 2002; G. Hardin, 1968; Mazzoni & Cicognani, 2012; Ostrom, 1990).

Despite the wide range of applications of collective action theory, the theory has hardly been applied to the ICT domain to explain inter-organisational collaboration for the development of common service platforms. Exceptions are: Markus et al. (2006) and Klein and Schellhammer (2011).

1.3.2 Platforms

Common service platforms can be seen as a specific type of platform. The concept of a platform is not new and has been used in different streams of literature such as product development (e.g., Chai et al., 2012; Meyer & Lehnerd, 1997), economics (e.g., Evans & Schmalensee, 2010; Hagiu & Yoffie, 2013) and business strategy and management (e.g., Boudreau, 2010; Choi & Phan, 2012; Eisenmann, 2008; Enkel et al., 2009) to describe products, digital systems, services or even organisations (e.g., real estate agencies, clubs). From a technological perspective, a platform can be viewed as “a building block, providing an essential function to a technological system which acts as a foundation upon which other firms can develop complementary products, technologies or services” (Gawer, 2011, p. 2). What all platforms have in common is that they mediate interactions between two or more groups of participants (i.e., service providers and service consumers) (Evans & Schmalensee, 2008; Rochet & Tirole, 2008).

Existing research on platforms, from economics, strategy and management sciences, largely contributes to understanding characteristics of platforms and how such characteristics influence innovativeness and the growth of existing platforms (e.g., Boudreau et al., 2008; Gawer, 2011; Gawer & Cusumano, 2012; Parker & Van Alstyne, 2010). For example, many scholars study how characteristics of a service platform influence complementary providers (i.e., third-party application developers or service providers providing complementary products and services for the platform) to join the platform and innovate around the platform (e.g., Boudreau, 2010; West & Dedrick, 2000). Others look into the evolution of platforms over time (Basole & Karla, 2011). Nevertheless, platforms developed jointly by multiple actors have not been studied. There is no study, to the best of our knowledge, which explores collaboration issues for the development of common service platforms by multiple actors.

Platform concepts as originated in economics and strategic management sciences have recently attracted attention in the field of Information Systems (IS), referred to as digital platforms or digital infrastructures. Especially, advances in architectural paradigms such as Service Oriented Architecture (SOA) can transform decades of legacy information systems into flexible platforms which provide several services for management of business processes (Tilson et al., 2012). As a result of such transformation in information systems, there are calls from IS scholars to put platforms at the centre of research in the IS field to understand how digital platforms arise, evolve and govern (Bharadwaj et al., 2013; Tilson et al., 2010; Yoo et al., 2010). So far, research on digital platforms studies mobile, social networking and computing platforms in telecommunication and computer industries. However, there is a lack of studies on emerging platforms in other industries such as

Smart Living. Moreover, existing research focuses on single-provider platforms rather than common service platforms provided by multiple actors.

1.3.3 Business Ecosystems

The concept of business ecosystems, which was first introduced by Moore (1993), has attracted the attention of scholars who use it as a lens for analysing inter-organisational networks in high-tech industries such as computer and mobile industry (Basole & Karla, 2011; Ceccagnoli et al., 2012; Gawer & Cusumano, 2012; J. Zhang & Liang, 2011). The term has also achieved popularity among practitioners to illustrate the dynamics of emerging and evolving industries. Moore’s view of a business ecosystem is a network of collaborating and competing organisations from different sectors around a technology. The members of a business ecosystem share a common vision; their capabilities and roles co-evolve over time and they tend to align themselves with the directions of central leadership.

Depending on the core technology in a business ecosystem, scholars use other terms such as platform ecosystems (Basole & Karla, 2011; Ceccagnoli et al., 2012), service ecosystems (Scholten & Scholten, 2010), digital business ecosystems (Petrou et al., 2006) and innovation ecosystems (Adner, 2006). In this thesis, we use the term ‘platform ecosystem’ to refer to the network of organisations collaborating and competing to provide a service platform and complementary services around it.

Although there are several other perspectives being used to study inter-organisational networks such as value chains (Porter, 1998), value networks (Allee, 2000) and strategic alliances (Eisenhardt & Schoonhoven, 1996), we found business ecosystems more relevant for this study. Unlike the traditional concept of value chain, a business ecosystem does not merely focus on activities in a particular sector of industry (Peppard & Rylander, 2006) and the exchanges between members are not limited to tangible assets. Moreover, dissimilar to supplier/buyer relationships in value chains, in business ecosystems relationships are multi-directional with organisations that share values and interests (Battistella et al., 2013). While the view of business ecosystems seems to be almost in line with value networks (i.e., sharing tangible and non-tangible assets, members from different industries), unlike value networks, in business ecosystems collaboration and competition co-exist. Furthermore, the network of organisations in a business ecosystem is rather flexible compared to stable relations in strategic alliances (Rong et al., 2010).

Existing research focuses on modelling and analysis of business ecosystems (e.g., Basole et al., 2012; Battistella et al., 2013; Tian et al., 2008), exploring platform strategies along business ecosystem lifecycles (Rong et al., 2013) and using the business ecosystem as a perspective to study an industry (J. Zhang & Liang, 2011) or evolution of a company in an industry (Li, 2009). Nevertheless, until now, no research has applied principles of collective action theory in a business ecosystem to address typical issues of collaborative networks, such as dealing with interdependencies between members, balancing competition and cooperation (Brandenburger & Nalebuff, 1997) and dividing costs, risks and revenues. A collective action perspective on business ecosystems could provide insight into how and why inter-organisational collaboration in business ecosystems arises, complementing recent theorizing from a governance point of view (De Reuver, 2009).

1.4 *Research Objective and Research Questions*

As explained in Section 1.2, dealing with the issues of interoperability and the raise of proprietary service platforms in the Smart Living domain requires inter-organisational collaboration to establish common service platforms. Collective action theory has been widely used as a lens to study collaboration issues. Nevertheless, the theory has been hardly applied to study platform collaboration in ICT domain. Moreover, the theory has not been yet related to platform-related theories and the business ecosystem concept. Therefore, based on the problem description (Section 1.2) and the identified theoretical gaps (Section 1.3), the purpose of this study is:

> **"To explain why and how collective action for establishing common service platforms for Smart Living services arises among organisations in platform ecosystems"**

Service platforms and platform ecosystems have characteristics that differ from each other and such characteristics can influence the intention of organisations to collaborate for the platform. For instance, the degree to which technical information of a platform is provided for third parties or availability of funding for the platform development may influence the decision of organisations to collaborate for the platform. Therefore, in line with the aforementioned research objective, this research aims to answer the following research question:

What characteristics of service platforms and platform ecosystems influence organisations' decisions to become engaged in collective action for developing common service platforms for Smart Living services?

Based on the research question, the unit of analysis in this study is the platform ecosystem (i.e., organisations that are involved in the development of a common service platform) and their technologies for the common service platform. We are especially interested in the reasoning of organisations about how certain characteristics of platforms and business ecosystems influence their decisions to become engaged in a collaborative common service platform project.

1.5 *Contributions and Relevance*

1.5.1 Theoretical Relevance

This study will contribute to literature on collective action theory as well as platform theory. The study applies collective action theory to the IS field of (digital) platforms to explain how and why inter-organisational collaboration for establishing common service platforms arises. While the theory of collective action has been previously applied to the adoption and diffusion of information systems (Markus, 1987; Rogers, 1991), it has not hardly been applied to analysing the providers of common service platforms (Exceptions: Klein & Schellhammer, 2011; Markus et al., 2006).

The concept of service platforms is becoming increasingly important in the field of IS, as modular architectures (e.g., Service Oriented Architecture (SOA)) "seek to transform legacy information systems into flexible service platforms" (Tilson et al., 2012, p. 2). As a result, there are calls from IS scholars for research that theorize development, governance and evolution of service platforms (Tilson et al., 2010; Yoo et al., 2010). However, empirical research on service platforms jointly developed by multiple organisations is scarce. This thesis aims to contribute to this gap by studying joint development of common service platforms in an emerging cross-sectoral domain (i.e., Smart Living).

This thesis also contributes to literature on business ecosystems by applying the concept of business ecosystems to collective action theory in order to explain how ecosystems' structures can influence decisions for collaboration.

1.5.2 Practical Relevance

Despite technology advancement regarding the Internet of Things and numerous research on users and technology aspects of Smart Living services, the uptake of Smart Living services is limited (Peine, 2008, 2009). This suggests that there is a need for a coherent body of knowledge in this domain that not only pays attention to technical issues but also to organisational issues (Solaimani et al., 2013). The results of this thesis fill this knowledge gap in the domain and inform practitioners and policy makers about disregarded inter-organisational challenges that need to be taken into account when planning to promote platform collaboration for Smart Living services. In addition, in the internet economy, many companies are looking to become platform providers and to orchestrate platform ecosystems. As a result, business model literature is shifting from a product and service focus towards business models for (digital) platforms (Ballon et al., 2011; Bharadwaj et al., 2013; El Sawy & Pereira, 2013). For instance, an issue such as platform openness or closedness is often debated when comparing Apple and Google. Therefore, giving insights into the factors that motivate organisations to collaborate can inform organisations which trade-offs to take into account when formulating business models for their innovations.

1.6 *Research Design*

In order to address the research question and fulfil the research objective, this research adopts a multi-method approach (Campbell & Fiske, 1959), which comprises four phases. With regard to the multi-method approach, we use a qualitative case study and a quantitative survey method, in which the results of the case study method serve as input for the survey method.

The research starts with a literature study on relations between the core theories of the research (i.e., Collective Action Theory, Service Platforms and Business Ecosystems) (Chapter 2). Based on the insight from the literature study, a theoretical framework of *collective action for common service platforms* is developed, which contains a set of propositions on characteristics of service platforms and business ecosystems that influence organisations' decisions to become engaged in collective action. Although there is literature on collective action theory, platforms and business ecosystems, the literature streams have not been integrated or applied to common service platforms. Therefore, formulating specific hypotheses is not possible and only propositions can be formulated.

We view propositions as abstract statements about the relationship between two concepts, while hypotheses are specific testable, measurable and falsifiable statements. Therefore, propositions can be seen as a starting point to develop testable hypotheses later.

After developing the theoretical framework in Chapter 2, in the next phase, trends and developments in the Smart Living domain are reviewed (Chapter 3) and the theoretical concepts from Chapter 2 are specified onto the research domain.

Next, propositions in the theoretical framework are tested and refined through multiple qualitative case studies on collaborative platform development projects in the Smart Living domain (Chapter 4). The case study method is appropriate for answering questions of 'why' and 'how' and understanding a contemporary phenomenon of interest, especially when the phenomenon is unresearched and theoretical knowledge on the phenomenon is limited or inadequate (Cavaye, 1996; Eisenhardt, 1989; Yin, 2009). The case study method is suitable for this thesis as we study why and how collective action can arise between organisations for establishing common service platforms for Smart Living services. To do so, we require insights into the context (e.g., social, political, organizational and economic surroundings) organisational relationships, knowledge and experiences of informants and practitioners in the field. We follow an inductive approach in the case studies, though not purely inductive because we make our theoretical propositions that serve as a basis for guiding the case studies, explicit. These theoretically grounded propositions are needed to guide the case study approach and to systematically collect data (Eisenhardt, 1989; Miles & Huberman, 1994; Yin, 2009). Furthermore we follow a replication strategy for the case selection. Given the scarcity of available platform collaboration cases in the Smart Living domain, this choice is also based on pragmatic arguments. This approach results in research in three cases. We are aware that differences in terms of countries, culture and technologies might bring spuriousness. Nevertheless, the intention of the case study is not to generalize based on the cases under study. We follow more a content related approach, like in an experimental research in which the validity of our results are more related to theoretical considerations and to assess the validity of our propositions. On a more practical side the case study methodology, unit and level of analysis, data collection methods and data analysis approach are extensively discussed in Chapter 4.

In the next step, a survey study is conducted. The objective of the survey is to prioritize the importance of specified factors in the theoretical framework, by a large-scale expert validation in the Smart Living domain again with the objective to increase the theoretical validity. The specified propositions from case studies are used in the survey study. The operationalization of core concepts and their relevance are the core objective of this survey approach.

The two methods can be seen as complementary as the strength of one method compensates for the weakness in the other method (Gable, 2010). While the case study method provides contextual richness in understanding what is actually occurring, the strength of the survey is in deductibility and external validity, which are missing in the case study method (Gable, 2010; Kaplan & Duchon, 1988). Therefore, by combining two methods and corroborating the findings from qualitative case studies with a quantitative survey, we strive to increase the external validity of our theoretical concepts. The combined findings from two methods then provide an overview of how different factors influence decisions of organizations to become engaged in collective action (from case studies) and which factors are the most important in platform collaboration according to experts (from the survey study). The specific design of the quantitative survey and the rationale behind the choice of the method are discussed at length in Chapter 5.

1.7 *Thesis Structure*

This section outlines the remainder of the thesis. Chapter 2 includes theoretical background underlying this research. It provides an overview of previous studies on collective action theory, platform and business ecosystem concepts. The aim of Chapter 2 is to identify gaps in these three steams of literature, relate the concepts to each other and provide a theoretical framework of platforms and business ecosystems characteristics that influence organisations' decisions to become engaged in collective action.

Chapter 3 presents current trends and developments in Smart Living and specifies the application of theoretical concepts from Chapter 2 to the research domain. The chapter starts by defining the notion of 'Smart Living' and explaining how it differs from the concept of smart homes. Then, an overview of Smart Living services, service platforms, networking technologies, devices and technology trends are presented. The chapter closes by providing an overview of involved actors and sectors in the Smart Living domain.

In Chapter 4, the case study methodology and the results of case studies are presented. The chapter finishes with cross-case analysis of findings from case studies. The findings from Chapter 4 are the basis for the quantitative survey in Chapter 5. The detailed design and results of the quantitative survey are presented in Chapter 5.

Finally, in Chapter 6, findings of this research, theoretical contributions and implications for the Smart Living domain are discussed. The thesis finishes with discussing limitations of the research as well as exploring avenues for the future studies.

2 Theoretical Background

This thesis uses the lens of collective action theory to study why and how collective action for establishing common service platforms for Smart Living services arises among organisations in platform ecosystems. This chapter reviews collective action theory, platform related theories and business ecosystem concepts and relates them to each other to develop a theoretical framework for the empirical study of this research.

The chapter proceeds as follows. In Section 2.1, we review collective action theory. First, we explain the theory and its application in different contexts for studying collaboration for a common goal. Then, we explain the challenges of collective action with regard to the shape of production function and specify the challenge of collective action in this thesis (2.1.1). Afterward, we review characteristics of groups (2.1.2) and collective strategies (2.1.3) which can influence the start-up of collective action within groups. We close the section by summarizing relevant factors influencing group collaboration for a common goal (2.1.4).

In Section 2.2, we review platform-related theories. First, we define the concept of platform (2.2.1). Then, we discuss platform related concepts, namely network effects (2.2.2), platform openness (2.2.3), platform competition (2.2.4) and platform leadership (2.2.5). We conclude the section by explaining how existing platform theories can explain collective action between multiple organisations for establishing common service platforms (2.2.6).

In Section 2.3, we review studies on business ecosystems. We start by defining the concept of business ecosystem and discussing how it differs from similar concepts of value chain, value network and strategic alliances (2.3.1). Then, we describe main roles in business ecosystems (2.3.2). Finally, we conclude the section by explaining how the concept of business ecosystems can be used to study typical issues of collaborative networks (2.3.3).

Finally, in section (2.4), by relating concepts from these three streams of literature, we present a theoretical framework with eight propositions. The propositions suggest how different factors influence decisions of organisations to become engaged in collective action for developing a common service platform.

Methodology

First, we started by collecting articles from journals, conference proceedings, books and online scientific databases. We searched keywords of ‘collective action’, ‘platform’, ‘digital platform’, ‘business ecosystem’, ‘two-sided market’, ‘network effects’, ‘value network’, ‘value chain’, ‘motivation’, ‘selective incentives’, ‘platform openness’, ‘platform leadership’, ‘platform competition’, ‘free-rider’, ‘keystones’, ‘co-opetition’, ‘ecosystem leadership’, and ‘ecosystem governance’, in Google Scholar, Scopus and Science Direct. We often searched for combinations of two or three keywords to find the most relevant articles. At the end, a total number of 300 articles were collected of which 160 were selected, based on their abstracts, to be included in our literature review. We used snowballing technique to track related citations in the collected articles to find more articles that are relevant.

While reviewing literature on collective action, we mainly build on seminal articles and books to use the theory in its original format. We do refer to recent studies if they complement the original sources.

2.1 *The Theory of Collective Action*

This section begins by explaining the theory of collective action, its application in different contexts and the reason why the theory is relevant to study collaboration for setting up common service platforms. After that, we discuss several conditions that influence collective action within groups. We close the section by suggesting factors that can be taken into account for studying collective action in the context of common service platforms.

2.1.1 Why Collective Action Theory?

Collective action theory, first developed by Olson (1971) in his seminal book ‘The logic of collective action’, is used to explain how groups of individuals may collaborate for a common goal even if the incentives to do so are smaller than not collaborating. In other words, the theory seeks to explain the conditions under which individuals or organisations collaborate with each other to accomplish a common goal (Markus et al., 2006). The theory has been widely applied to study collaboration for a common goal in different fields of sociology, politics and management of natural resources (e.g., Gebremedhin et al., 2004;

Hodge & McNally, 2000; Matta & Alavalapati, 2006; Nyikahadzoi, 2009; Steins & Edwards, 1999).

The common goal of a group for collective action is also referred to as shared goal, shared interest, common interest, collective interest or collective goal (R. Hardin, 1982; Oliver, 1993; Olson, 1971; Ostrom, 1990). The importance of a 'common goal' for a group is not new and was already discussed by Arthur Bentley, the founder of group theory, who stated that "there is no group without its interests" (Bentley, 1908, p. 211).

What the common goal is depends on the group and the context that ties members of the group together. In the field of sociology, the common goal is to establish social activities or movements and sociologists use collective action lens to find factors and conditions that explain how and why social movements take place (e.g., Klandermans, 2004; Oegema & Klandermans, 1994; Walsh & Warland, 1983). In the economic branch of collective action, the common goal is to provide a 'collective good' (i.e., a good which is in the interest of all members of the group and cannot be provided individually) (e.g., Monge et al., 1998; Von Hippel & Von Krogh, 2003). In the field of natural resource management, the common goal is to preserve a 'common pool resource' such as a forest, water resource and grazing land from overharvesting (e.g., Agrawal, 2002; Matta & Alavalapati, 2006; Wade, 1987).

The focus of this thesis is to study inter-organisational collective action for the development of common service platforms. Therefore, the common goal for collective action is to develop a common service platform, which is a collective good. Collaboration for setting up a common service platform can be studied though the lens of collective action since (1) it requires several organisations to collaborate to realize the common goal (Oliver et al., 1985; Poteete & Ostrom, 2004); (2) the common goal cannot be achieved individually (Keohane, 1984).

The Collective Action Dilemma and the Shape of the Production Function

A number of scholars (e.g., R. Hardin, 1982; Heckathorn, 1989; Runge, 1984) started from Olson (1971) argue that when benefits of the common goal of a group cannot be excluded from non-contributors, rational individuals will free-ride on the contributions of others and this will sabotage efforts for collective action in two ways: 1) participants would be tempted to free-ride on contributions of others and behave rationally; 2) the possibility of free-riding reduces individuals' incentives to collaborate because of fear that others might free ride (Kollock, 1998). In response to Olson's argument about the free-riding issue, Marwell and

Oliver (1993) argue that the free-rider problem can be solved by an initial small group of highly interested and resourceful contributors, whose efforts can generate a ‘bandwagon’ effect and encourage more contributors to support the action. They refer to such group of contributors as a ‘Critical Mass’. It should be noted that while critical mass and collective action are two separate concepts, many scholars link then together.

From the viewpoint of critical mass theory (Bouwman & Slaa, 1992; Oliver et al., 1985), what matters for collective action is not contribution of all group members, but contribution from a small part of the group who are highly resourceful and interested in providing the collective good. From this view, collective action involves two major challenges. The first challenge is how to get critical mass of contributors to start collective action (i.e., a start-up issue) and the second challenge is how to ensure that the collective action will be sustained (i.e., a continuance issue) (Markus, 1987). Which challenge is relevant depends on the shape of the production function of the collective good (i.e., an s-shape curve that describes the relationship between provision of the collective good and contribution of resources) (Markus, 1987; Oliver et al., 1985).

Oliver and Marwell (1985) discuss two particular types of production function for collective goods: 1) a decelerating production function and 2) an accelerating production function. In a decelerating production function, initial resource contributions benefit most from providing the collective good and the subsequent contributions benefit less. This implies that there are more benefits for early contributors and fewer benefits for the followers. This production function leads to the continuance issue of collective action. The reason is that despite of significant incentives for initiating collective action (because of initial high marginal return), contributions will not continue due to the decreasing rate of marginal return for later contributors (Monge et al., 1998). Therefore, collective action may not continue.

Accelerating production function, by contrast, starts with an initial period of low profits follows by a period of high returns. Therefore, it requires a ‘critical mass’ of highly interested and resourceful actors to pay the start-up costs and provide conditions for less interested parties to join collaboration (Oliver et al., 1985). In contrast to decelerating production function, the issue is to obtain initial contributions (i.e., the start-up issue) and after that due to increasing marginal return, collective action will continue (Monge et al., 1998).

The development of a common service platform (i.e., a collective good) can also be described by a production function. Typically, the development of new technologies such as common service platforms, initially involves uncertainties over technology, market and investment, which makes actors doubtful about collaboration. However, once the platform is developed and there are reasonable numbers of services and users on it, the platform produces high returns for its providers and thus more providers would be willing to join. Therefore, we expect that the development of a common service platform has an accelerating production function, which suggests that especially the start-up issue for collective action is relevant.

In the remainder of this section, we review collective action literature for factors and conditions initially influencing actors to become engaged in collection action. We categorize influencing factors into: 1) characteristics of the group and 2) collective strategies employed in the group. Because collective action literature is very broad, we do not claim to include every factor discussed in previous studies.

2.1.2 Characteristics of Groups

Typically, studies on collective action consider a group as a total number of potential contributors for providing a collective good. Several researchers suggest that group characteristics can influence the start-up and continuance of collective action in a group (e.g., Bandiera et al., 2005; Centola, 2013; Markelova et al., 2009). In this section, we review characteristics of groups (i.e., size, heterogeneity and interdependency) which are discussed to influence collective action.

Group Size

Group size is considered as one of the important factors in studying collective action, although there are conflicting views about how group size affects collective action (Oliver & Marwell, 1988).

One of the controversial arguments about group size is the one asserted by Olson (1971). He argues that collective action is less likely to happen in large groups, because when contributions of group members are not noticeable (which happens in large groups) and the cost of provision of the collective good exceeds the benefit to each member, rational individuals would not contribute and are likely to free-ride. Several researchers followed Olson's proposition about group size and even showed it empirically (Chamberlin, 1974; Sandler & Blume, 1992).

In opposition to the Olson's argument on group size, other (empirical) studies show that small groups are not necessarily better than large groups (Bouwman & Slaa, 1992;

Esteban & Ray, 2001; Haag & Lagunoff, 2007; Oliver & Marwell, 1988; Perez-Verdin et al., 2009). For instance, Oliver and Marwell (1988) discuss that decisions for contribution in collective action are often based on costs and benefits. They mathematically show that if increasing the group size leads to more costs and/or less benefits for members, then it would have a negative effect on collective action. However, they argue that when increasing the group size does not raise costs, it is more likely to obtain an initial group of highly interested and resourceful contributors for collective action in larger groups.

Several other scholars also analyse the relation between group size and the provision of a collective good (Chamberlin, 1974; Pecorino, 1999), demonstrate effects of group size by interplaying different features of lobbying costs, intergroup interaction and types of collective good (Esteban & Ray, 2001) or study the effects of group size on trust and resource mobilization (Poteete & Ostrom, 2004). Nonetheless, the findings of these studies cannot direct us to a straightforward conclusion about the effect of group size on the start of collective action or provision of a collective good.

Group Heterogeneity

The term group heterogeneity describes having a group with dissimilar members. Depending on the context of the study and whether the group's members are individuals or organisations, heterogeneity may be seen along a diversity of dimensions. Typically, the impacts of group heterogeneity on collective action varies according to circumstances and types of heterogeneity (Varughese & Ostrom, 2001). For instance, heterogeneity in a group can be seen in forms of differences in interests, economic wealth and socio-cultural characteristics of the group's members (Baland & Platteau, 1995; Poteete & Ostrom, 2004; Vedeld, 2000).

The critical mass view of collective action suggests that interest heterogeneity and resource heterogeneity are two favourable conditions to overcome the start-up issue for collective action (Markus, 1987). As, this thesis deals with the problem of start-up in collective action for common service platforms, we specifically consider heterogeneity of interests and resources.

There are no specific definitions for interest and resource heterogeneity in collective action literature. Moreover, perceptions on resource and interest heterogeneity seem to differ in different contexts. Therefore, based on the context of this thesis (i.e., inter-organisational collective action for common service platforms) we define these two dimensions as follows. We define interest heterogeneity as the situation when organisations in a group have different economic (commercial)/noneconomic interests and/or dissimilar preferences as to the provision of a collective good, e.g., one organisation is interested in the economic value of collaboration or the collective good while another one is interested in gaining knowledge. We define resource heterogeneity as the situation when organisations have different technical, financial and/or organisational resources, including power position in the market, customer base, and strong inter-organisational relationship with other actors in a market, to contribute to the provision of the collective good.

In the context of standardization, Markus et al. (2006) find that organisations participating in collective action are not always united in their interests because of several reasons including being competitors or belonging to different sectors of industry. Therefore, they suggest that to ensure participation of all relevant sectors and actors, it is critical to reconcile divergent interests of different groups of participants. Another study by Klein and Schellhammer (2011) on the development of inter-organisational information systems shows that interest heterogeneity can result in conflicts of interest which is detrimental to collective action. With regard to resource heterogeneity, the study by Markus et al. (2006) shows that in collective action for developing an industry standard, i.e., a collective good, specific resources of several actors (i.e., technical knowledge, business knowledge of industry) are required, otherwise the collective good cannot be provided.

Similar to collective action for standardization or development of inter-organisational information systems, the development of common service platforms includes different groups of participants across industry sectors. Following Klein and Schellhammer (2011), we expect that heterogeneity of interests among different groups of participants would be problematic, because it is less likely that organisations with diverse interests reach to an agreement (e.g., on properties of the collective good or/and the business model for sharing costs and benefits) in collective action. Following Markus et al. (2006), we expect resource heterogeneity to be favourable for collective action especially when the collective good (i.e., a common service platform) cannot provided individually. Moreover, heterogeneity of resources is favourable to overcome the start-up issue because it increases the chance of having highly resourceful actors who are interested and willing to bear the initial costs for providing the collective good (Marwell et al., 1988; Oliver et al., 1985).

Group Interdependency

Generally, dependency upon resources of others encourages participation in collective action (Offe & Wiesenthal, 1980). Many researchers argue that interdependency between group members is required to overcome the start-up issue in collective action (R. Hardin, 1982; Oliver et al., 1985; Sheppard et al., 1990). For instance in the context of high-technology alliances, Walter et al. (2012) argue that when the degree of interdependency between partners in alliances decreases, the partners perceive less necessity to become engaged in collective action. This suggests that lack of interdependency between actors reduces their incentives and willingness to participate in collective action, which causes the start-up issue. Monge et al. (1998) argue that participants in collective action are interdependent on each other to provide the collective good. If any participant stops contributing, the collective good may not be achieved. Therefore, interdependencies may not only contribute to starting up collective action, but also to continuance.

In the context of development of information architectures (e.g., using Web 2.0 technology), Constantinides (2012) discusses that the nature of collective action is becoming more heterogeneous, derived from networked interdependencies between several actors which do not have complete information about the possible future combination of information and web services. Similar interdependencies between actors can be found in cross-sectoral innovative domains (e.g., Smart Living) where providing a collective good (i.e., a common service platform) depends on technology, knowledge, competencies and capabilities of several actors (Janssen et al., 2014).

2.1.3 Collective Strategies

Beside the discussed characteristics of groups' structure, strategies employed within a group can influence actors' willingness to participate in collective action.

Selective Incentives

Olson (1971) argues that only separate and selective incentives will stimulate actors in large groups to work collectively. Such incentives are 'selective' because they are only provided to the actors contributing to the provision of a collective good and not for those who do not. Selective incentives can be seen as any tangible or intangible benefits that are offered to actors who contribute to the provision of a collective good, as well as any tangible or intangible losses from not contributing such as fines or sanctions.

Prior to Olson, Clark and Wilson (1961) identified three types of incentives for collaboration: 1) material incentives (i.e., tangible rewards such as financial aids); 2) solidarity incentives (i.e., intangible rewards such as status and reputation) and 3) purposive incentives (i.e., intangible rewards based on the ideology of a group such as supporting a political candidate). Sociologists often discuss selective incentives in forms of solidarity and purposive incentives (e.g., enhanced social relations or high reputation). However, in the context of inter-organisational collaboration, material incentives are often more central (Von Hippel & Von Krogh, 2003).

Following Olson, many scholars investigate effects of selective incentives on individuals' contributions and discuss the value of selective incentives as a solution to eliminate the free-rider problem (R. Hardin, 1982; Knoke, 1988; Oliver, 1980). In addition, selective incentives can also solve the start-up issue as exclusive additional rewards (i.e., advantages other than ones from collective action) such as financial supports may encourage actors with a lack of interest to collaborate for a collective good (Olsson, 2009). Oliver (1980) shows that positive incentives are costlier than negative incentives. For instance, providing financial support, for every member of a group would be costly, especially if the group size is large. As such, positive incentives are efficient to be used for motivating actors in small groups while negative incentives are often used to ensure collaboration in large groups. Nevertheless, because of potential side effects of disharmony and discord, Oliver suggests to enforce negative incentives only when the chance of non-contributing is high. Whether negative or positive, enforcing selective incentives requires monitoring mechanisms to control the efforts of group members. In this regard, Ostrom (1998) argues that enforcing monitoring mechanisms is easier and less costly in small groups where members can easily communicate with each other.

Despite potential benefits of selective incentives, scholars discuss the problem of second-order free riding for selective incentives (i.e., "who will contribute to the administration of selective incentives?") (Frohlich et al., 1975; Willer, 2009, p. 6). In fact, selective incentives are also considered as 'collective goods' in which non-contributors benefit and thus they are subject to free-riding in their own right. A number of studies suggest that the problem of second-order free-riders can be solved more easily than the first-order and thus second-order collaboration is more robust than the first-order collaboration (Heckathorn, 1989).

To sum up, providing selective incentives can be seen as a strategy to encourage actors to participate in collective action. A number of scholars discuss that imposing rewards and punishments to contributors and free-riders requires a central authority (so called an organizer or a leader) (Olson, 1971). Such a central authority is an actor who is highly interested in collective action and thus bear the costs of providing selective incentives to stimulate actors' participation in collective action (Salisbury, 1969; Sandholtz, 1993). The role of such an actor is discussed in the following section.

Leadership

Many researchers highlight the critical role of leaders, organizers or entrepreneurs to provide selective incentives and organize group activities for achieving the common goal or provisioning the collective good (Frohlich et al., 1971; Salisbury, 1969). Salisbury (1969) defines leaders as those who invest capital to create a set of benefits (i.e., selective incentives) for potential members to join a group. He adds that if the benefits fail or costs exceed the benefits for potential members and leaders, the group will collapse.

Marwell et al. (1988) discuss that in a centralized network with the presence of resource and interest heterogeneity, leaders can select the most prospect contributors and thus promote likelihood of collective action. Bianco and Bates (1990) show that leadership is more critical in initiating rather than sustaining collective action. They identify leader's capabilities (i.e., information and strategies) and reward structures (i.e., selective incentives) as two main indicators of a leader's proficiency for organizing collective action. Their study suggests that selecting a leader with specific capabilities and resources as well as appropriate reputation can facilitate and maintain the efforts for collective action (i.e., the start-up and continuance). Sandholtz (1993) studies effects of leadership in mobilizing, supporting and promoting collective action at international level (i.e., international leadership). Based on several case studies in the telecommunication industry, he argues leadership as a necessary condition for collective action to arise. Monge et al. (1998) argue that a leader in collective action is often the actor who is most dependent on the resources of others. This implies that leadership for collective action will arise when a leader realizes resource interdependencies on other actors.

In brief, leaders play an important role in initiating collective action by deploying collective strategies and creating selective incentives to encourage actors to participate in collective action. Therefore, leadership can be seen as an essential condition to overcome the start-up issue and mobilize collective action.

2.1.4 Conclusions

In this section, we reviewed existing studies on collective action to find how characteristics of groups and collective strategies in groups can solve the start-up issue in collective action.

We argued that the provision of common service platforms involves an accelerating production function (i.e., the benefits of contributing to a common service platform increase as more organisations contribute). Typically, collective goods with accelerating production functions involve a start-up issue for collective action because early contributors face lower pay-offs. Next, we reviewed literature on how characteristics of groups and collective strategies affect the start-up issue in collective action (See Figure 2.1).

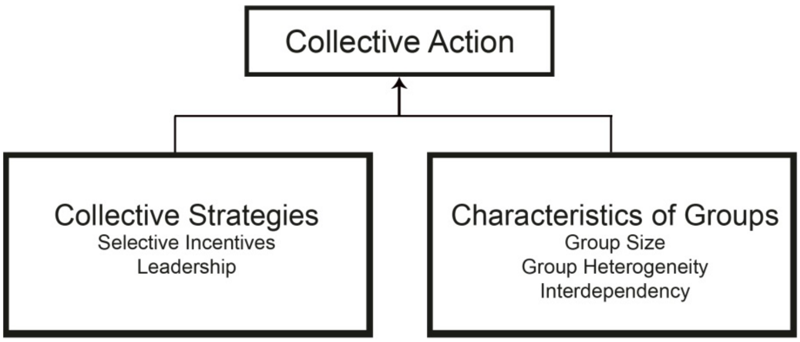

Figure 2.1 Framework to review the collective action literature

Regarding characteristics of groups, we reviewed the likely impacts of group size, group heterogeneity and interdependency on collective action. We found conflicting arguments about the impact of group size on collective action. With regard to group heterogeneity, we found that resource heterogeneity is critical for the start-up of collective action, especially in cross-sectoral domains. However, interest heterogeneity can sabotage efforts for collective action because of possible conflicts of interest among participants. With regard to interdependency, we discussed that actors are interdependent on each other to provide a collective good. Typically, interdependency for providing the collective good encourages actors to be engaged in collective action.

Concerning collective strategies, we found selective incentives and leadership as important approaches to encourage collective action in groups. We discussed the relevance of both tangible and intangible selective incentives for collective action. Finally, we explained the importance of leadership to implement selective incentives, mobilize and govern collective action.

2.2 *Platform-Related Theories*

2.2.1 What is a platform?

The concept of 'platform' has been discussed in different streams of literature on product development, economics, business strategy and management, as well as Information Systems (IS). As each stream of literature focuses on different empirical contexts of platforms, different definitions and terms are used to describe and refer to a platform.

In the product development literature, a 'product platform' can be viewed as a system consisting of underlying components that are used in common for the development of dissimilar products within a firm (Meyer & Lehnerd, 1997). Gawer (2009) uses the term 'internal platforms' to refer to 'product platforms'. According to Gawer, the benefits of 'internal platforms' are fixed-costs saving, flexibility in product design and products variety that meet customer requirements and maintain the economies of scale and scope. The empirical examples of (internal) product platforms can be seen in manufacturing industries such as automotive and aircraft, where a product platform is used in common across multiple products (i.e., different models of automobiles or aircrafts). These intra-organisational platforms are out of the scope of this thesis, as we focus on inter-organisational platforms.

In the economics literature, the terms 'two-sided market', 'two-sided platform' or 'multi-sided platform' are being used to describe a product, system, service or even organisation that mediates interaction between two or more groups of agents (Ballon, 2009b; Evans et al., 2006; Rochet & Tirole, 2003). This stream of literature uses the term platform for phenomena ranging from social media websites to dating bars or shopping malls. For instance, social media mediate interaction between different groups of end-users, application developers and advertisement companies. Typically, in a multi-sided platform, complementary products and services running on top of the platform are offered by different 'independent' providers (Hagiu, 2006). The interconnectedness of different groups of providers around a multi-sided platform is referred to as 'network effects' which involve the problem of 'chicken and egg' as well as reaching 'a tipping point' (discussed in 2.2.2).

In business strategy and management field, many scholars study how to organize and manage the network of firms around a platform, drawing on cases of Intel, Apple, Google and Microsoft. Gawer (2011, p. 45) uses the term industry platform and defines it "as building blocks (they can be products, technologies or services) that act as a foundation upon which an array of firms (sometimes called business ecosystem) can develop complementary products, technologies or services". Two key conditions of an industry platform are: 1) it should perform a critical function of a system or should solve a crucial technological issue of an industry; 2) It should be 'easy to connect to' and 'build upon' and provide space for new and unplanned usage (Gawer & Cusumano, 2012). An industry platform also creates strong interdependencies between the platform and its complementary products and services in a way that there is no demand for complementary products when they are isolated from the platform (Gawer & Henderson, 2007).

Scholars in the field of IS use different terms (e.g., 'digital infrastructures' (Tilson et al., 2010), 'digital platforms' (Eaton, 2012)) and definitions to refer to systems or architecture which can serve as platforms. Tiwana et al. (2010) use the term 'software platform' and define it as "the extensible codebase of a software-based system that provides core functionality shared by the modules that interoperate with it and the interfaces through which they operate". Hanseth and Lyytinen (2010) use the term 'information infrastructures' and define it as "a shared, open, heterogeneous and evolving sociotechnical system of information technology capabilities {...} (which are) recursively composed of other infrastructures, platforms, applications and IT capabilities and controlled by emergent, distributed and episodic forms of control". While terms such as software or digital platforms are used specifically to refer to software-based systems, the term information or digital infrastructure encompasses a broader range of systems from software to hardware infrastructure. Regardless of the term being used, the core to this stream of platform literature is to study large complex information systems as platforms, on which new services can be added to benefit from shared data resources (Tilson et al., 2010). This stream of literature calls for studies which explore sociotechnical aspects of emerging platforms in the IS field. Although similar examples of platforms may have been studied in the literature on IS and business and strategy management, the core to the IS literature is to theorize the development, governance and evolution of large complex information systems as platforms.

What is common in all definitions of a platform across economic, business management and IS fields is that platforms have modular architectures in which core independent modules are being used and reused across multiple products and services (Baldwin & Woodard, 2008; Boudreau, 2006). Moreover, as products and services running on platforms are often provided and being used by different groups of participants, platforms mediate multi-sided networks, which exhibit ‘network effects’.

In this thesis, we use the term ‘service platform’ to refer to any software architecture, hardware configuration or combinations of these which consists of a set of core modules being used by service providers to offer internet-enabled services to end-users. Reusing core modules on service platforms to offer different services to end-users can enable service providers to lower fixed costs and shorten the time to market for the development of new services. As a ‘service platform’ coordinates interaction between two or more groups of platform participants (i.e., end-users and complementary providers), a service platform also exhibits ‘network effects’. We distinguish service platforms from standards. We consider standards as parts of the platform and can be in forms of technical rules and specifications that have to be followed by firms to ensure interoperability and compatibility between the platform’s modules and complementary services running on it.

2.2.2 Network Effects

‘Network effects’ or ‘network externalities’ occur when the value of a platform depends on the number of users or on the number of services or complementary modules on the platform. Network effects arise when the desirability or functionality of a product depends on the number of complementary goods available for it (Schilling, 2009). For example, a game console has no value if there is no game for it and the value of the game console increases as the number of games for the console increases. The presence of network effects for platforms is directly related to accelerating production functions of platforms (see Section 2.1.1). Because of the importance of network effects for platforms, many scholars study strategies that platform providers deploy to internalize network effects and maximize profits from their platforms (Church & Gandal, 2004; Katz & Shapiro, 1985; Roson, 2005b; Shapiro & Varian, 1999b).

Network effects can be direct or indirect. Direct network effects (intra-side externalities) occur when users value a platform based on the number of users in the same group (e.g., network effects between the users of social networking platforms). Indirect network effects (inter-side externalities) occur when the value of a platform for a group of users depends on participation of another group of users (e.g., indirect network effects between users of a game console and game developers) (Evans, 2010; Gawer & Cusumano, 2012; Roson, 2005b).

Typically, direct network effects refer to positive effects between users in the same group. In the presence of (positive) network effects, more users and services for a platform increase the value of the platform for other user groups (i.e., end-users, complementary providers and platform providers). Nevertheless, when more users for a platform reduce the value for similar users, the platform entails a negative direct network effects. The negative indirect network effects also occur when existence of a group of users disturb another group of users (Evans, 2010). A familiar example of negative indirect network effects is the number of advertisements on YouTube platform that are disturbing for end-users.

Direct network effects can accelerate the diffusion of a platform. For instance, the existing number of users for a social networking platform matters for attracting more potential users to join and extend the platform. Mahler and Rogers (1999) emphasize the essence of reaching a critical mass to ensure further diffusion of an innovation. Indirect network effects are crucial to ensure balance between two sides of platforms (i.e., users and complementary modules and services) (Evans, 2010; Evans & Schmalensee, 2010; Rochet & Tirole, 2003). Indirect network effects are especially important for platforms that depend on outside complementary providers, because if such platforms fail to attract enough complementary providers, they might lose end-users and vice versa. For example, in the mobile domain, platforms such as Symbian (Nokia) and RIM (Blackberry) failed to create indirect network effects.

Direct network effects are most relevant to this thesis as we are interested to see if direct network effects between providers of a common service platform can encourage other contributors to join collective action for the development of a common service platform. In the context of collaboration for the development of a common service platform, positive direct network effects may occur when the participation of particular actors is highly valued for other actors and encourages others to join. Negative direct network effects, on the other side, occurs when the presence of certain actors or high numbers of participants (i.e., large group size) reduce willingness of others to join collective action for development of a common service platform.

Scholars in the economic field use the terms ‘marquee users’ or ‘marquee buyers’ to refer to actors or users who create positive network effects by attracting others to a platform (Parker & Van Alstyne, 2012; Rochet & Tirole, 2003). In this thesis, we use the term ‘marquee actors’ to refer to providers of a common service platform whose presence attracts other providers to join for the development of the common service platform.

2.2.3 Open and Closed Platform Strategies

Given the diversity between rather closed strategies from platform providers like Apple and Microsoft and more open strategies from providers like Google, fierce debate has emerged as to how open a platform should be to foster collaboration. As a result, an extensive body of literature on platforms studies platform openness in different contexts of strategic management and leadership (Eisenmann, 2008), complementary markets (Boudreau, 2008) and network effects (Katz & Shapiro, 1985). Generally, platform openness can be seen as the tension between control of a platform to extract value and retain power versus opening the platform to facilitate innovations by complementary providers (Ghazawneh & Henfridsson, 2012). In this thesis, we study platform openness from the perspective of technical openness (i.e., accessing to technical specifications and standards of the core components through API (Application Programming Interface) or SDK (Software Developers Kits)) (Anvaari & Jansen, 2010; Schlagwein et al., 2010) and organisational openness (i.e., which roles of platform providers, service providers, application developers, and end-users can participate in the development, commercialization and usage of a platform) (Economides & Katsamakas, 2006).

Making a decision on how much control should be exercised on technical and organisational aspects of a platform is critical for growth and sustainability of the platform (Boudreau, 2006; Gawer & Cusumano, 2002; West, 2003). Such a decision is typically made by the platform owner. Scholars use the terms 'platform owner', 'platform sponsor' or 'platform provider' to refer to the firm that has the authority over a platform. Typically, platform owners or platform sponsors are responsible for technologies of the platform and hold property rights over the platform while platform providers are the primary point of contact with users and interact with platform users. The roles of platform provider and platform sponsor can be fulfilled by the same or different firms (Boudreau, 2006; Eaton, 2012; Na, 2008; West, 2003). For the sake of simplicity, in this thesis we use the term 'platform provider' to refer to a firm that invests in a platform and/or controls the platform technology and the network of complementary providers around the platform.

From a technical perspective, the modular nature of platform architectures enables the platform owner to open technical facets of the platform to complementary providers to take advantage of innovative complementary products and services on the platform (Hilkert et al., 2011). Such technical facets are Application Programing Interfaces (APIs), Software Development Kits (SDKs) as well as technical supports through documentaries, blogs and forums that enable complementary providers to access and reuse core modules of the platform for developing new services. A number of scholars argue that a technically open platform should share a set of design and development rules and guidelines (e.g., programming languages, technical standards) to ensure interoperability between the platform and complementary products and services (Boudreau, 2010; Scholten & Scholten, 2010). While open platforms pose no or limited restriction in accessing core modules or interfaces, in closed (so-called proprietary) platforms, core modules or interfaces are not accessible for complementary providers.

From an organisational perspective, platform openness involves control over participation of complementary providers, the degree of interoperating with other rival platforms (Eisenmann et al., 2008) as well as social, economic and legal relationship with complementary providers through licencing agreements and contracts (Yoo et al., 2012). Platform providers may reduce organisational openness through rules and contracts on which services are allowed to be offered on the platform. According to Eisenmann et al. (2008), a platform is organisationally open if: 1) restrictions are not placed on participation in the development, commercialization or usage of the platform; or 2) any restrictions (e.g., license fee) are reasonable and non-discriminatory, which means restrictions are equally applied to all potential participants. The organisational perspective of platform openness suggests that the platform openness is not merely about strategies of platform providers towards complementary providers. Especially, in cases where several actors are jointly providing a platform, platform openness involves making decision on whether or not other actors can participate in the development of the platform.

Although the terms ‘open’ or ‘closed’ are widely used to describe platform openness, there is no common consensus about what is open and what is closed (Ballon, 2009b; Gawer, 2009; West, 2003). Moreover, the openness of many platforms is usually a mixture of different degrees of organisational and technical openness, which has been called ‘open but not open’ or ‘closed but not closed’ (Cusumano, 2010). For instance, a platform could be open for participation of complementary providers while being closed to other actors to participate in the development of the platform. Moreover, platform openness is not static and tends to change in response to different market situations and strategies of platform providers (Ballon, 2009b; Boudreau, 2006; Gawer & Cusumano, 2002, 2012; Parker & Van Alstyne, 2008).

The degree of which a platform is technically or organisationally open can influence innovation opportunities around the platform. With regard to innovation opportunities around a platform, Zittrain (2008, p. 70) proposes the concept of 'platform generativity' to refer to "a system's capacity to produce unanticipated change through unfiltered contributions from broad and varied audiences". Platform generativity implies that the design of a platform (in terms of technical and organisational openness) can influence the degree to which complementary providers can independently create, generate and produce complementary products and services on the platform (Eaton, 2012; Tilson et al., 2010). The highest degree of generativity can be seen in a 'quasi-open platform' (Na, 2008) or an 'open source platform' (West, 2003), when the platform is allowed to be changed and modified from its original state by external contributors (e.g., Linux platform).

Although platform openness is often associated with high generativity, widespread adoption and innovation, many scholars argue that a high degree of openness may intensify competitive pressure and consequently reduce incentives of complementary providers to invest on the platform (Eisenmann et al., 2008; Na, 2008; West, 2003). By modelling and measuring a dataset on handheld computers in the period of 1990-2004, Boudreau (2008) shows that granting access to platforms (i.e., licence or Intellectual Properties (IP) rights) for developing complementary products and services significantly foster innovation (i.e., the rate of development) and increases incentives for complementary providers to invest in the platform (i.e., encourage collective action). Nevertheless, he finds that opening platforms to multiple contributors during the development of the platform require extraordinary institutional arrangements to coordinate several contributors, which is not possible for many platform providers.

Opening or closing a platform involves advantages and disadvantages for the platform providers. Platform providers may close a platform to third-parties (by limiting participating roles or enforcing strict rules in accessing critical assets of the platform) to provide barriers to imitation and ensure better margins (West, 2003). Closed strategies are especially relevant when 1) the platform is immature and openness may put platform functionalities at risk, 2) openness requires coordination among multiple contributors (West, 2003) and 3) platform providers intend to become the dominant platform in the market (Church & Gandal, 2004). Nevertheless, platform providers tend to give up exclusive control over the platform when competitive advantage of platform architecture shifts to another layer of the platform. This mainly happens for platforms which have a modular architecture and consist of several layers controlled by different providers. For example, in personal computer industry, the layers are semiconductors, operating systems and software (Eisenmann et al., 2008). Another situation in which platform providers give up control over their platform is when they lose momentum, face severe competition pressure in the market or encounter falling market share (West, 2003). The main challenge in such situations is to balance between keeping some level of appropriability (i.e., to appropriate parts of the economic benefits to recoup the cost of developing the platform) while opening the platform for adoption to promote network effects, reduce users' switching costs and stimulate innovation around the platform (Boudreau, 2006; Eisenmann et al., 2008; Gawer & Cusumano, 2002; West, 2003). The trade-off between keeping appropriability and opening the platform is especially difficult when each architectural layer of the platform is controlled by different rival firms (Eisenmann et al., 2008) and when shifting control of the platform to another parties does not disrupt the value for users (West, 2003). A typical example for such a situation is the shift of control in personal computer industry where Intel and Microsoft take over IBM.

Opening the platform may intensify competition among complementary providers, which can foster innovation around the platform. Severe competition though increases uncertainties which may reduce motivation of complementary providers to invest in the platform (Eisenmann et al., 2008; Na, 2008; West, 2003). By studying the case of the internet platform, Greenstein (2010) show that openness can assist the development and commercialization of the platform, by encouraging participation in the development and fostering structural changes in the commercialization. Nevertheless, he finds that openness does not have any significant effect on making the platform more innovative. He further explains that platform openness may act as an incentive for Small/Medium Enterprises (SMEs) with innovative ideas to participate and invest in the platform. However, it is less likely to encourage the large ones to join because lack of restrictions reduces the value of their investment.

At which stage in the platform life cycle to open up the platform is also important for platform providers. Opening up the platform to outside contributors during the development stage benefits platform providers in several ways: 1) reducing fixed costs of R&D by sharing it with other parties (West, 2003); 2) selecting which technologies to include into the platform, based on experiences of different parties (Chesbrough, 2003); 3) improving the quality of the platform by constant feedback from parties during an open development process (Chesbrough, 2003; West et al., 2007); and 4) decentralizing value creation (by contributions from several independent parties self-select their tasks) which facilitates rapid scalability and evolvability of the platform (Olleros, 2008). Nevertheless, opening the platform during the development stage creates several challenges: 1) difficulties of coordinating collaboration between parties (Garud et al., 2002); 2) rejection of the platform provider's innovations by incumbents to protect their investment and competitive advantage; 3) complementary providers may lack required skills to work with the platform technology (Eisenmann et al., 2008). Considering the advantages and disadvantages of open and closed strategies during the development of a platform, it is difficult to conclude which approach outperforms the other.

Most studies reviewed in this section focus on cases where there is one single platform provider rather than when multiple organisations collectively develop a platform. Moreover, existing research mainly focuses either on the consequences of openness for innovation or on collaboration between a platform provider and complementary providers. It has not been studied if platform openness can be an incentive to encourage or discourage organisations to be engaged in joint development of common service platforms.

2.2.4 Platform Competition

Platform competition emerges naturally as a result of firms' strategies to 1) establish their positions in the market and 2) preserve competitive advantage over market share and/or customer ownership (e.g., by internalizing network effects). According to Church and Gandal (2004), two types of competition occur in multi-sided platform industries: 1) competition 'for the market'; 2) competition 'in the market'. Roson (2005a) refers to these two types of competition as 'outside competition' and 'inside competition'.

Competition for the market or 'outside competition' occurs between proprietary platforms and leads to platform wars (and also standard wars) until one or two proprietary platforms dominate the market with a dominant design. Platform providers use different strategies to become the dominant platform, keep the power over other platform providers and maximize profits. Examples of competitive strategies are marketing to shape users' expectations, pricing strategies, internalizing network effects, developing IP policies to restrain rivals from developing complementary products and services on the platform as well as reducing initial lock-in risk (by increasing interoperability and compatibility with other platforms or complementary products and services) to encourage users to adopt the platform (Katz & Shapiro, 1986, 1994).

Competition in the market, 'inside competition', occurs when platform providers agree on interoperable standards to make their platforms compatible. Platform providers focus on providing a subset of compatible components while they compete on price and/or product differentiation rather than the platform itself (Church & Gandal, 2004; Shapiro & Varian, 1999a). Typical example of this type of competition can be seen in the telecommunication industry where telecom operators agreed upon interoperable standards to interconnect their networks while they strive to benefit from indirect network effects (e.g., by bundling a variety of complementary services on their platforms).

Besides inside and outside competition between platform providers, competition may also take place between platform providers and complementary providers. Complementary providers are often concerned with the risk of the platform provider's entry in their market and knowledge leakage during collaboration with the platform provider (Gawer & Cusumano, 2002). The degree of such threat depends on whether or not complementary providers participate and innovate on the platform (Heeb, 2003; Huang et al., 2009a). Such risks especially increase when the platform provider and complementary providers compete in comparable markets (e.g., providing similar type of services on the platform). In the presence of intense competition with the platform provider, complementary providers are less motivated to provide services on the platform (Huang et al., 2009a).

Of particular interest to this thesis is platform competition during the development of a platform. Studying the development of common technological standards, Garud et al. (2002), suggest that competition during the development of a technology imposes several challenges to collaboration: 1) *mobilization challenges*: persuading organisations to invest in a platform, as especially dominant actors will resist uncertainties associated with a new platform; 2) *maintaining challenges:* there is a risk of fragmentation or loss of control for the platform provider as complementors may gradually depart from the platform for different reasons. As a result, departed parties may offer differentiated versions of the platform to preserve competitive advantage over other parties. Their findings suggest that competition challenges may sabotage attempts for collaboration across different stages.

To sum up, competition concerns including threats of entry from parties in each other's markets, loss of control over core platform components and knowledge leakage may hinder organisations to collaborate for developing a platform. In the next section, we discuss how strategies of a platform leader can reduce competition and encourage collaboration.

2.2.5 Platform Leadership

The strategies of platform providers to stimulate the growth of platforms and encourage involvement of complementary providers are typically referred to as platform leadership

(Gawer & Cusumano, 2002). Platform leadership strategies are considered as various approaches a platform leader takes to 1) create a multi-sided market around the platform; 2) enable multiple groups of participants to collaborate and compete in the multi-sided market (Evans et al., 2006; Messerschmitt & Szyperski, 2005; Williams & Tapscott, 2006).

From an economic perspective, Choi and Phan (2012) emphasize that the goal of a platform leader is not being merely a benevolent donator (by providing a platform technology), but to increase the size of the economic pie for all parties while keeping parties dependent on the leader.

By studying the cases of Intel, Microsoft and Cisco, Gawer & Cusumano (2002) identify four levers of platform leadership: 1) what activities should be done inside and what activities can be left to outside parties; 2) the degree of platform openness and disclosure of information to complementary providers; 3) the strategies to balance cooperation and competition with complementary providers and solving conflicts of interests and 4) structure of internal organisation to solve conflicts of interests and build consensus with complementary providers to cooperate and compete simultaneously. Their study shows how strategies of platform leaders in different circumstances influence innovation and overall growth of their platforms.

Regarding to the first lever of platform leadership Gawer and Cusumano (Gawer & Cusumano, 2012) emphasize that platform leaders should at least take over responsibilities for an essential part of the platform and ensure that the essential part is easy to connect to and add to. Other activities such as providing complementary services then can be assigned to external contributors. To identify what part of a platform should be provided by the platform provider and what needs to be left for external contributors, Choi and Phan (2012) suggest platform providers to focus on parts which are core to their business to ensure a significant contribution and maintaining the business for a long time.

The second lever of platform leadership deals with platform openness. As discussed in Section 2.2.3, platform providers adopt different platform openness strategies to leverage participation of complementary providers while keeping competitive advantage over them. Examples of openness strategies are providing appropriate information regarding rules, standards and APIs of the platform and/or developing SDKs to encourage and assist complementary providers to innovate on the platform. This part of leadership is especially critical as while strict control may hamper innovation, complete openness intensifies competition and may discourage investment by complementary providers and/or put the platform leader at risk of losing control over the platform.

The main challenge of platform leaders for the last two levers is to mobilize collaboration while fighting off destructive competition among platform participants. Choi and Phal (2012) suggest that platform leaders should have the capability to leverage their influence among platform participants to enable collaboration, not only to coordinate or support participants. According to Garud et al.(2002), such a capability requires platform leaders to possess social and political skills. Social skills indicate a leader's ability to encourage collaboration by defining common values for parties. Political skills refer to a leader' abilities to sustain collaboration even when private interests of parties outweigh common goals of the group. Many scholars in the platform field discuss how known platform leaders, in mobile and computer industries, utilize social and political skills to develop strategies for mobilizing and maintaining collaboration around their platforms (De Reuver, 2009; Gawer & Cusumano, 2002; Greenstein, 2010; Huang et al., 2009a, 2009b; West, 2003). Common examples of such strategies are: 1) building trust relations with complementary providers by employing Intellectual Property Rights (IPR); 2) providing financial and technical supports for complementary providers as well as 3) coordinating activities between internal and external parties to exploit the most value of the platform.

With regard to trust relations with complementary providers, many platform providers invest in developing and sustaining positive trustworthy reputation to attract different groups of contributors to their platforms (Gawer & Henderson, 2007; Perrons, 2009). However, scholars discuss that maintaining trust might be even more difficult in platform businesses as relationships around a platform evolve over time and parties in one stage may become competitors in another phase of platform development (Gawer, 2011; Gawer & Cusumano, 2002). Perrons (2009) puts forward that trust and power are often equivalent. He suggests platform leaders to adopt strategies that make a balance between trust and 'benevolent form of power' to benefit platform providers as well as complementary providers. Describing the case of Intel as an example, he shows that how good reputation of Intel as a trustworthy partner with a benevolent form of power stimulates collaboration around Intel platform.

Studies on platform leadership indicate that platform leaders often adopt different strategies and that the effective strategy for one platform may not have the same effect for another platform. This makes it more difficult to decide on what strategy to adopt for which platform. In a study by Tee and Gawer (2009), it was found that similar strategies followed by two platforms (i.e., NTT Docomo in Japan and KPN in the Netherlands) resulted in different outcomes. Their findings suggest that platform leaders need to take into account differences in roles, regulatory frameworks and standardization dynamics across different industries when deciding on strategic moves.

In addition to the importance of strategies adopted by a platform leader, its size can also influence the likelihood of attaining and keeping the role of platform leadership. Typically, large firms have the advantage of being able to create and extend network effects by accessing resources such as customers or partners. The capability of platform leader to extend the market can thus foster diffusion and adoption of the platforms (Choi & Phan, 2012). Nevertheless, developing leading-edge technology and architecture does not depend on the size. Many known platform providers including Microsoft, Intel and JVC, were small start-up companies when they introduced their technologies (Gawer & Cusumano, 2012).

In summary, the main roles of platform leaders are designing and modifying platform technical architecture, coordinating activities of platform participants, providing financial and technical support to assist complementary providers to innovate around their platforms, creating new business models to benefit different participants as well as balancing the profit distribution (Greenstein, 2010; Rochet & Tirole, 2003). In this thesis, we study how strategies of a platform leader can encourage collaboration among multiple organisations to develop a common service platform. Therefore, the aim is to go beyond collaboration between a platform provider and complementary providers and move on towards studying the impact of platform leadership on collaboration between providers of common service platforms.

2.2.6 Conclusion

In this section, we defined a service platform as any digital architecture, hardware configuration or combinations of these, which consists of a set of core modules being used by service providers to offer internet-enabled services to end-users. We found that several characteristics of a service platform (i.e., network effects, platform openness, platform competition and platform leadership) can explain collaboration around a service platform. With regard to platform openness, we found that platform providers control platform openness from technical and organisational sides. In addition, we found that even though different types of competition in platform markets may hinder collaboration, strategies of a platform leader can balance collaboration and competition around the platform.

Prior research on the platform mainly contributes to understand impacts of network effects, platform openness, platform competition and platform leadership on participation of *complementary providers* in innovating around platforms (Boudreau, 2008; Parker & Van Alstyne, 2010). The contribution of this thesis is to study how such platforms' characteristics may persuade or discourage collaboration *among platform providers* of common service platforms.

2.3 *Business Ecosystem*

2.3.1 What Is a Business Ecosystem?

The organisations which are collaborating and competing around a technology are often referred to as a business ecosystem. The concept, which was first introduced by Moore (1996), is increasingly used to analyse high-tech industries such as computer and mobile industries (Basole & Karla, 2011; Ceccagnoli et al., 2012; Gawer & Cusumano, 2012; J. Zhang & Liang, 2011). The term is also increasingly used by practitioners often in an ambiguous sense.

Moore (1996) defines a business ecosystem as a network of collaborating and competing organisations around a technology. He explains that the members of a business ecosystem, though from different sectors, share a common vision, co-evolve their capabilities and roles over time, and tend to align themselves with directions of a central leader. As the members of a business ecosystem transcend industries and change over the time, it is difficult to set and define boundaries for a business ecosystem.

The blurred boundaries of business ecosystems make it difficult to understand whether or not an actor belongs to a business ecosystem. There are debates among scholars about defining boundaries of business ecosystems (Adner & Silverman, 2013). Peltoniemi and Vuori (2004) suggest researchers to define boundaries for business ecosystems based on the objective of the study and the questions that need to be answered. In this thesis, any organisation collaborating in the development of a common service platform is included in the ecosystem we study.

According to Iansiti and Levien (2004c), the core technology in a business ecosystem can be a platform, a service, or a tool that is required by other members. Depending on the core technology in a business ecosystem, scholars use other terms such as platform ecosystems (Basole & Karla, 2011; Ceccagnoli et al., 2012), service ecosystems (Scholten & Scholten, 2010), digital business ecosystems (El Sawy & Pereira, 2012; Petrou et al., 2006) and innovation ecosystems (Adner, 2006). In this thesis, we use the term 'platform ecosystem' to refer to the network of organisations collaborating and competing to provide a common service platform and complementary services around it.

Although there are several other perspectives being used to study inter-organisational networks such as value chains (Porter, 1998), value networks (Allee, 2000) and strategic alliances (Eisenhardt & Schoonhoven, 1996), we found business ecosystems more relevant for this study. Unlike the traditional concept of a value chain, a business ecosystem does not merely focus on activities in a particular sector of industry (Peppard & Rylander, 2006) and the exchanges between members are not limited to tangible assets. Moreover, while relationships in value chains are one-directional between suppliers and buyers, relationships in business ecosystems are multi-directional as organisations jointly create and exchange value (Battistella et al., 2013). Unlike value networks, in business ecosystems collaboration and competition co-exist. Furthermore, the network of organisations in a business ecosystem is rather flexible compared to strategic alliances where the focus in on finding stable relations within complementary resources and partners (Rong et al., 2010).

2.3.2 Main Roles in Business Ecosystems

Iansiti & Levien (M. Iansiti & R. Levien, 2004a, 2004b; M Iansiti & R Levien, 2004; 2004c) suggest three primary roles which often exist in business ecosystems: 1) keystones; 2) dominators and 3) niche players. The members of a business ecosystem often fulfil one or multiple of these roles.

Keystones are the key actors in business ecosystems. Keystones 1) create value by providing a core technology (e.g., a platform) to be used by other members of the business ecosystem, 2) provide incentives to encourage more participants to join the ecosystem and innovate around the platform and 3) share the value from business ecosystem with other members (e.g., by charging a moderate fee) or providing tools and facilities that benefit members (M Iansiti & R Levien, 2004).

Unlike keystones, dominators tend to extract most of the value of business ecosystems, eliminate members to take over most of the roles and control a large part of the business ecosystem (Iansiti & Levien, 2002). Iansiti and Levien (2002) argue that dominators' strategies reduce diversity in business ecosystems, eliminate competition, hinder innovation and finally damage the health of business ecosystems. Typical examples of keystone and dominator roles are Intel and IBM respectively. While IBM strategies in extracting large part of the value and reducing diversity was stifling innovation and growth in the Personal Computer (PC) ecosystem, Intel took over the leading role and tried to manage distributed resources in the PC ecosystem, create niches and encourage innovation.

Niche players are members of business ecosystems that use the value created by dominators or keystones (i.e., platform technology) to develop complementary products and services around the platform. The term niche may infer that niche players are the least influential members of business ecosystems. However, as niche players are specialized in different domains, their presence is essential to ensure diversity around business ecosystems (Iansiti & Levien, 2002; M. Iansiti & R. Levien, 2004b). Examples of niche players in the PC ecosystem are hardware and software companies that develop complementary products or software for Intel and Microsoft platforms.

Because of complex and dynamic interactions between members of a business ecosystem, their roles change during the time and in different contexts (M. Iansiti & R. Levien, 2004c). Therefore, there is not a specific role definition model in business ecosystems. Depending on the roles that members of a business ecosystem carry out, they can be divided into smaller sub-groups (M. Iansiti & R. Levien, 2004c). For instance, niche players around Microsoft platform can be divided into application developers and hardware providers groups and each group can be even divided into smaller subgroups.

In this thesis, we divide members of a platform ecosystem into three main groups of platform providers, complementary providers and end-users. Platform providers are actors who participate in the design, development and sponsoring the platform technology. According to Iansiti & Richards (2006), platform providers play the leadership role in business ecosystems and their strategies (i.e., keystone or dominator) are critical for the growth of business ecosystems. Complementary providers are niche players that use core modules of the platform to develop complementary products and services for the platform. Finally, end-users use the platform and complements around it. Although collaboration between all groups of participants around a platform ecosystem is required for the growth of the platform, the main interest of this thesis lies in collaboration between those who participate in the development of a common service platform. Therefore, the unit of analysis in this thesis is a sub-set of platform ecosystems, which consists of organisations collaborating for the development of the platform.

2.3.3 Conclusions

In this section, we defined the concept of business ecosystem as a network of organisations collaborating and competing around a core technology. We selected the term ‘platform ecosystem’ to describe the network of organisations around a platform. We argued that business ecosystems can better describe dynamic, competitive, evolving and cross-sectoral networks in high-tech industries such as Smart Living than other network concepts of value chains, value networks and strategic alliances. Moreover, we explained how dynamic characteristic of business ecosystems makes it difficult to define boundaries for business ecosystems. Finally, we defined three main roles of keystone, dominator and niche players in business ecosystems.

Prior research focuses on modelling and analysis of business ecosystems (e.g. Basole et al., 2012; Battistella et al., 2013; Tian et al., 2008), exploring platform strategies along business ecosystem lifecycles (Rong et al., 2013) and using the business ecosystem as a perspective to study an industry (J. Zhang & Liang, 2011) or evolution of a company in an industry (Li, 2009). The contribution of this thesis is to apply principles of collective action theory in business ecosystems to address typical issues of collaborative networks, such as leadership, interdependencies, and competition versus cooperation.

2.4 *Theoretical Framework*

In this section, we relate insights from platform-related theories and business ecosystems to collective action theory to develop a set of propositions that explain how and what factors influence decisions of organisations to join collective action for the development of a common service platform. We only study organisations collaborating for the development of a common service platform. Therefore, the unit of analysis in this thesis is only a subset of platform ecosystem, which includes providers of a common service platform.

Interest Heterogeneity

One of the challenges of collective action is that despite of sharing a common goal, organisations may have dissimilar individual interests. For instance, telecom companies and technology providers may have different (conflicting) goals of developing a common service platform. We refer to dissimilarity of interests among participants in collective action as interest heterogeneity (Kollock, 1998; Oliver et al., 1985), see Section 2.2.2. Studies on collective action show that the interest heterogeneity can be detrimental to collective action because of likely conflicts of interests among participants (Baland &

Platteau, 1995; Streeck, 1991). The conflicts of interests can fragment a group into groups of rivals which then makes it challenging to achieve consensus among members and this is not in favour of collective action. Therefore, our first proposition is:

P1) The interest heterogeneity in a platform ecosystem negatively influences decisions of organisations to become engaged in collective action for establishing a common service platform.

Resource Heterogeneity

Besides the interest heterogeneity, resource heterogeneity can also influence decisions for collective action. In platform collaboration, complementary providers (i.e., organisations providing complementary products, technology or services for the platform) often avoid collaboration with platform providers when they have comparable resources to platform providers (e.g., technical resources or knowledge), see Section 2.2.4. The reason is that complementary providers perceive platform providers as a threat that can enter into their businesses (Gawer & Cusumano, 2002). This suggests that having comparable organisations in a platform ecosystem, with respect to resources and markets, increases competition rather than collaboration. While the literature on platforms mainly discusses competition between a platform provider and complementary providers, competition can also happen among a group of organisations developing a common service platform, if they have comparable resources.

From a collective action perspective, scholars hold positive views about the impacts of resource heterogeneity on collective action, see Section 2.1.2. We define resource heterogeneity as the degree to which organisations have different technical, financial and/or organisational resources, including power position in the market, customer base, and strong inter-organisational relationship with other actors in the market, to contribute to providing a collective good. Scholars argue resource heterogeneity as an advantageous condition that can speed up the start of collective action, because it is probable that the most resourceful individuals contribute to collective action and provide the collective good for others (Heckathorn, 1993; Marwell et al., 1988).

This line of arguments suggests that having dissimilar resources and capabilities reduces competition in platform ecosystems and thus can positively influence decisions of organisations to be engaged in collective action. Therefore, the second proposition in this study is:

P2) The resource heterogeneity in a platform ecosystem positively influences decisions of organisations to become engaged in collective action for establishing a common service platform.

Interdependencies

As argued above, having dissimilar resources and capabilities in the platform ecosystem can be beneficial in itself since it reduces the fear for competition. However, the incentives for collaboration are even higher if organisations also require each other's resources in order to ensure sustainable productivity and innovation within the platform ecosystem (M Iansiti & R Levien, 2004; J. Moore, 2006).

From a collective action perspective, interdependencies in a network of organisations can solve the start-up issue in collective action because when interdependency is in place, organisations find it rational to collaborate, see Section 2.1.2 (Marwell et al., 1988). We define interdependencies as mutual relationships between actors who need each other to meet their objectives. From these arguments, we propose that:

P3) The resources heterogeneity in a platform ecosystem causes interdependencies in the platform ecosystem.

P4) The interdependencies in a platform ecosystem positively influence decisions of organisations to become engaged in collective action for establishing a common service platform.

Leadership

The importance of leadership for collaboration has been highlighted in all three streams of literature. From a collective action perspective, it has been argued that sharing a common goal is not a sufficient condition for collective action (Olson, 1971) and the presence of a leader is a prerequisite to start and mobilize collective action (Bianco & Bates, 1990; Sandholtz, 1993), see Section 2.1.3. Leaders are required to attract contributors (Bianco & Bates, 1990) and select the most potential organisations for collective action (Marwell et al., 1988).

Platform literature uses the notion of 'platform leadership' to refer to strategies of platform providers to encourage complementary providers to invest and develop products and services for a platform, see Section 2.2.5 (Gawer & Cusumano, 2002; Greenstein, 2010; Huang et al., 2009b; West, 2003). Scholars in business ecosystems use the terms 'keystone' or 'dominator' to distinguish platform leaders based on strategies they adopt to organize business ecosystems, see Section 2.3.2. Iansiti and Levien (2004) argue that a keystone's strategies encourage collaboration and facilitate innovation while a dominator's strategies exploit other organisations in a business ecosystem and drain all the business ecosystem's value.

This line of arguments suggests that the platform leadership can influence participation of organisations in collective action. We define platform leadership as approaches of an organisation (i.e., platform provider) to ignite, lead, support and coordinate collective action in a platform ecosystem. As such, our fifth proposition is as follows:

P5) Platform leadership in a platform ecosystem influences decisions of organisations to become engaged in collective action for establishing a common service platform.

Selective incentives

Selective incentives have been suggested as an effective mechanism to promote participation in collective action and eliminate the start-up issue (R. Hardin, 1982; Knoke, 1988; Oliver, 1980). Selective incentives, which can be in the control of a leader, can be seen in two forms: 1) private benefits or reward for those who contribute to collective action and 2) penalties or punishments for free-riders (Oliver, 1980), see Section 2.1.3.

Despite of potential benefits of selective incentives, scholars discuss the problem of second-order free-rider (i.e., who will contribute to the administration of selective incentives) (Frohlich et al., 1975; Willer, 2009). However, this issue is more crucial for self-organizing collaboration networks that do not have a leader to coordinate collaboration. Studies on collective action suggest that deploying selective incentives requires a central authority with high interest in collaboration to impose rewards and punishments (Olson, 1971; Salisbury, 1969; Sandholtz, 1993). This is also supported in platforms studies that selective incentives created by a platform leader encourage participation of complementary providers, see Section 2.2.5 (Gawer & Cusumano, 2002; Greenstein, 2010; Huang et al., 2009a; West, 2003).

From this line of arguments, we conclude that selective incentives created by a platform leader can inspire collective action among organisations for setting up a common service platform. Therefore, we propose the following propositions:

P6) The presence of selective incentives in a platform ecosystem positively influences decisions of organisations to become engaged in collective action for establishing a common service platform.

P7) The presence of platform leadership is required to deploy selective incentives in a platform ecosystem.

Platform Openness

From a platform perspective, how a platform is technologically and organisationally open or closed can influence the growth of the platform as well as incentives for collaboration around the platform, see Section 2.2.3. While opening a platform to complementary providers can create a competitive setting and foster innovation, severe competition in the platform ecosystem increases uncertainties and thus reduces incentives of complementary providers to invest in the platform (Eisenmann et al., 2008; Na, 2008; West, 2003). Moreover, high degree of openness (e.g., open source) may suppress competitive advantage of platform providers and reduce their margins (West, 2003).

This line of arguments suggests that the degree of platform openness towards complementary providers can influence decisions of organisations for platform collaboration. However, the type of effect (i.e., positive or negative) is not clear. Therefore, we propose the following proposition:

P8) The degree of platform openness towards complementary providers influences decisions of organisations to become engaged in collective action for establishing a common service platform.

Because we study impacts of technical openness as well as organisational openness of platforms on collective action, we break down the above proposition into two parts.

P8-A) The degree to which a platform is technically open towards complementary providers influences decisions of organisations to become engaged in collective action for establishing a common service platform.

P8-B) The degree to which a platform is organisationally open towards complementary providers influences decisions of organisations to become engaged in collective action for establishing a common service platform.

We define technical openness as the degree to which a platform grant complementary providers access to technical specifications and standards of the core components of the platform through APIs (Application Programming Interfaces) or SDKs (Software Developers Kits) (Anvaari & Jansen, 2010; Schlagwein et al., 2010). Organisational openness, on the other hand, determines which roles of platform providers, service providers, application developers, and end-users can participate in the development, commercialization and usage of a platform (Economides & Katsamakas, 2006).

Figure 2.2 summarizes the propositions into a theoretical framework.

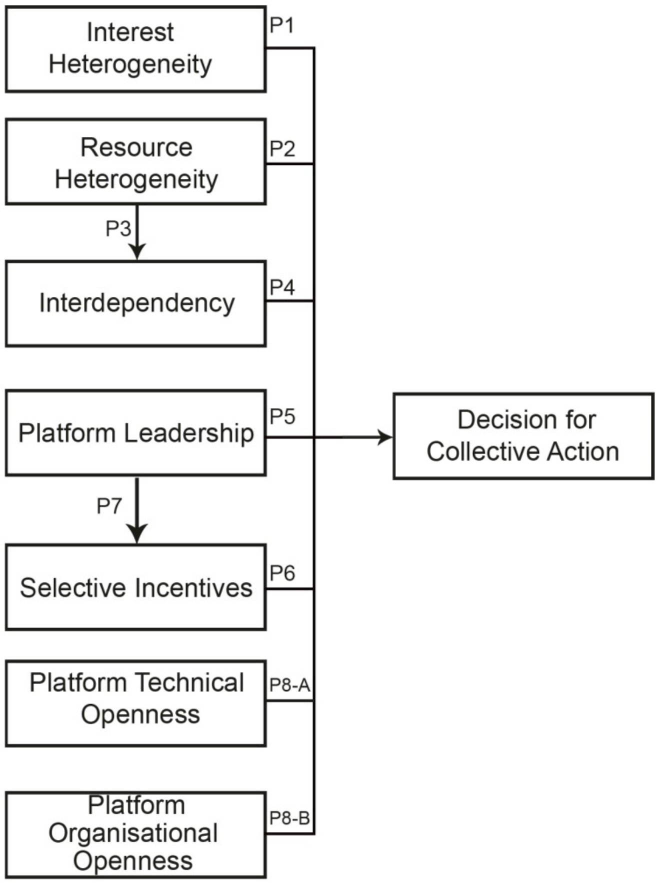

Figure 2.2 Theoretical Framework

3 The Smart Living Domain

This chapter provides an overview of trends and developments in the Smart Living domain and specifies the theoretical concepts from Chapter 2 onto the research domain. This chapter consists of five sections.

We begin in Section 3.1 by defining the notion of ‘Smart Living’ and identifying different categories of Smart Living services for households. In Section 3.2, we review enabling technologies (i.e., devices, communication standards) and new architectural paradigms, (i.e., Internet of Things, Service-oriented Architecture and Cloud computing), enabling Smart Living services of the future. In Section 3.3, we specify the core concept of a ‘service platform’ from Chapter 2 in the Smart Living domain. To do so, first, we define Smart Living service platforms. Then, we analyse a number of Smart Living service platforms based on the location of intelligence (i.e., home-centric, network-centric, cloud-centric and hybrid service platforms) and the degree of platform openness. In Section 3.4., we specify the core concept of a business ecosystem into the Smart Living domain and identify typical actors and roles in Smart Living platform ecosystems. We conclude the chapter in Section 3.5 with a discussion of our findings from the domain study.

Similar to other technological domains, the Smart Living domain is essentially dynamic and evolving rapidly. The information in this Chapter describes the trends and developments until 2013. Information on Smart Living services, technologies and platforms was primarily gathered from publicly available news websites and blogs: e.g., Beet.tv, Business Wire, CNET, Energy Circle, Home automation daily, M2M, Prosyst, Smart House, and Xponent4. In addition, we searched information in the websites of respective platform providers and standardization bodies: e.g., AlertMe, Apple, Blue Line Innovations, Cisco, Control4, Digi, Dossia, Egauge, GEAppliances, Google, Homesafety, Microsoft, OSGI, Philips, PlugWise, Powerhouse Dynamics, Shaspa, The Energy Detective, Ucontrol, VignetCorp, Wattsup, Wattvision, WoonVeilig, Yahoo, Zorgsite, ZYXEL, for whitepapers, technical notes, documents and reports. Typically, we found between 2 and 3 sources per platform, technology or service.

When available, the information was complemented with academic papers or articles. We collected relevant papers from journals, conference proceeding, books and online databases. We searched on Google, Google Scholar, Scopus and Science Direct for keywords ‘smart homes’, ‘connected home’, ‘home automation’, ‘Smart Living’, ‘networked home’, and ‘intelligent home’ in the title, abstracts and keywords of papers. A total number of 220 articles were collected out of which 43 articles, which describe Smart Living services, service platforms and related standards and technologies, were used.

In addition to different sources of data, an in-depth understanding of the Smart Living domain was derived from several interviews with specialists and professionals working as consultants, executive managers or researchers in knowledge institutes and commercial companies in Smart Living domain.

3.1 *From ‘Smart Homes’ to ‘Smart Living’*

Several terms such as ‘integrated home’ (Roberts, 2009), ‘connected home’ (Harper, 2011), ‘networked home’ (Chetty et al., 2007), ‘intelligent home’ (Skrzypczak, 1987) and ‘smart home’ (Aldrich, 2003; Lorente, 2004; Marsh, 1998) are used interchangeably by scholars and practitioners to refer to a home with advanced automated appliances. Nevertheless, the terms are often not precisely defined and it is not clear what is meant with these terms and how they differ from each other. Therefore, in this section, we define the notion of ‘Smart Living’ which we use in this thesis and explain how ‘Smart Living’ is different from the widely used term of ‘smart home’. Then, we identify different types of Smart Living services.

3.1.1 Defining the Notion of Smart Living

The notion of ‘smart homes’ is widely used to refer to automation of homes and domestic appliances. Aldrich (2003) defined the term ‘smart home’ as “a residence equipped with computing and information technology which anticipates and responds to the needs of the occupants, working to promote their comfort, convenience, security and entertainment through the management of technology within the home and connections to the world beyond” (p. 17). Such an intelligent environment is equipped with a varied of networked sensors, devices and appliances that are used to automate various activities inside the home to support domestic tasks (Goumopoulos & Kameas, 2008).

Evolving Information Communication Technologies (ICT) and mobile equipment are enabling truly adaptive and intelligent smart home services that go beyond mere home automation (Spinellis, 2003) and are integrated in several industries. Such advancements in ICT have opened up a window from inside the home to the world outside (Barlow & Venables, 2003) and thus from ‘Smart Home’ to ‘Smart Living’.

‘Smart Living’ as a term first was defined as an integrated design of our homes and neighbourhoods in which functional and non-functional requirements are woven into an integrated value-sensitive design (Baken, 2010). In this thesis, we propose a more specified definition for ‘Smart Living’ and define it as bundle of ICT-enabled services offered to households, accessible within and outside the house that combine value drivers of energy, health, surveillance and entertainment services to facilitate comfort living for households. Based on this definition, our view of ‘Smart Living’ differs from ‘Smart Home’ as it transcends home boundaries and promises flexibility in access to services also from outside the home. Furthermore, the wide range of Smart Living services suggests opportunities for actors from across industry sectors to provide Smart Living services to households. Although we are aware that this definition is still broad, we use it in this thesis because we do not want to focus on a specific sector or a category of Smart Living services. Moreover, we purposely provide a general definition to shed light on complexity of diverse actors, technology and services in this domain.

3.1.2 Smart Living Services

Edvardsson et al. (2005) suggest to view a service as a perspective on value creation rather than merely a market offering. Following Edvardsson et al, and from a managerial perspective, Grönroos and Ravald (2011) define a service as a mediator between a provider and customers in the process of value creation. Similarly, Smart Living services can be seen as mediators for service providers to create values for households.

Smart Living services, aimed at households, address a wide range of application areas, from (mobile) broadband connection, video and audio services to several online applications or client software programs used for energy management, healthcare, entertainment and surveillance purposes. We categorize up-and-coming Smart Living services into five main categories of 1) home automation, 2) energy management, 3) e-healthcare/independent living, 4) surveillance and 5) entertainment and telecommunication services. Typically, actors from across industry sectors are providing particular categories of Smart Living services to their customers. In the remainder of this section, we describe each group of Smart Living services.

Home Automation Services

Home automation services (domotica) are the most generic and primary type of Smart Living services, which merely involve automation and remote control of home devices to ease basic daily routines. Home automation services are enabled by means of automated appliances which control conditions of home environment and enhance households' comfort accordingly. This category of Smart Living includes a wide range of applications including controlling blinds, home ventilation and automated lighting.

Home Energy Management Services

Home Energy Management (HEM) services enable households to remotely control electrical devices at home, monitor and manage energy consumption to reduce the electricity bill. HEM services are typically enabled by smart meters. Smart meters can be seen as "advanced meters that identify consumption in more detail than conventional meters and communicate via a network back to the utility for monitoring and billing purposes" (Climate Group, 2008, p. 85). Depending on the functionalities of smart meters, which vary across countries, smart meters can enable a range of HEM services for consumers; from real-time information on energy consumption to more advanced remote energy management and billing services.

Following an action plan adopted by the European Commission (i.e., "Action Plan for Energy Efficiency: Realising the Potential"), which aims to reduce energy consumption of Europe by 20% until 2020 from 1990 levels (European Commission, 2013), several countries in Europe aim to roll out smart meters to meet the requirements from the European Energy Efficiency Directives (AlAbdulkarim et al., 2012). Accordingly, the Dutch government obliged regional grid operators to roll out smart meters for new buildings or when demanded by customers (Global Smart Grid Federation, 2011). In addition to the benefits of smart meters for HEM services, deploying smart meters is also considered as one step towards upgrading traditional grids to smart grids for remote and automated supply, management and distribution of energy (ABI Research, 2011).

E-healthcare/Independent Living Services

As the ageing population is growing across the world (World health Organization, 2011), there will be more elderly and chronically ill people demanding care services. Therefore, innovative healthcare solutions are required not only to provide elderly care services with less cost but also to improve the quality of life for elderly people (Ambient Assisted Living, 2013; Stroetmann, 2012).

E-healthcare/independent living services, so called tele-care and tele-medicine, refer to a range of e-healthcare, medical monitoring, assisting, supporting, and emergency alarming services (Oh et al., 2005) that enable ageing populations or disabled people to live independently at home (Rialle et al., 2002). Vermaas (2010) identifies three main categories of e-health services: comfort, care and treatment services. The comfort services include communication facilities to connect elderly people with their relatives for monitoring or communication purposes (Martín et al., 2009b). Moreover, comfort services cover safety and surveillance services, by means of fire protection systems, night route lighting, alarm systems, door video systems installed at elderly's homes as well as location tracking services. The care services include remote monitoring of medicine intake or health status of elderly people by caregivers and/or personal doctors. Finally, treatment services consist of remote diagnosis and cure services using several technological devices at home. These types of e-healthcare/independent living services are often enabled by a secure communication between healthcare service providers and elderly people at home.

Surveillance Services

Surveillance services entail a wide range of security alarm and audio/video connections to the home which are offered through web pages or via smartphone applications. Examples of such services are home remote monitoring, motion detectors, intruder and burglar alarms, fire alarms, perimeter detections and access control services. The main goal of surveillance services for households is to efficiently capture details at home, by means several sensors, cameras and motion detectors installed at a premise and inform households of security issues at home (Patrick & Bourbakis, 2009).

Upon activation of any of the installed devices at home, an alarm will notify the households. Moreover, an email, SMS or MMS message will be send to the owner outside the home to raise awareness about the home situation. Several security service providers such as Woonveilig, Homesafety, Securitas, and SecureOne in the Netherlands, are offering a range of ICT-enabled surveillance services to the household. Surveillance services are sometimes provided in a bundle together with home automation or e-healthcare/independent services.

Telecommunication and Entertainment Services

Telecommunication services to households include telephony, mobile and internet connection, which enable a wide range of entertainment services, including TV services (e.g., cable TV, internet-TV (IPTV), Interactive TV and HDTV), video conferencing as well as video on-demand (VoD) and Audio-on-Demand (AoD) services. Typically, the telecommunication and entertainment services are bundled together and offered to households as triple play services. The power of recent entertainment services lies in interactivity and on-demand features of them. There is an increasing number of on demands audio and video services in the market.

3.1.3 Conclusions

In this section, we defined the notion of Smart Living as a bundle of ICT-enabled services offered to households, accessible within and outside the house that combine value drivers of energy, health, surveillance and entertainment services to facilitate comfort living for households. We categorised Smart Living services into five categories of home automation, energy management, e-healthcare/independent living, surveillance and entertainment services.

Reviewing Smart Living services, we found that while previously service providers in each sector used to provide specific services for their customers, recently there are overlapping activities in service offerings. For instance, internet service providers, which were previously providing IP connectivity, are now integrating other value-added services (e.g., voice-over-IP and multicast TV) into their service offerings. Moreover, many telecom and cable companies are developing plans to offer e-healthcare, surveillance and energy management services to homes. For instance, Deutsche Telekom planned to launch HEM services to homes in 2013 (Tom Kerber, 2013). In the Netherlands, KPN telecom is tapping into e-healthcare services (KPN, 2013) in an attempt to consolidate the health market by building a network with healthcare services running on it (Poulus, 2008). In addition to telecom companies, many other organisations such as manufacturers (e.g., Philips), and technology providers (e.g., IBM, Cisco) are looking for opportunities in the Smart Living market (eHealthNu, 2009; IBM, 2013; Jeff St., 2013). The attempts of service and technology providers from across industry to provide Smart Living services highlight a considerable potential in this domain.

3.2 *Enabling Technologies for Smart Living Services*

Smart Living services are often enabled by communication between several appliances, devices and sensors at homes. Recent technological advancements and architectural visions such as ‘Internet of Things’, Cloud Computing and ‘Platform as a Service’, influence the way data and services of different devices can be exchanged, shared and reused for offering Smart Living services. In this section, we discuss technologies and architectural paradigms enabling the vision of Smart Living.

3.2.1 Home Devices Enabling Smart Living Services

Several devices at homes are used for enabling Smart Living services. The devices at home can be divided into three types of white appliances (e.g., dishwashers, refrigerators, ovens, washing machines), control devices (e.g., sensors, actuators and switches) and assistive devices (Ricquebourg et al., 2006).

White appliances are becoming increasingly intelligent which can collect data from the environment. This data together with users’ preferences serve as the basis for the devices to work (e.g., to reduce energy consumption during peak hours or when no one is at home).

In addition to white appliances, control devices collect different types of data from the home environment. Sensors detecting motion/no motion, vibration, temperature, humidity, pressure, light, smoke and even carbon monoxide in an environment (Culler et al., 2004) and actuators control sensors and make decisions or deliver management or maintenance services based of the data received from sensors (Dengler et al., 2007). The main idea behind using sensors is to build a network of sensors embedded in several objects and devices and then use the data and information collected and communicated between sensors to enable several Smart Living services including e-healthcare (Suryadevara & Mukhopadhyay, 2012) and home energy management (Ozturk et al., 2013). Although the cost of integrating sensors in every object used to be very high, thanks to rapid technology advancements, the costs are dropping rapidly (ScienceDaily, 2011).

Besides appliances and sensors which are used for generic home automation, energy management or surveillance services, there are assistive devices and technologies addressing particular needs of elderly and disabled people (Robinson et al., 2013). Currently, several technology providers are developing assistive devices and related web services, each addressing a niche in the e-healthcare market, enabling elderly people to live independently and service providers to reduce costs. Examples of assistive devices are watches, necklaces and a variety of (wearable) sensors which collect and communicate data from the body or environment of an elderly or disabled person with care service providers for remote medical, care or safety purposes (Oh et al., 2005).

All devices, appliances and sensors at home need to be interconnected to exchange data and information for service delivery. To do so, there should be communication infrastructures within the home to connect devices to each other.

3.2.2 Home Communication Infrastructures

Home communication infrastructures are required to interconnect devices and appliances at home for enabling Smart Living services. There are several communication standards interconnecting devices at home, via wire or wireless media. For instance, HomePlug, X10, Home PNA and MoCA are communication standards based on a wiring infrastructure (i.e., electrical, telephone and coax cable) and IEEE 802.11x, Bluetooth, Zigbee, Z-wave and Infrared are communication standards using radio frequency medium to interconnect devices at home.

Most of the existing communication standards for home appliances have been developed for specific purposes. As such, depending on the preference of manufacturers or requirements of devices, different communication standards are used for home devices. Using different and in many cases proprietary standards for home devices has caused interoperability issues in home networking (O'Sullivan, 2005). As an example, interfacing high-speed wireless supported devices (e.g., Wi-Fi devices) with low-speed wireless devices (e.g., ZigBee, Z-Wave and Bluetooth supported devices) is one of the difficulties.

Accordingly, several initiatives have been arisen to define open standards or develop middleware solutions which can work on several media and can be scaled to different Smart Living application areas. Middleware can be viewed as “a software component that sits on top of a home device’s operating system” and enables the device to discover and communicate with other devices in the home network (Ngo, 2007). Here, we shortly review the most noted open standards and middleware solutions that have gained attention of device providers in the Smart Living domain.

KNX

KNX (Konnex), which is a unification of three European standards (i.e., EIB, EHS and BatiBUS), is a worldwide open standard supporting several communication media, including twisted pair, power line, radio frequency and Internet Protocol (Ethernet) (DomoLogic Home Automation GmbH, 2003; Laberg et al., 2005). The capability of KNX to support communication between several standards makes KNX applicable for a wide range of home automation application areas. The standard has been already adopted by appliance manufacturers such as ABB, Siemens and Bosch (KNX, 2013).

Universal Plug and Play (UPnP)

UPnP is a middleware solution built upon well-established and open internet-based standards (i.e., IP, TCP, UDP, HTTP and XML) and can be run on any networking media (e.g., WiFi, Power line, coax and copper network) (UPnP, 2013). UPnP is intended to interconnect multiple devices from different manufacturers into a network in order to communicate and share contents and information with each other and with the World Wide Web. Upon joining a network, the device gets an IP address to communicate with other devices in the network in a peer-to-peer manner. UPnP is a platform, language and network independent standard and can be used on any operating systems. Furthermore, its plug and play capability simplifies installation and management of networks of UPnP devices (Messer, 2011). Currently UPnP is supported by a wide variety of audio/video devices, home automation devices and home appliances.

Digital Living Network Alliance (DLNA)

DLNA is a non-profit organisation started by Sony in 2003. DLNA standards act as a bridge and enable seamless streaming of multimedia contents between electronic devices at homes (Allegro Software Development Corporation, 2006). DLNA standardized interoperability between audio/video devices to easily connect and quickly share their contents without any technical installation and configuration. DLNA based its interoperability solution on accepted standards including IETF, World Wide Web Consortium (W3C), Motion Picture Experts Group (MPEG), and Universal Plug and Play Forum (UPnP). To communicate using DLNA standards, all digital devices need to be connected to an Ethernet, WiFi, or Bluetooth network, use TCP/IP for communicating, and support HTML and SOAP for media transport and management (Allegro Software Development Corporation, 2006).

The main limitation of UPnP and DLNA is that they merely support audio/video devices (i.e., entertainment services) and thus they are not widely applicable to other application areas of Smart Living. Furthermore, currently they only support contents sharing between multimedia devices at home and they do not support connectivity from outside the home. However, several attempts are going on to extend capabilities of UPnP and DLNA to outside the home and also to a wider range of Smart Living services (e.g., e-healthcare/independent living and home energy management) (UPnP, 2013).

Open Services Gateway Initiative (OSGi)

OSGi is an open source middleware initiative aimed to provide a standardised service delivery and execution framework based on open specifications and modular software design. The OSGI middleware can be deployed on any device and operating system. Moreover, thanks to open specifications, developers can easily develop and run applications on top of the middleware. These two features make OSGi applicable for Smart Living devices.

OSGI middleware enables device manufacturers to remotely control, update services on devices (OSGI Alliance, 2011). OSGi also includes functionalities to ensure connectivity and interoperability with UPnP/DLNA devices. The middleware has been widely adopted for many appliances and applied in commercial Smart Living projects such as Xanboo, DIAS and IPbox (OSGI Alliance, 2011).

Despite attempts in defining open standards and middleware for appliances and devices at home, still many device providers deploy proprietary standards for their devices. Two possible reasons for adopting proprietary standards by device providers are: 1) to have control over the device functions and 2) to make their standards dominant in the field. It might also be the lack of a holistic view that causes actors to pursue their individual advantages without considering wider practical implications.

On-going attempts of several initiatives in defining open standards and gateways would only solve the problem of interoperability if the developed solutions are mature enough to be largely adopted for many application areas in the Smart Living domain. Solving the problem of interoperability between devices is one step towards enabling the vision of Smart Living. The next step is how to share and reuse common intelligences in devices to speed up service innovation and to reduce service costs in the Smart Living domain.

3.2.3 Internet of Things

As discussed in Section 3.2.1, advancing sensor technologies and integrating sensors are transforming devices into ‘smart objects’, which are capable of collecting information from the environment (Kortuem et al., 2010). The vision of identifiable and 'interconnected smart objects' on a global level is generally referred to with the term 'Internet of Things' (Floerkemeier et al., 2008). The term 'Internet of things' (IoT) can be interpreted as ''a world-wide network of interconnected objects uniquely addressable, based on standard communication protocols" (EPOSS, 2008). This definition highlights the importance of *identifying smart objects* and using *common communication standards* to enable communication among them. Such networks of interconnected smart objects enable a wide range of application areas, including Smart Living (Domingo, 2012; Gubbi et al., 2013b; Miorandi et al., 2012).

The Radio Frequency Identification (RFID) technology has first been considered as a technology enabler of IoT and attracted attention of many industries for asset tracking, logistics and supply chain management (Atzori et al., 2010). RFID enables identification, tracking, communication and interaction between objects (Atzori et al., 2010; Kortuem et al., 2010).

The Internet Protocol (IP) is another enabling technology for IoT. An increasing number of devices at home, including sensors and appliances, are becoming internet-connected with an IP address (Morrish, 2010). It is predicted that the number of IP connected devices will grow up to 30 billion in 2020 (Gartner Research, 2013). This indicates the important role of IP for interconnecting devices (West Technology Research Solutions, 2011).

Not only IP addresses (IPv6) are now available for almost every object and device, the cost of implementing an IP address even in objects such as lights or sensors is also dropping. For instance, Dutch NXP semiconductors company has announced that its new IP-enabled chip will enable every light to have its own wireless IP address with the cost of 1 US$ (Hanlon, 2011). This suggests that in the future many home devices and objects will be connected to the internet using IP protocol. The proliferation of internet-connected (IP) devices and the massive amount of data from the connected devices serve as a basis for several innovative Smart Living services.

3.2.4 Cloud Computing

Thanks to the wide availability of high-speed and broadband internet connection, the cloud computing paradigm is gaining momentum. Cloud computing is a new paradigm of sharing assets and resources over the internet rather than on local servers. According to the National Institute of Standard and Technology (NIST), cloud computing can be viewed as “a model for enabling ubiquitous, convenient, on-demand network access to a shared pool of configurable computing resources (e.g., networks, servers, storage, applications, and services) that can be rapidly provisioned and released with minimal management effort or service provider interaction” (Mell & Grance, 2011, p. 2). Depending on the type of shared computing resources over the internet, there are three models of cloud computing: 1) Infrastructure as a Service (IaaS), 2) Software as a Service (SaaS) and 3) Platform as a Service (PaaS).

In the IaaS model, the cloud service provider has created an infrastructure which can be used by service providers to develop platforms and services to be run on the internet. SaaS is typically used when service providers do not want to deal with the management of software on client computers and prefer to provide the software as a service online. In the PaaS model, the cloud service provider offers an online development environment (i.e., a platform) which can be used to develop and run a variety of services (G. Lin et al., 2009).

There are two types of development PaaS and business PaaS (Weinhardt et al., 2009). The development PaaS is mainly used by application developers to create end-user applications without having to buy and manage underlying hardware and software infrastructure (Marston et al., 2010). Business PaaS is commonly used by service providers to develop, deploy and manage business services such as Customer Relationship Management (CRM), Human Resources (HR) and inventory services and applications (Weinhardt et al., 2009). The services on PaaS can be accessed through web interfaces on computers or mobile devices. Force.com and Google AppEngine are familiar examples of business PaaS and development PaaS, respectively.

While all three models enable service providers to offer Smart Living services over the internet, PaaS seems to be more influential for sharing technical resources and functions on cloud platforms. Regardless of the location of a service provider, PaaS enables the service provider to locate technical functions for service delivery on a cloud platform accessible through a web interface. Examples of technical functions are storage and management of data, access to smart objects and home devices, authentication and authorization services. The PaaS platform then serves as a basis for developing and offering new services or applications to end-users in different locations. PaaS platforms also enable decentralized control over core resources as technical functions for service delivery are provided and shared among multiple service providers (IBM, 2010). Sharing resources on PaaS platforms reduces high costs of IT infrastructure and lowers IT barriers for innovation, especially for start-up companies (Marston et al., 2010). Moreover, end-users benefit from on-demand services and pay based on the usage scheme. Such advantages are driving service providers across industry to deploy PaaS for service delivery (Armbrust et al., 2009; Barnatt, 2010; Mell & Grance, 2011).

Beside potential benefits of using PaaS for service offerings, PaaS enables service providers to store, process, monitor and share a massive amount of data from 'smart objects' in real time, which otherwise would be costly and difficult. Given that, PaaS can be considered as an enabler of IoT (Caprio, 2010).

3.2.5 Service Oriented Architecture and Web Services

Scholars define Service-Oriented Architecture (SOA) from different perspectives. Minhas and Vogt (2005) define SOA as a paradigm to create and deploy a set of services to perform specific functions in a system in a way that such services can be removed, changed or used for developing new services. MacKenzie et al. (2006, p. 8) take distributed resources into account and describe SOA as "a paradigm for organizing and utilizing distributed capabilities that may be under the control of different ownership domains". What is common in these definitions is that SOA is a design approach that enables agility and mash-up of services. Using the SOA design approach, the core functions for service delivery can be abstracted to a set of services. Coupling SOA with Web Services technology enables the services to be run, shared, linked and accessed over the internet (Buyya et al., 2009).

The vision of SOA is to create an architectural design which ensures reusability of existing resources, eliminates duplication and supports flexibility in developing new services based on existing ones (D. K. Barry, 2003; Gulledge, 2007; Ricken, 2007). SOA is often discussed as a design architecture to share and link Smart Living services (Feng, 2010). Many scholars propose and develop architectural design based on SOA to ensure service availability at home (Wu et al., 2007), enhance interoperability between services (G. Lin et al., 2009) or integrate communication standards (e.g., UPnP, Zig-Bee, Bluetooth) and ensure communication between several home devices (R. T. Lin et al., 2008; Ngo, 2007; Wu et al., 2007).

Coupling the SOA design approach with PaaS, service providers can publish and share their services on cloud platforms to provide building blocks for developing new applications (Raines, 2009). Such PaaS platforms serve as large libraries of services from different providers which can be easily and quickly accessed by developers. In addition to accelerating new applications, SOA fade away geographical boundaries for service sharing and service offerings, as the core services, data centre, and applications can be situated anywhere without having any impact on the final service delivery to households.

3.2.6 Conclusions

In this section, we reviewed several devices ranging from home appliances and sensors to assistive devices used for offering Smart Living services to households. We found that the lack of interoperability among communication standards as a barrier to interconnecting devices to each other. We also found that architectural visions of IoT, PaaS and SOA can facilitate sharing, exchanging and reusing of data and services across devices for realizing the vision of Smart Living. In order to share and use data and services of different devices for service delivery, service platforms are required. In the next section, we discuss the role of service platforms in delivering Smart Living services.

3.3 *Smart Living Service Platforms*

Smart Living services are delivered to households through architectures which we refer to as service platforms. As defined in Chapter 2, a service platform can be seen as any digital architecture, hardware configuration or combinations of these which consists of a set of core services being used by service providers to offer internet-enabled services to end-users. In this section, we focus on service platforms used for offering Smart Living services to households. First, we review several sector-specific service platforms (3.4.1). Then, we discuss the importance of establishing common service platforms for service offerings in the Smart Living domain (3.4.2).

We collected information on various Smart Living service platforms that are used in five application areas: Energy, E-health/ Independent Living, Surveillance, Entertainment and Telecommunication and Home Automation. We created a list of such service platforms by searching on Google with keywords: ‘smart homes’, ‘connected home’, ‘home automation’, ‘networked home’, and ‘intelligent home’. Service platforms that were mentioned by at least two different news media and blog websites were included in the overview. Although we do not claim to provide an exhaustive overview of all the platforms in the market, we did review platforms that appear prominent in the market.

We analysed collected information on sector-specific service platforms on two dimensions: platform openness (i.e., whether third parties able to deliver services over the platform, see Section 2.3.3) and location of intelligence (i.e., whether the platform is located in the user’s home, in the cloud, on the network or distributed on multiple locations). This categorisation was done through the following steps. First, the technologies enabling the platforms were identified and listed and a technological architecture was drawn. From the technological architecture, it was then derived whether the platform is based mainly in the home, in the cloud, the telecom network or distributed between home and cloud (i.e., hybrid). Subsequently, technological and organisational openness were assessed. Cases were considered technologically open if the technological architecture lists open APIs and SDKs. Cases were considered organisationally open, either if third party service providers are collaborating on the platform or if other third-parties are allowed to participate in the development of the platform or applications.

3.3.1 A Review on Sector-Specific Smart Living Service Platforms

Home Automation Service Platforms

Home automation service platforms are used for offering a bundle of generic home automation services: lighting, ventilations, and energy monitoring and surveillance services. There are several home automation service platforms being used by service providers to offer home automation services to households.

MoMas Honeywell, as an example, is a closed home-centric service platform offering a combination of lighting, ventilation and surveillance services to households. This internet-connected service platform communicate with a wireless network of controlling devices and sensors within the home and allows remotely controlling services for end-users via telephone, mobile, internet or any WiFi devices (Honeywell, 2013). Shaspa, in comparison, is a hybrid platform based on open standards that ensure communication across multiple protocols and home appliances from different vendors. Shaspa transmits gathered data and information from a home gateway to a cloud service platform. Shaspa provides SDKs for application developers to develop home automation services on the platform (Shaspa, 2013).

Home Energy Management Service Platforms

Smart meters are intended to raise consumers' awareness of electricity consumption to stimulate energy saving. A smart meter, which can be a gas or electricity meter or even both, provide a two-way communication for data exchange between energy providers and the meter which can enable energy providers to remotely control energy consumption of users for billing, monitoring and management purposes. Moreover, energy providers can remotely update smart meters for information regarding tariff or payment mode. Smart meters usually connect to a Home Energy Management (HEM) service platform which provides feedback and information for energy management. A HEM service platform can be an online tool, a web application or an in-home display.

Many HEM service platforms are home-centric (e.g., iPhilips Dynalite, Toon), which integrate a combination of sensors, motion detectors, LED lights and other technologies at home to cover different types of energy management services to households. Most HEM service platforms provide remote monitoring and controlling devices at home. A few merely provide monitoring services (e.g., eMonitor, Alert me). Similar to home automation service platforms most HEM service platforms we found are closed and home-centric. Although there were a few attempts for open cloud service platforms (e.g., Google PowerMeter and Microsoft Hohm), the low rate of market adoption has resulted in discontinuing these platforms (Google Blog, 2011; Microsoft Hohm, 2011)

Besides home-centric and cloud-centric HEM service platforms, other types of solutions are offered for energy management purposes. For instance, Plugwise, in the Netherlands, is a solution based on wireless mesh network of intelligent sensors. By connecting sensors to appliances and using a software program and a management portal, Plugwise enables users to manage their energy consumption or even to program the devices to switch on or off at pre-set time (PlugWise webpage, 2011). Nevertheless, the solution is proprietary and is not open to be extended with other services.

E-Healthcare/independent Living Service Platforms

E-healthcare/independent living services, which are growing rapidly, are usually delivered through home-centric service platforms. Such platforms are commonly connected to different assistive devices and sensors at home and exchange data between elderly people and service providers. Service platforms may activate alarm systems or send notifications to formal or informal carers. Moreover, (mobile) applications can be used to remotely monitor the health status of people at home.

Many assistive devices have their own service platforms for service delivery. However, there are also commercial e-healthcare service platforms enabling a wider range of e-healthcare services rather than a device-specific service. For instance, ZyXEL smart home gateway is a home-centric e-healthcare platform that can be connected to any ZigBee/Bluetooth-enabled sensors or devices for remote medical or monitoring services (BusinessWire, 2010). Philips TeleStation is another home-centric platform that transmits data from health monitoring sensors and devices between home and healthcare service providers (Philips Website, 2011). Typically, these types of platforms are technically closed and can only be adopted by healthcare service providers for offering remote healthcare services to households.

In addition to home-centric e-healthcare platforms, there are cloud-centric platforms enabling end-users to manage and share healthcare information. For instance, the Microsoft HealthVault platform offers a set of tools to analyse health related data and to get guidelines for health management (Microsoft HealthVault Portal, 2013). Google also developed Google Health platform as a cloud-centric service platform for collecting individual health information (e.g., weight and level of activities), which can be automatically transmitted to the platform using supported applications and devices. However, similar to Google Powermeter, this platform also was discontinued due to the low rate of adoption (Google Blog, 2011).

There are also open e-healthcare service platforms including Vignet which works on PCs and mobile devices for data gathering and connectivity between end-user and caregivers. The platform enables integration and management of health data and enables healthcare service providers to offer medical services to end-users remotely. Vignet provides APIs so that third-party application developers can offer health management applications on the platform (Business Wire Portal, 2010).

From a technical perspective, only a few platforms offer APIs for third-party application developers. From an organisational perspective, most e-healthcare service platforms we reviewed are closed to third parties for the development and commercialization of the platform. Moreover, all reviewed service platforms are developed by technological companies to be adopted by healthcare providers.

Surveillance Service Platforms

For surveillance services, a home-centric service platform is usually connected to a variety of sensors and cameras at home, which transmits data, through the internet or a secure network, from households to a security service provider. Whenever home security is compromised, the security service provider provides appropriate security services, which range from traditional simple alarming services to more advanced remote audio/video connection to the home through internet or mobile devices. Surveillance services are also provided by many home automation or healthcare service platforms (e.g., Shaspa, icontrol and Vignet).

Most of the surveillance service platforms we found are home-centric and closed to third-parties. WoonVeilig is an example of a closed surveillance service platform which is connected to a set of wireless sensors and cameras at home to notify the home owner of any abnormal situations at the home by means of email or phone call. The home owner can also access directly to the alarm system through mobile or internet (WoonVeilig Portal, 2013).

Entertainment and Communication Service Platforms

Cable companies and Internet Service Providers (ISPs) deliver telecommunication, digital audio and video services to a home through network infrastructure, set-up boxes or receivers. Such communication networks and devices can be viewed as service platforms to deliver entertainment and communication services to households. These platforms can be used by telecom operators or third-parties to deliver entertainment services (Zoric, 2010).

While access to online video and audio services on typical TVs is possible through specific set-top boxes (e.g., Apple TV, Vudu, Boxee Box and TiVo HD), Blue-ray player (e.g., LG players, Samsung players) or even game consoles (e.g., Wii and Xbox 360), electronic manufacturers deployed internet-enabled service platforms (e.g., Google TV, Yahoo TV) on their TVs to make them smarter. Such smart TVs act as service platforms and eliminate the need for set-top boxes or any other devices. The internet TVs also enable new business models for TV manufacturers to profit from online content providers (Brown, 2011).

3.3.2 Conclusions

Most Smart Living service platforms we found are closed to third-party application developers. The large number of closed service platforms indicates intense competition for dominance in the market, which makes it difficult for application developers (with no platform) to offer complementary applications to end-users (Hwang et al., 2006). Even service platforms providing SDKs or APIs impose specific standards and rules or charges for accessing APIs or SDKs. While most reviewed home-centric service platforms are technically and organisationally closed to third parties, network-centric and cloud-centric service platforms show a higher degree of openness. From the review, we also found that while there are platforms for home automation, surveillance and entertainment services, these services are often bundled in home energy management and/or e-healthcare service platforms.

3.4 *Smart Living Platform Ecosystems*

As discussed in Chapter 2, the network of organisations collaborating and competing around a service platform can be seen as a platform ecosystem. The actors in networks (e.g., Smart Living platform ecosystems) fulfil different roles in providing and delivering services to end-users (Bouwman et al., 2008). In this section, we describe actors and their roles in Smart Living platform ecosystems.

3.4.1 Roles in Smart Living Platform Ecosystems

Smart Living platform ecosystems often consist of platform providers, service providers, application developers, device manufacturers, installation companies, construction companies as well as government and R&D funding agencies.

Platform providers refer to companies providing service platforms (i.e., home, network, cloud or hybrid platforms) for service delivery to households. *Service providers* are companies which provide any type of Smart Living services (i.e., home energy management, e-healthcare, surveillance, telecommunication and entertainment) to households. For instance, Eneco is an energy service provider in the Netherlands offering energy management services to households (i.e., through the Toon energy management platform). Typically, service providers require a service platform to deliver Smart Living services. A service provider may own the service platform to offer services to their customers (e.g., Eneco owns the Toon platform). In such cases, both roles of service provider and platform provider are played by one actor.

Application developers are companies or individuals creating complementary applications for a service platform. *Device manufacturers* produce complementary devices (e.g., white appliances, electronic devices and sensors) that can be connected to and work with a service platform to enable service delivery at home. Application developers and devices providers can be generally referred to as *complementary providers*.

Given that installing and configuring many Smart Living solutions at home is often a complex task for ordinary households, there are *installation companies* offering installation and maintenance services to households. Typically, installation companies offer packaged solutions (i.e., consisting of platforms and complementary devices required for a set of Smart Living services) or customized solutions based on requirements of clients.

Construction companies design and build commercial and residential buildings. Because of increasing popularity of Smart Living services, construction companies need to address customers' demands by building residential and commercial buildings with integrated Smart Living platforms and complementary devices.

Finally, *Government and R&D funding agencies* might be involved in Smart Living platform ecosystems to provide financial supports for development projects.

Although actors in a Smart Living platform ecosystem need to collaborate with each other to provide services for households, they may also compete when they are involved in overlapped activities. For instance, an application developer may offer an application which can be accessed independent of the service platform or develop a comparable application to the one the platform provider offers on the platform. The concerns over internal competition in platform ecosystems might be the reason why most of the reviewed Smart Living service platforms are closed to complementary providers.

In addition to internal competition within a platform ecosystem, there are external competitions between providers of different service platforms. For instance, ADT, which is a market leader in surveillance services in the US, is recently compete with major communication service providers including AT&T and Verizon, by adding additional Smart Living services (e.g., home energy management and healthcare management) to its surveillance service packages (ADT, 2013; BusinessWire, 2013). Likewise, another leading surveillance service providers in the US (Surveillance System Security.com), is now offering other Smart Living services in a move to widen its customer base (PRWeB, 2013). Although increasing competition in Smart Living domain may improve the quality of Smart Living services for end-users, the attempt of providers to dominate the market by providing silos of devices and services (i.e., closed platforms with a set of services) may disenfranchise application developers to step in and utilize services across devices and platforms to create innovative service opportunities.

3.5 *Conclusions*

In this chapter, we applied the core theoretical concepts from Chapter 2 (i.e., Platforms and Platform Ecosystems) into the domain of Smart Living. First, we defined the term Smart Living as a vision on bundle of ICT-enabled services offered to households, accessible within and outside the house that combine value drivers of energy, health, surveillance and entertainment services to facilitate comfort living for households. We specified five categories of Smart Living services and briefly discussed how several devices and home networking enable Smart Living services at home. We found that using different (proprietary) standards for devices has resulted in several interoperability issues in connecting devices at home. We also discussed how technology trends of ‘Internet of Things’, ‘Platform as a Service’ and ‘Service Oriented Architecture’ can facilitate sharing and reusing of existing resources (i.e., network infrastructure, data and services of different devices) among service providers for providing Smart Living services. With regard to platforms, we defined the platform as an intermediary with several core services enabling interaction between service providers and households. Then, we reviewed several Smart Living service platforms based on the degree of platform openness to third-party complementary providers and the location of platform’s intelligence. From the review, we found several closed home-centric service platforms for sector-specific types of Smart Living services. We found that despite of technology trends, which can enable the vision of common service platforms, many service providers still use proprietary service platforms. We also explored roles in Smart Living platform ecosystems and found many roles other than that service and platform providers. We found intense competition between actors as a reason for using closed proprietary platforms in this domain. Despite of our attempts to find examples of collaborative platforms for Smart Living services, we did not find any examples of common service platforms in this domain. Although we found information about partnerships between companies to deliver Smart Living services, most were closed alliances between two or three large known players from the telecom, IT or energy sector which were still in the initial phases of development. The lack of collaboration despite enabling technologies implies that there might be organisational issues, which hinder collaboration in this domain.

4 Case Studies

In this chapter, the eight propositions in the theoretical framework (See Chapter 2) are validated and refined through three in-depth qualitative case studies on collaborative platform development projects in the Smart Living domain. First, the case study design, including case study selection, data collection and analysis, is presented in Section 4.1. Then, results of three case studies are presented in Sections 4.2, 4.3 and 4.4. Finally, we conclude the chapter with a cross-case comparison and alternative explanations in Sections 4.5 and 4.6.

4.1 *Case Study Design*

The case study method is "a research strategy that focuses on understanding the dynamics present within single settings" (Eisenhardt, 1989, p. 534). The method is especially appropriate for answering questions of 'how' and 'why', which often deal with causal links (Yin, 2009). Case studies typically combine a variety of qualitative and quantitative data sources, including documents, interviews, questionnaires and observations to test or generate theory (Eisenhardt, 1989; Yin, 2009) and to offer a deep and comprehensive understanding of a contemporary phenomenon of interest (Pettigrew, 1985).

The case study method is appropriate for this thesis as we study how and why collective action for establishing common service platforms for Smart Living services arises among organisations in platform ecosystems. To answer the main research question, test and specify the propositions (developed in Chapter 2) in the Smart Living domain and get a deeper understanding of the casualties underlying the propositions, we require insights into contexts, organisational relationships, knowledge and experiences of informants and practitioners in the field. These needs match criteria for the case study method (Benbasat et al., 1987; Cavaye, 1996; Miles & Huberman, 1994; Yin, 2009).

We are aware of several criticisms of the case study method, such as the lack of rigor and reliability, external validity, high costs and time, the mass of data and details (A. S.

Lee, 1989; Yin, 2009) as well as the limited internal validity resulted from lack of control over independent variables (Cavaye, 1996, p. 229). Issues of rigor and massive amount of data can be dealt with by using a precise structure and procedure in collecting data and reporting results. While statistical generalization is not possible in case studies, by sampling cases on theoretically relevant dimensions, theoretical validation is possible (Yin, 2009). In the remainder of this section, we discuss the unit of analysis, case study selection, data collection and data analysis.

4.1.1 Unit of Analysis

In case study research, it is critical to first identify the unit of analysis, which is based on the research question (Benbasat et al., 1987). Then, depending on the unit of analysis, different case study design and data collection strategies can be adopted (Yin, 2009).

The unit of analysis in this research project is a sub-set of platform ecosystems, which consists of organisations that jointly develop a common service platform. In addition, we study the technology architecture, as doing so is a prerequisite for understanding the platform ecosystem (Tee & Gawer, 2009). The unit of observation is each organisation in the platform ecosystem and its relations with other organisations. We are especially interested in the reasoning of organisations on factors influencing their decision to be engaged in a common service platform development project. These decisions combined explain why collective action has arisen.

4.1.2 Case Study Selection

One important decision in case study research is between a single or multiple cases (Cavaye, 1996). We opt for a multiple case design mainly to achieve theoretical validation by sampling cases on theoretically meaningful dimensions. In addition, a multiple case design allows for cross-case comparison (Pettigrew, 1985).

To ensure theoretical validation, i.e., providing theoretical insights for formulating new propositions or hypotheses, we strive for theoretical replication strategy in selecting cases, i.e., cases which are expected to predict contrasting results (Yin, 2009). However, due to scarcity of platform collaboration in the Smart Living domain, we have to follow a pragmatic approach in selecting cases. We consider the following necessary criteria to select cases for this research:

1) The case should be a platform development project in the Smart Living domain.

2) The case should be a collaborative project consisting of more than two organisations.
3) The case should represents a collective action situation in which developing the platform is the common goal of involved organisations and no organisation can develop the platform individually.
4) The informants involved in the case are accessible for interviews and willing to be interviewed.

We have taken extensive efforts to discover cases both in the Netherlands and abroad. We examined presentations in conferences, research and development (R&D) project websites, and used our personal academic network to discover cases. In the end, only three cases were found that match the criteria above: Active Life Home (ALH), Home-based Senior Care (HSC) and West Orange (WO). ALH and HSC are Finnish and Chinese projects respectively and are focused on the development of e-healthcare service platforms. WO is a Dutch project focused on the development of a home energy management platform. The case studies were carried out in Finland, China and the Netherlands. We are aware that difference in combining countries, culture and technologies might bring spuriousness. Nevertheless, the intention of the case study is not to generalize towards differences between cases. We consider differences when interpreting the findings and validating the propositions.

4.1.3 Data Collection

We rely on multiple data sources. We interviewed representatives of organisations to understand their reasons for joining the project. Table 4.1 shows an overview of the interviewees in each case.

We considered the following necessary conditions for selecting the interviewees:

1) The interviewee should be from an organisation collaborating in the development of the common service platform.
2) The interviewee should be a high-level decision maker or project manager involved in making strategic decision for the organisation. This enables us to ask the interviewee about how decisions on collaboration are made and what factors influence such decisions.
3) The interviewee should have basic technical knowledge to discuss issues of collaboration created by platform technology and architecture.

Table 4.1. List of Interviewees in each cases

Active Life Home			
Code	**Organisation**	**Role of the organisation**	**Job Description**
DI	Playground Ltd	Data Integrator	Co-Founder
DP1	Beddit	Assistive Device Provider	Chief Technology officer
DP2	Arcticare co.		Managing Director
DP3	Vivago Company		President
ALV1	Active Life Village Oy	Project Leader	Managing Director
ALV2			Project Manager
AU1	Aalto University	Platform Provider	Senior Researcher
AU2			Project & Financial manager
AU3			Professor
AU4			Professor and Initiator of the project
Home-based Senior Care			
TT	Tech-Top	Device Provider Platform Developer	General Manager Assistant
BC	Baibuting Community	State-owned care home provider	Government officer
WU	Wuhan University National Engineering Research Centre for Multi-media and software	Platform Developer	Researcher
ALV1	Active Life Village (Espoo-Finland)	Project Initiator	Coordinator With China
ALV2			Technology Adviser
ML	My Lab	Potential Platform Developer	International Project Manager
W1	Wuxin Ltd.	Platform Provider Project Leader	Founder of the company
W2			Project Manager
W3			Coordinator With Finland
LV	Loviages Ltd.	Care Service Provider	President
West Orange			
IBM1	IBM	Platform Developer	Project manager
IBM2			Project manager
IBM3			Project manager
HAE	Home Automation Europe	In-home Display Provider	Founder & CEO
L	Liander	Smart Meter Provider	Strategic manager

N1	Nuon	Platform Provider	Project manager
N2			Project manager
N3			Project initiator
C1	Cisco	Technology Knowledge Provider	Media & communication manager
C2			Regional Sales Manager
TNO	TNO	TNO-External Expert	Principal consultant

Key informants from the cases helped identify potential interviewees. In addition to our initial list of interviewees for each case, we also asked interviewees to suggest other relevant potential interviewees. Interviews were conducted in January 2012 (ALH case), June and July 2012 (HSC case) and December 2012 (WO case).

Interviews were semi-structured and the interview questions were designed to cover the propositions developed in Chapter 2 (See Appendix A for an overview of the interview questions). Each interview lasted one to two hours and was conducted in person. We stopped the interviews for each case when no additional insights or information were presented. For some cases, informants were interviewed a second time after the initial analysis for missing or unclear information.

In addition to interviews, when available we also consulted documents about each project, websites of involved organisations (for information about their resources and technologies), as well as scientific publications, white papers or reports of other researchers about the project. These documents were mainly used for factual description of the case, i.e., understanding the platform architecture and the setting of the platform ecosystem and in some cases to ensure the reliability of insights from interviews. Especially for the West Orange case, 39 documents were available with extensive background information. The case study database contains specific references to documents to maintain a chain of evidence (Yin, 2009). However, since various documents are confidential, these documents are not referred to in this thesis. For each case, all interviewees were asked to read the interview transcript and validate findings for the case.

4.1.4 Data Analysis

Interviews were recorded and transcribed. Then, the interview transcripts were printed and read carefully. After that, all the transcripts were open coded manually in two rounds of coding; focusing on the propositions but keeping an open mind to alternative explanations. The first two rounds of coding served to get an in-depth understanding of the data. Thereafter, all the transcripts were open coded for a third round using Atlas.Ti 6.2

software. The qualitative data analysis software facilitates data analysis by creating a structure for codes and memos. Moreover, the use of software provides a more systematic way of studying relationships in data which helps to avoid data analysing biases (C. A. Barry, 1998; Miles & Huberman, 1994).

A code (label) was assigned to a relevant part of transcripts that constituted aspects related to the core concepts in the propositions (i.e., platform openness, resource heterogeneity, interest heterogeneity, interdependency, platform leadership and selective incentives). After the third round of coding, the quotations for each code were checked again to ensure that the underlying quotations actually stand for the assigned code; even if they have a different choice of words or phrasing. The third round of coding resulted in so many codes, which include overlapping or redundant codes. To reduce the number of codes, all the overlapped codes were merged.

Just assigning codes to text may demote analysis to merely a classification of concepts which is not sufficient for the purpose of interpretation (Muhr, 1991). As such, while doing coding memos were written to document the interpretations during the course of analysis. The memos were later used to develop a line of argumentation in the discussion of data.

As the aim of case studies is to test causal relations in the propositions, code networks were also created during the third round of coding, where relevant. The code networks visualize and clarify underlying relations and structures among codes that were inferred during the time of interpretation. Finally, using the codes, memo and code networks, the respective proposition was concluded to be supported, partially supported or not supported. To illustrate the findings, we provide a selection of quotes. Intermediate conclusions were validated throughout constant communication and discussion with at least one of the members of each case.

4.2 *Active Life Home*

In Finland, local governments (i.e., approximately 440 municipalities) are responsible for providing care services for elderly people. In the Espoo area, Active Life Village Ltd. (ALV) is a non-profit organisation which has been founded by the municipality of Espoo city, Aalto University, Laurea University of Applied Sciences to promote the development and commercialisation of innovative ICT technology for e-healthcare and independent living services. Active Life Home (ALH) is one of the main projects that ALV is working on and is partially funded by Tekes (i.e., the Finnish Funding Agency for Technology and Innovation).

The Active Life Home is a collaborative platform development project for e-healthcare and elderly independent living services. The project aims to (1) integrate assistive devices and related customer data into one common service platform to provide information services for independent living and 2) to set up a marketplace where solutions of multiple companies are presented so that customized combinations can be selected based on each customer's individual needs.

4.2.1 Active Life Home Platform

The Active Life Home platform realizes integration on three levels: The user interface level (ALH Portal), the information level (Activity and Health Record, AHR) and the device level (Home Gateway, VALPAS). See Figure 4.1 for a simple schema of the ALH platform. Not all assistive devices are included in the figure.

The ALH portal (developed by Aalto University) has a user database of different user groups (i.e., administrator, elderly persons and their families, nurses, and other caregivers). The portal manages access rights to various services and provides single-sign-on to the providers' own systems. The user interface has been implemented on the portal so users have access to all services from one screen.

The Activity and Health Record (AHR) is the integrator of data collected of the elderly people and their assistive devices. Each device provider has opened their server's Application Programming Interfaces (APIs) to enable collection of data into the common database (i.e., AHR), provided by Playground Ltd. The decision on what needs to be collected on AHR is made by an agreement between assistive device providers and ALV. AHR, also accessible from the ALH portal, shows the collection of data, the status and recent events of a selected customer.

Most of the assistive device providers in this project use home gateways to receive information from devices at home. A gateway is a communication device that links and transmits information between care devices at home and servers of the device providers. This means that elderly people with multiple devices would end up having multiple gateways in their homes. To avoid the added cost of gateways and their management, the ALH framework is providing integration at the home level, using VALPAS home gateway, which is developed by Aalto University.

Figure 4.1 The ALH Platform Architecture

4.2.2 Organisations and Roles in the Platform Ecosystem

Table 4.2 shows participating organisations and their roles in ALH platform development project.

Besides Active Life Village (i.e., the leading organisation) and Tekes (i.e., providing partial funding for the project), fifteen companies participate in the project which develop assistive devices and related web-service packages (i.e., medicine reminders, alarms, notifications, activity and sleep quality trend analysis, and location tracking) or provide social or security services. At the time of study, the web services of only five assistive devices were integrating their services into the platform and other assistive device providers were merely marketing their solutions in the platform marketplace. In addition to five device providers, three departments of Aalto University participate in the development of the platform. Although the university is involved, the aim of the project is to commercialize the platform and thus to move beyond the stage of research and development.

Table 4.2 Organisations and Roles in ALH Platform Ecosystem

Organisations	**Role**	**Services**
Tekes	Funding provider	N/A
Active Life Village	Project leader	N/A
Addoz	Assistive device provider (Medication dispensers)	- An online portal services to track medication intake - Alarm and SMS services
Arcticare	Assistive device provider (Indoor positioning trackers)	-SMS, emails services in terms of big changes in daily behaviour
Beddit	Assistive device provider (Bed sensors)	- Online web service to monitor sleep patterns
Everon	Assistive device provider (Location tracking watches)	- Automatic alarms - Two ways speech, call button - Working with call centres
Vivago	Assistive device provider (Care watches)	- Control and monitor activity level - Automatic alarms - Call button
Aalto University	Platform developer	- Design and development of the platform framework, including architecture, interface, gateway and portal
Playground	Data Integrator	- Integrating data of assistive devices into a common database

(N/A: Not Available)

Figure 4.2 represents an overview of roles and value exchange in the platform ecosystem. The information for drawing the figure has been derived from interviews and verified by an informant from the project.

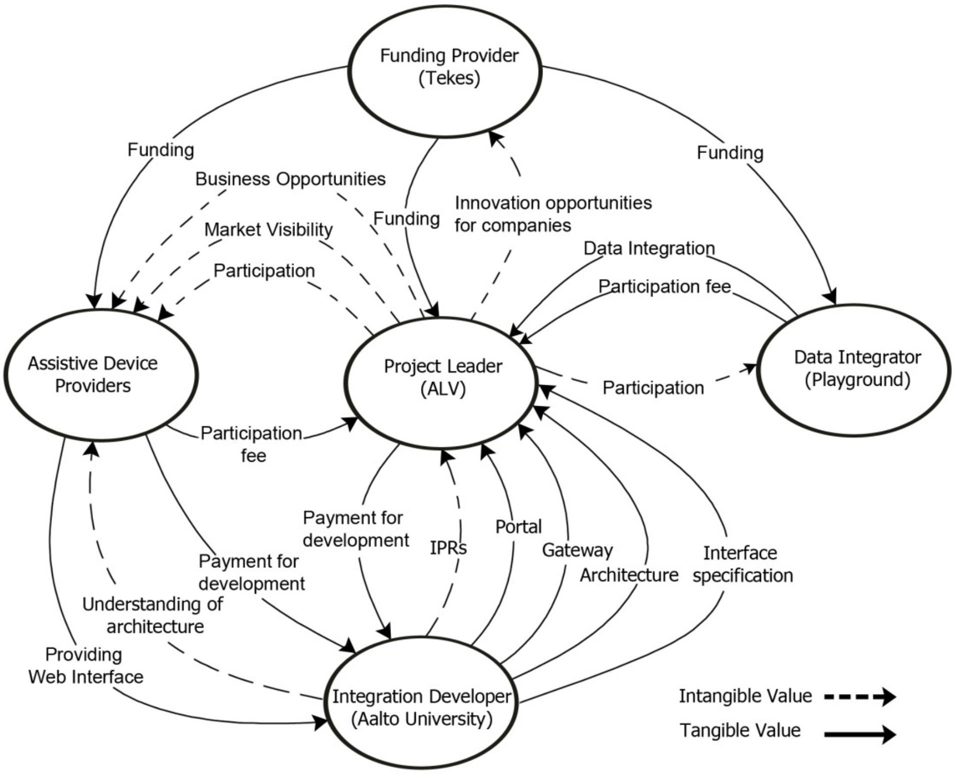

Figure 4.2 ALH Platform Ecosystem in R&D Phase

Active Life Village as the leader of the project coordinates value exchanges and connects different parties in the projects. Active Life Village pays Aalto University for the platform development and owns the IPR of the ALH platform.

4.2.3 Findings

Interest Heterogeneity

To analyse the first proposition, we asked interviewees why they are participating in this project and they provided a variety of reasons. Table 4.3 shows a summary of interests of each group of participating organisations.

The primary interests for assistive device providers were to be visible in the market, have a wider range of offerings, obtain a strategic position in the market and create new business values. They also expressed interests in business opportunities that the project creates. For instance, one interviewee from assistive device providers put that *"it [the project] might result in collaboration with three big municipalities in Finland, so of course we want to be involved"* [DP3]. Another interviewee reasoned: "*marketing was one of the* *main reasons for us to be involved in this project, because the project was running some demonstration facilities and ALV was inviting guests from municipality of Espoo and other places and we could also use the demonstration room for our guests. So, it was a good opportunity to use the facilities and do some marketing"* [DP2].

Table 4.3 Interest Heterogeneity

Organisations	**Interests**
Assistive device providers	Visibility in the market Having a wider range of offerings Obtaining a strategic position in the market by having a common service platform Creating new business value
Active Life Village (ALV)	Creating benefits for society Stimulating collaboration among companies Providing networking opportunities for companies
Playground	Creating new value for society Complementing their business
Aalto University	Access to realistic use cases Solve technical problems Provide technical solutions Publish scientific papers

Respondents from ALV mainly expressed interests in collaboration activities, such as networking and creating benefits for society. According to one interviewee from ALV, *"the whole company was established for the purpose of establishing a collaborative service platform for elderly care services"* [ALV1]. Another interviewee from ALV emphasized that the main goal of the organisation is to solve issues of isolated service offerings by gathering companies to complement their offerings and create value together [ALV2].

Similar to ALV, a respondent from Playground (i.e., the data integrator) also pointed to the need for collaboration among companies to complement their offerings and to create new value. The interviewee put that "*I believe in the value proposition that we will be able to create together. We do not have it yet, but we are working on it and I believe it is going to be a great value proposition. We see that working together is going to provides us with a good business"* [DI]. As Playground is not offering any assistive devices or services in the elderly care market, we can speculate that the project is a mean for them to get involved in e-healthcare market.

The interviewees from Aalto University were particularly interested in the project to access realistic use cases to apply their research and update their information, to solve technical problems, provide innovative solutions and last but not least to publish scientific papers.

Despite the diversity of interests among participants, when we asked respondents about any conflict of interests in collaboration, the respondents from ALV stated that there is no conflict among participants in the project. Apparently, each group benefits from the project in different ways without corrupting the motivation of the others. However, four interviewees [AU1, AU2, AU4, DP3] mentioned the tension between research versus market interest in the project. According to an interviewee from Aalto University, the potential conflict, which is not articulated properly, is that Aalto University is a research institute with no interest in the market. Once the platform is developed, Aalto University is not going to provide any support or maintenance services for the platform. This, then, could be a potential source of conflict, which has resulted from a lack of clarity of role definition and expectations, not necessarily interests of participants [AU4].

According to interviewees from Aalto University, the potential conflict observed in the project may impede the continuance of collective action in subsequent phases of the project (i.e., pilot, implementation and commercialization); especially when the next phases involve high costs and market uncertainty. Nevertheless, as the interest heterogeneity among different groups of participants and the potential conflict were not apparent to participants in the start of the project, it did not influence the initial decisions of organisations to become engaged in the project.

P1) The interest heterogeneity in a platform ecosystem negatively influences decisions of organisations to become engaged in collective action for establishing a common service platform.

Not supported

Resource Heterogeneity and Interdependency

To validate the second proposition, first we analysed the documentary information of the project for resources each group of participants contributes to the project. Table 4.4 shows a summary of resources for each group of participants.

Table 4.4 Resources Heterogeneity

Organisations	**Resources**
Tekes	Funding
Active Life Village oy	Inter-organisational relationship with potential customers Planning and coordinating capabilities Business and market knowledge Marketing capabilities
Assistive Device Providers	Assistive devices and web services packages
Playground	Technical expertise in data integration
Aalto University	Technical expertise in development of the platform Expertise in designing business models

The table shows high resource heterogeneity in the platform ecosystem. Apparently, each group contributes different resources (i.e., finance, assistive devices and services as well as platform technology and market knowledge) to the project. The participants are either non-profit organisations (ALV and Aalto University) or small/medium assistive device providers with limited financial and technological resources. Broadly speaking, each group of participants has parts (not all) of required resources for the platform development.

Interviewees from ALV and Aalto University argued that the platform ecosystem is heterogeneous as each organisation offers dissimilar technical resources [ALV1, ALV2, AU1]. The project manager from ALV put that having partners with dissimilar technical resources in the platform ecosystem can positively influence collaboration as the final platform solution cannot be developed without complementary resources of partners [ALV1]. Similarly, an Interviewee from assistive device providers said that we would like to collaborate with parties that are complementary to our companies [DP2].

Respondents from device providers and Aalto University put that there are overlapped functionalities (similar technical resources) in devices, which increase competition in the platform ecosystem. They argued that competition among partners negatively influences collaboration during the project (AU2, AU3, AU4, DI, and DP3). An interviewee from Aalto University elaborated that technologies such as location tracking are quite cheap and every assistive device providers would like to add such functions to their devices. In this project, two assistive device providers offer this function in their devices and they see each other as competitor. As a result, “*they are not opening their interfaces, they are not telling what they are going to do or how they marketing and so on*” [AU2]. This finding also suggests an interaction effect between resource heterogeneity and platform openness *(i.e., the less resource heterogeneity the less platform openness).* With regard to competition, another interviewee put that *"If there were no direct competitors in the [platform] ecosystem, they would be more open for joint platform development in this context, but now they cannot disclose some of the relevant activities that they are doing"* [AU4]. Despite the competition between two assistive device providers, an interviewee from Playground explained that the initial goal of the project from the beginning was to create a diverse consortium of dissimilar resources to reduce competition [DI]. Apparently, similarity of resources between the two assistive device providers has not been so prominent in the beginning or both device providers did not want to miss the opportunity to be involved in the project.

Interviewees generally agreed that having a heterogeneous network of organisations with dissimilar complementary resources is favourable for collective action as it reduces competition and increases collaboration in the platform ecosystem. Although respondents from Aalto University argued that lack of resource heterogeneity among two assistive device providers (i.e., because of similar technology in their devices) hindering collective action among them, two respondents from assistive device providers put that having partners with similar resources (even though not preferred) did not influence their initial decisions to become engaged in collective action. They explained that developing the common service platform is only one goal of joining the project and they joined the project also for other reasons, marketing opportunities or visibility in the market [DP1, DP2] (See Interest Heterogeneity).

Figure 4.3 summarizes the findings about resource heterogeneity in the project. The green ellipses represent independent variables and the yellow one represents the dependent variable in the theoretical framework. The numbers show how many interviewees have mentioned each relation.

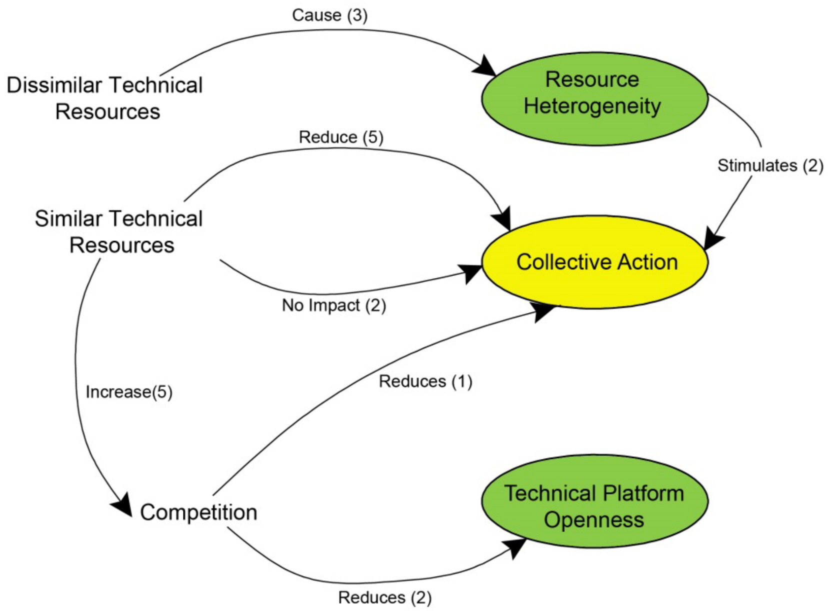

Figure 4.3 Resources Heterogeneity

Other than two assistive device providers offering similar services, the platform ecosystem exhibits heterogeneity of technical and organisational resources (e.g., Aalto University and Playground technical knowledge; ALV's marketing capabilities and relations with potential customers). We heard from assistive device providers that initially organisational resources of ALV and technical knowledge of Aalto University for developing the platform have been complementing resources that have encouraged them to become engaged in collective action. Therefore, we conclude that:

P2) The resource heterogeneity in a platform ecosystem positively influences decisions of organisations to become engaged in collective action for establishing a common service platform.

Supported

All interviewees from device providers pointed out that they need resources of each other for developing the final solution (i.e., ALH platform). Respondents from Aalto University put that they need to access interfaces of assistive devices and services to develop the integration platform. The interviewee from Playground said that they need access to the data of assistive devices to integrate data. Similarly, assistive device providers explained that they depend on Playground and Aalto for data and service integration on the platform.

Finally, all interviewees put that they depend on ALV because its organisational relationships with potential customers (e.g., municipality of Espoo) which also help in extending the network. These findings about interdependencies in the platform ecosystem indicate that resources and capabilities of each partner are valuable for the others and have created interdependencies in the ecosystem:

P3) The resources heterogeneity in a platform ecosystem causes interdependencies in the platform ecosystem. **Supported**

Although all groups of respondents declared that they need resources of each other to develop the platform, two respondents from ALV and Playground argued that there were no interdependencies in the beginning of the project. In fact, interdependencies appeared as a side effect of collective action for developing the platform [ALV1, DI]. Seven respondents also elucidated that partners in the platform ecosystem are loosely interdependent as many of them can be replaced by other companies providing similar resources [DI, AU1, AU2, AU3, AU4, DP3, ALV2]. This is especially the case for assistive device providers. Nevertheless, an interviewee from Playground put that agreeing on technical approach and creating the platform bound partners together which is important for collaboration because then it is easier to work based on the agreement with existing partners rather than reaching agreements with new partners [DI]. The importance of the platform as a bond that creates interdependencies in the ecosystem was also discussed by other respondents [DP2, DP3, ALV1].

Another aspect of interdependencies, which was raised by an interviewee from ALV, is funding. He explained that the funding provided by Tekes is critical in a sense that they have agreed on existing partners for platform development and thus the funding created (organisational) interdependencies among partners [ALV2]. Figure 4.4 shows finding for interdependencies in the platform ecosystem.

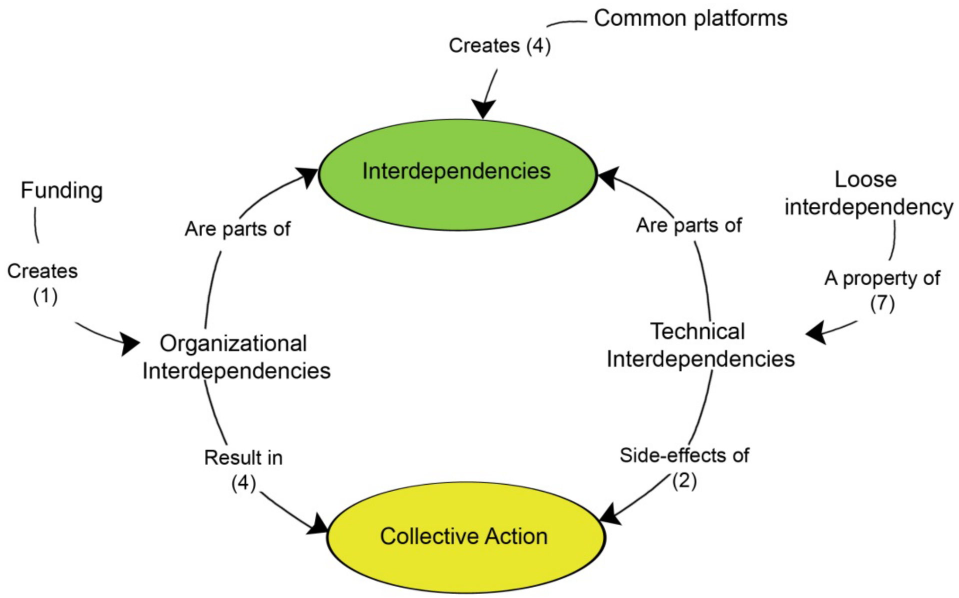

Figure 4.4 Interdependencies in the Platform Ecosystem

These findings indicate that financial and technical interdependencies in the platform ecosystem are rather loose and have been emerged because of collective action and not as an antecedence of collective action. However, many of interviewees discussed that they need organisational resources of ALV to access city of Espoo as a potential customer for their products and services [DP1, DP2, ALV2, AU1]. One respondent elaborated that ALV is like a magnetic channel and their relation with city of Espoo was an important factor in the beginning for small assistive device providers to become engaged in the project [DP2]. From this finding, we can speculate that while technical and financial interdependencies has not influence initial decision of organisations for collective action, organisational dependency on the platform leader to access to customers has positively influenced initial decision of organisations to participate in the project.

P4) The interdependencies in a platform ecosystem positively influence decisions of organisations to become engaged in collective action for establishing a common service platform.

Supported

Platform Leadership

All interviewees described ALV as the coordinator, facilitator and driver of the platform development project. According interviewees ALV plays an important role in the project by supporting finance, driving development, networking and marketing, coordinating collective action among participants by aligning interests of parties, managing conflicts of interests and creating incentives for collective action. An interviewee described ALV's strategies in coordinating the project as follow: *"ALV drives the project with soft values […] not hard values like forcing the companies to participate and/or bringing lots of money on the table and say just do this plan […] ALV looks at different partners' interests and tries to align interests so that we can work with parallel interests"* [DI]. This quote is in line with how the managing director of ALV described the mission of the organisation: to bring organisations together and promote and support common interests of all participants [ALV1].

Despite general positive opinions of interviewees about the role of ALV in the project, one of assistive device providers criticized ALV for lacking knowledge of customers' needs. The interviewee argued that to ensure the market success of the platform, beside the integration, the platform should address real needs of customers and this needs to be emphasized by the leader of the project [DP3].

There were also comments on the type of organisation (i.e., ALV is a non-profit organisation). Two respondents from assistive device providers and one from Aalto University discussed the positive influence of ALV as a non-profit organisation on collaboration. According to interviewees, ALV does not have any incentive against the device providers and this reduces corporation risk for parties and thus creates trust in the platform ecosystem [DP2, AU2, DI]. Moreover, ALV does not impose a specific technology and force the other companies to use that [DI]. However, according to a number of interviewees, a non-profit organisation in the lead also imposes limitations to commercializing the platform as 1) it does not have financial resources to ensure that the project will evolve in the market and 2) it is not their objectives to have revenue from the project [AU2, AU3, AU4]. An interviewee from Aalto University described differences between a non-profit and a commercial organisation in the lead as: *"It (a non-profit organisation in the lead) makes the project more risky […] the question is that how to make sure that this project really develops and evolves in the market. Usually one large commercial player can attract the customers and make sure that the ecosystem is healthy. In this case [Active Life Home project], you don't have guarantee for the market part" [AU3].*

Although ALV as a non-profit organisation may not have resources to guarantee commercialization of the platform, all interviewees believed that collective action would have not been started without ALV. According to interviewees, ALV played a central role in bringing small companies together, creating a trustworthy environment and promoting collaboration for a common service platform. Moreover, good reputation of ALV and having direct connection with municipality of Espoo make ALV an attractive partner to collaborate with [DP2, ALV2, DP2, AU1]. These findings indicate that strategies and organisational resources of ALV as the leader of the project has positively influenced decisions of organisations to become engaged in collective action.

P5) Platform leadership in a platform ecosystem influences decisions of organisations to become engaged in collective action for establishing a common service platform.
Supported

Selective Incentives

Tekes provides a partial funding (as a selective incentive) for all participants in the project. The interviewees from ALV found initial funding encouraging for attracting organisations to the project. Nevertheless, they acknowledged that the funding is small and assistive device providers may even need to invest for the development [ALV1, ALV2]. In contrast to what we heard from ALV, no interviewee from assistive device providers pointed out to the funding as an encouraging factor for collective action. The funding has been only important for Aalto University as it covers 70% of research costs [AU2]. These findings indicate that financial incentives are not always encouraging for collective action. Instead, we heard a lot from assistive device providers that the added value of the platform to their separated offerings gives them a competitive edge compared to companies with no integration into the platform. Apparently, the vision of having a competitive advantage of accessing to a common service platform has been a stronger selective incentive, though a non-tangible incentive, to encourage assistive device providers to *become* engaged in collective action.

P6) The presence of selective incentives in a platform ecosystem positively influences decisions of organisations to become engaged in collective action for establishing a common service platform.
Supported

The findings about platform leadership showed that a majority of respondents believe that ALV is responsible to support finance and create incentives for companies to work collectively (see findings for Platform Leadership). In fact, inclining assistive device providers to envision the platform as a competitive edge may have not been done without the leadership of ALV.

> *P7) The presence of platform leadership is required to deploy selective incentives in a platform ecosystem.*
> **Supported**

Technical Platform Openness

Four interviewees stated that the ALH platform is technically open [DP1, DP3, ALV1, ALV2, AU4]. They defined openness in terms of industry standard interfaces, meaning that once the platform is developed complementary devices or services can be integrated into the platform on the IT system level using open industry standards. Although partners have agreed on using open standard interfaces, three interviewees noted that still interfaces need to be identified, which requires agreements on what data need to be shared on Activity and Health Record (AHR) database and what data should remain on the servers of assistive device providers [DP3, ALV1, AU1].

Interviewees discussed platform openness as a driver for collective action because openness enables the partners to extend functions of the platform in future by integrating new products and services [ALV1, ALV2, AU4] and share platform data with third-parties to gain more benefits and value out of the data [DP3, AU2]. An interviewee from ALV explained that “the companies are more willing to take part in the project when they know it is an open platform […] many of the companies have done closed platform development and they have seen that this is not the smartest way for the future” [ALV1]. He further elaborated that it is not clear what kind of companies or assistive devices of services will be emerging in a few year time. Therefore, having an open platform gives assistive device providers an opportunity to integrate new products or services to their whole service offerings. Figure 4.5 shows a summary of findings for platform openness from a technical perspective.

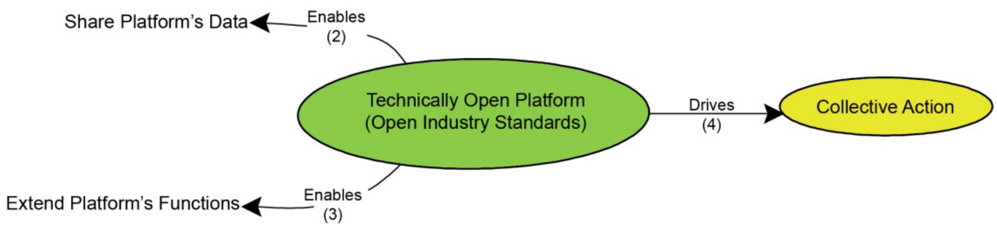

Figure 4.5 Technical Platform Openness

Although most interviewees found platform openness as an important factor encouraging their participations in the project, the degree of technical openness (in terms of what data and interfaces would be open and shared) was not defined. Nevertheless, the findings suggest that platform openness (in terms of open industry standard interfaces) has encouraged assistive device providers to join the project in order to extend their current service offerings, stay competitive and provide their customers with a complete solution.

P8-A) The degree to which a platform is technically open towards complementary providers influences decisions of organisations to become engaged in collective action for establishing a common service platform. **Supported**

Organisational Platform Openness

All interviewees generally pointed out that there are rules and agreements for new companies joining the platform project. First of all, there should be an agreement among members (at least more than half of the members) to accept new companies. Moreover, new companies should be complementary and not direct competitors of any existing members of the project. Four interviewees emphasized that the current members will not allow a new partner to join the project without investing money or bringing new resources [DP1, DP2, AU1, AU2].

Two respondents noted that opening platform to new companies and having a large number of parties during the development increases difficulties in collaboration [DP3, AU2]. The reason is that openness may result in more competitors in the platform ecosystem which increases of likely conflicts of interest among the participants *(i.e., an interaction effect between organisational platform openness and heterogeneity of interests)* [DP3]. Therefore, it can be inferred that attributing strict rules to organisational openness of the platform during the development is important to reduce competition and encourage collective action in the platform ecosystem. Then, once the platform is developed, accepting new companies with complementary services or devices is required to keep the platform competitive. Otherwise, according to an interviewee, the platform will die in a few years when new companies with new solutions emerge in the market [AU4].

Regarding the impact of organisational openness of the platform on collective action, four interviewees discussed platform openness (towards complementary providers) as a positive factor for collective action [ALV1, ALV2, DI, DP2, DP3]. One interviewee from ALV reasoned that companies have already realized that individual approaches do not work and they were interested in open and collaborative projects [ALV1]. Moreover, organisational openness (to complementary providers) enables the companies to complement their service offerings [DP2] and to have more credibility in the market [ALV1]. Figure 4.6 shows findings for organisational platform openness.

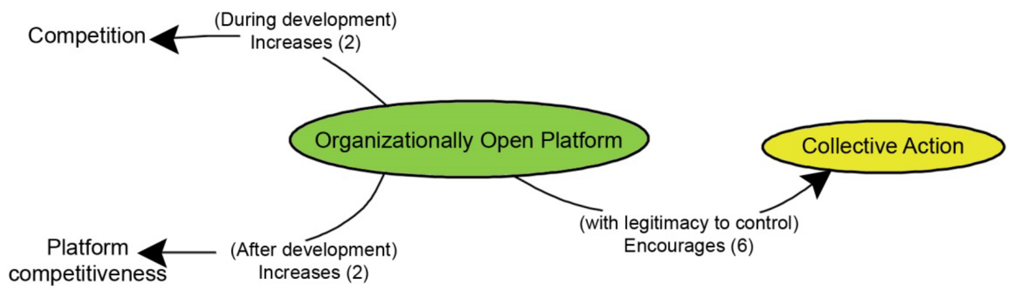

Figure 4.6 Organisational Platform Openness

The findings show that organisational openness (once the platform is developed) is favourable for assistive device providers to complement the platform and extend their offerings. Nevertheless, we found that the initial agreement between members of the project able them to control platform openness towards new members. Moreover, organisational openness with no or limited control was not found favourable for parties in the project because complete openness does not ensure competitive advantages of existing members. From this findings, we can speculate that while interviewees discussed that organisational openness has encouraged them to join the project, the companies would have not joined the project if there was no or limited organisational control over the platform ecosystem. This suggests that platform organisational openness (after the development) may encourage collective action only if initial members have legitimacy to control the platform ecosystem.

P8-B) The degree to which a platform is organisationally open towards complementary providers influences decisions of organisations to become engaged in collective action for establishing a common service platform.
Supported

Alternative explanations

In addition to the eight propositions that we explored, respondents also referred to other issues influencing collective action in this case. According to a majority of interviewees, one main source of uncertainty in this project is the lack of a clear value proposition that defines the value and benefits of the project for each participant. Moreover, there are no agreements of division of role and revenue in the project [DI, ALV1, DP3, AU1, AU2, AU4]. Defining a business case, which clarifies the financial equations, would have increased the companies' motivations for active involvement in the project, as put by an interviewee from Aalto University [AU2].

Another issue raised by another respondent from Aalto University is the tension between short-term plans of SMEs (assistive device providers in this project) to generate income and the long term plan of the project. The issue is that SMEs involved in the project have a very short life panel and look for short term issues (e.g., how to survive this month or next month) while the project has a longer life panel. Therefore, the challenge is to plan the project in a way that it is adjusted with the way SMEs are working [AU3].

Adoption is another issue of the project. While the municipality of Espoo city (i.e., a co-founder of ALV) is a potential customer for the platform, it is uncertain if the municipality would adopt the platform for service offerings, because of high costs of integrating the platform into their current systems for care services. An interviewee put that if municipalities are not going to adopt the platform or pay anything for it, there would not be any business value for us to provide support services for the platform [DP3]. Such uncertainty over adoption of the platform may threaten the continuance of collective action for the commercialization.

These findings suggest that uncertainties over business models, adoption and outcomes of the platform influence the companies' decisions for long-term investment in the platform and continuing collective action.

4.3 *Home-based Senior Care*

The economic reform in 1980s caused several social, political and economic changes in China. Many people had to leave their home town to work in large cities and the size of family reduced due to one child policy. Consequently, challenges emerged in providing care services for an increasing number of elderly people (Liu et al., 2006; Xu & Chow, 2011). Currently, one of the major concerns of the Chinese government is to provide care services for the growing aging population.

One way to address the aging issue in China is institutional care (i.e., elderly care homes). The government attempts to promote institutional care by 1) providing governmental care institutions and 2) supporting private care institutions by means of subsidies (Xu & Chow, 2011). Despite the increasing number of elderly care homes, only a small proportion of elderly people live in those care homes due to three reasons: 1) elderly care homes are rather expensive and not affordable for average Chinese families; 2) there are concerns over quality of the services and 3) cultural issues, i.e. families feel guilty for placing elderly people in elderly care homes (Zhan et al., 2006).

Beside the institutional care, there are also community-based services that provide supplementary and support care services for elderly people living alone at home. Such services include providing in-home care, community-sponsored meal programs, community kitchens, recreation centres, and mutual aid networks (i.e. exchange services between households) (B. Wu et al., 2005). The community-based services are mainly provided by small private care service providers and/or volunteers (Xu & Chow, 2011).These community-based services are not technology-enabled and they merely include typical daily care services which do not cover other needs of elderly people (e.g., healthcare or safety services). In order to provide wide-ranging services for the aging population, the Chinese government appointed the Ministry of Civil Affairs in each city to facilitate innovative technology-enabled solutions to enable elderly people to live independently at their homes as long as possible. As the Ministry does not have the expertise to provide the solution separately, they support initiatives that offer innovative solutions for the problem.

Home-based Senior Care project

The *Home-based Senior Care* project (HSC) has been initiated by Wuxin (i.e., a for-profit company partly funded by Wuhan University (WU) and a number of private investors). The project was set up when Wuxin found out about an elderly-care platform project (i.e., Active Life Home) through their personal contact working in Finland. Then, Wuxin started communication with related Finnish organisations involved in the project to export the platform concept, assistive devices and services from Finland to China.

The objective of the HSC project is to introduce a technology-based way of offering elderly care services, first in Wuhan city and later all over China. To do so, Wuxin and Chinese partners collaborate with assistive device providers and technology providers in Finland: 1) to import technology of assistive devices from Finland to China, and 2) to integrate services and data of assistive devices, provided by Chinese and Finnish providers, into one common service platform, called Home-based Senior Care platform, to be used by care service providers for care service offerings.

The care services enabled by the HSC platform include: 1) safety services (i.e., gas and electricity safety, location tracking and alarm services), 2) remote healthcare services (i.e., checking medication intake using a smart medication dispenser device; checking blood pressure, which is measured three times a day and is sent to the platform using mobile phones; checking activity levels, sleep patterns and calories consumption, which are measured and sent to the platform using wearable watches), 3) convenience and daily living services (i.e., shopping, cleaning and food services), and 4) entertainment and telecommunication services (i.e., video and audio services to communicate with relatives, nurses or doctors). The platform can be seen as a marketplace on which elderly people can select one service or a bundle of services, available on the platform, based on their needs.

4.3.1 The HSC Platform

The architecture of the HSC platform consists of two parts: 1)a data centre: collects information of elderly people, care givers, families and doctors as well as data from home sensors or assistive devices used by the elderly people; 2) a core business platform: providing a set of core services to manage and support services for customers and third party service providers.

The generic services provided on the core business platform are as follow:

1) User management centre: manages users' data on the platform and any party who wants to check users' information has to login to the platform. The identity authentication and information privacy are also of the key services.

2) Service registry centre: lists optional third parties' services on the platform. First, customers need to charge their personal account on the platform (see business reception centre below). Then, they can select and purchase third parties' services from the service registry.
3) Business reception centre: enables customers to charge their personal account on the platform in order to be able to purchase services (pre-paid services).
4) Scheduling service centre: prioritizes services and plans a schedule for service delivery.
5) Call centre: receives and manages calls from elderly people using assistive devices.

Figure 4.7 shows an overview of the platform architecture.

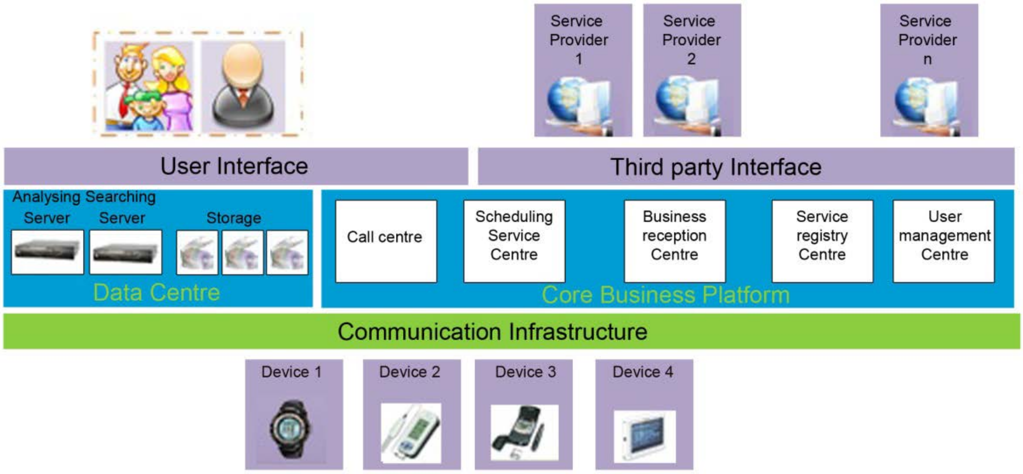

Figure 4.7 HSC Platform Architecture (adapted from the project's documents)

The HSC platform has the same concept as the ALH platform. Both platforms are aimed to collect data from different devices and services used by elderly people. Nevertheless, the emphasis of the ALH platform is on development of the portal for care service providers while the focus of the HSC platform is to provide interfaces for third party service providers (i.e., home care service providers, shopping service providers or rehabilitation service providers) to access and use the data of the platform for service offerings.

4.3.2 Organisations and Roles in the Platform Ecosystem

Table 4.5 shows organisations and their roles in the project. The organisations involved in the project can be divided into three main groups of 1) organisations providing the platform and technological devices and services; 2) organisations using the platform and devices to provide care services for elderly people and 3) organisations providing funding for the project.

Table 4.5 Participating Organisations and Roles

Platform and Technology Providers		
Organisation	**Background**	**Role**
Wuxin Ltd.	A commercial company founded by venture capitals, including Wuhan University Venture Capital. Wuxin together with Wuhan University, as the initial partners, have set up the consortium aiming at commercialization of technology-based services for elderly	1) Initiating the project 2) Defining the functional requirements of the platform 3) Provider and operator of home-based senior care platform
Wuhan University	Wuhan University is one of the main partners in the project. The National Engineering research centre for multimedia software of Wuhan University is directly involved in the project.	1) Designing the architecture of the platform, including design of the platform's interfaces 2) Developing the data centre which stores data from elderly people and their assistive devices
Tech-Top Ltd.	Tech-Top is a R&D company mainly in the field of positioning system techniques with the focus on market application. Tech-Top is also partially funded by Wuhan University.	Developing an affordable version of an assistive device for China market (in collaboration with a Finnish assistive device provider, Vivago)
Finnish assistive device providers (Vivago, Beddit, Everon)	Companies providing assistive devices and web service packages for independent living, e.g., location tracking, medication dispenser, sleep tracking sensors.	1) Exporting assistive devices from Finland to China 2) Providing support and maintenance services for the devices
Aalto University	Department of Computer Science and Engineering	Providing consultancy for the platform development

Active Life Village (ALV)	A non-profit organisation partially founded by the municipality of Espoo city in Finland. ALV initiated the project in Finland and then promoted it in China.	1) Initiating the project together with Wuxin 2) Promoting Finnish assistive devices in China 3) Providing consultancy for e-healthcare platform development projects
	Care Service Providers	
Baibuting Community	Senior care-home is located in Baibuting community and there are more than ten thousands elderly people living in the community. Through cooperation with the government, the pilot was planned to done in this community.	Giving access to buildings for the pilot of the platform and devices
Lovaegis Company	A care service integrator cooperating with different care service providers.	Providing elderly care services using the platform and technological devices.
	Project Funders	
Wuhan Local Government	Wuhan government wants to speed up development and adoption of technological solutions for independent living services	Partial project funder
Wuhan University Venture Capital (WUVC)	A commercial investor	1) Partial project funder 2) A shareholder of Wuxin

4.3.3 Findings

Interest Heterogeneity

Interviewees expressed a wide range of interests for participating in the project. The main drivers for WU are to apply their research into practice, localize the Finnish platform and develop their own technology; use the project for education purposes; create knowledge; and apply for the governmental funding.

The common drivers for Wuxin and Tech-Top are taking advantage of commercial prospects and future business opportunities of the novel concept of the platform. More specifically, Wuxin would like to access Finnish products and technologies and be the first platform provider in Wuhan. Tech-Top, on the other side, also declared solidarity types of motive, for instance, to solve the aging problem in China.

The main drivers for the care service providers are to change the traditional care service offerings, to use technology in their service offerings in order to reduce costs.

In the Finnish side, for ALV, the main motivation is to support Finnish companies to extend their businesses to China. The Finnish device providers see China as a huge market and thus they are interested in accessing the Chinese market. For Aalto University, it is interesting to compare collaboration for a same platform concept but in two different countries. They would like to know how Chinese would solve the conflicts that they have encountered in the Finnish project (see Section 4.3.3. for findings for Interests Heterogeneity in the ALH project). Table 4.6 summarizes interests of each group of participants.

Table 4.6 Interests Heterogeneity

Organisations	Interests
Wuhan University	Applying research into practice To develop a localized platform for China Knowledge purposes Governmental funding
Wuxin	Commercial prospects Business opportunities Access to Finnish Technology Being the first in the Chinese market
Tech-Top	Future prospect of the platform concept Solving the aging problem in China
Care service providers (Lovaeges, Babuting Community)	To change traditional ways of care service offerings To reduce costs
Active Life Village	Extent their business from Finland to China
Aalto University	Knowledge sharing and learning
Finnish assistive device providers	Grow their businesses and access to the Chinese market

While the platform ecosystem exhibits a high degree of interests heterogeneity (from knowledge to cost-reduction and market prospects), we heard from several interviewees that the partners, though targeting different individual objectives, share the same goal which is establishing common service platform for elderly care service offerings. Interviewees argued that because each partner has a distinct role and benefit from the project, conflicts of interest rarely happen and in cases of any disagreement, partners tend to negotiate with each other [TT, WU, W1, W2, W3]. For instance, when Wuhan University proposes an idea for the platform or Wuxin wants to include functions which are difficult to be implemented from Tech-Top point of view, they negotiated on possibilities and tried to hold to market rules (i.e., regulations) and market needs (i.e., demands from customers and care service providers).

Although the partners have been aware of the dissimilar interests of each other, they decided to participate in the project because they did not consider dissimilar interests as a potential source of conflicts in the project. Moreover, the main decision makers in the project and the providers of the platform are Wuxin and Wuhan University (which is also a shareholder of Wuxin). Other partners were chosen by Wuxin to fulfil the needs in the project [W1]. Therefore, interest heterogeneity is not hindering organisations from participating in the project as partners merely fulfil their roles and benefit from the project in different ways. Perhaps, interest heterogeneity would have become a source of problem if other partners were also involved in decision making for the platform.

P1) The interest heterogeneity in a platform ecosystem negatively influences decisions of organisations to become engaged in collective action for establishing a common service platform.
Not supported

Resource Heterogeneity and Interdependency

Table 4.7 shows the resources that each party contributes to the project. The table reveals a diversity of resources and capabilities in the platform ecosystem.

All interviewees agreed that partners in the project provide dissimilar complementary resources for the platform. Four interviewees argued that resource heterogeneity is required for collective action [TT, W1, W2, BC] because the imbalance of resources has united partners for the common goal (i.e., the common platform) [W1]. Moreover, dissimilar resources of partners reduce competition in the platform ecosystem because competition takes place between companies in the same market while in this case partners are from different industries (i.e., healthcare, information technology, research and government) [TT, W2]. Nevertheless, an interviewee from Wuhan University put that sometimes there are challenges in communication between parties with different background. For instance, Wuxin wanted to include certain functions into the platform while from the viewpoint of Wuhan University and Tech-Top, implementing such functions is not possible. However, the interviewee added that these types of issues happen during collaboration and are often resolved by negotiation between parties [WU]. Therefore, such communication issues have not influenced the initial decision of organisations to become engaged in collective action.

Table 4.7. Resources Heterogeneity

Participants	Resources
Tech-Top LTD.	Technical expertise for development of an assistive device
Wuxin LTD.	Inter-organisational relationships with Finnish companies and the Wuhan government Planning and coordinating capabilities Business and market knowledge
Wuhan University	Technical knowledge for designing the platform architecture Technical expertise for developing the data centre
Active Life Village	Contact point with Finnish device providers
Aalto University	Technical expertise about the platform concept
Assistive Device Providers	Assistive devices and web services packages
Baibuting Community	Access point to elderly people for the pilot of the platform and devices
Lovaegis Company	Expertise in providing elderly care services
Wuhan Local Government	Financial resources
Wuhan University Venture Capital (WUVC)	Financial resources

Figure 4.8 shows a summary of findings for resource heterogeneity.

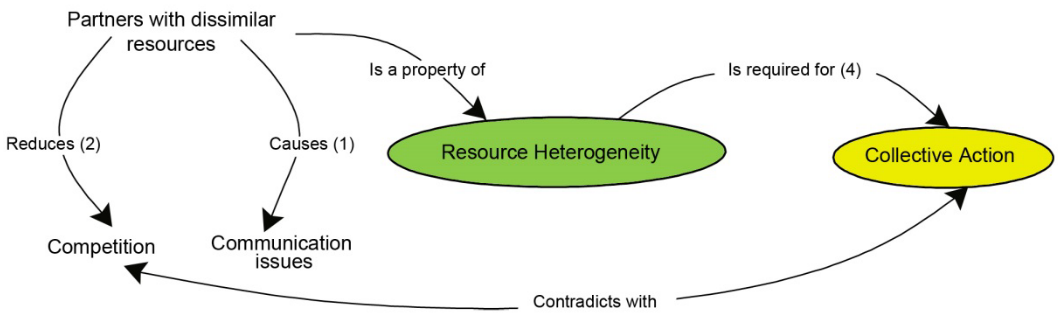

Figure 4.8 Resource Heterogeneity

In general, the organisations in the project discussed that resource heterogeneity in the platform ecosystem encourages participation in the project because parties can complement each other without being concerns about competition.

> *P2) The resource heterogeneity in a platform ecosystem positively influences decisions of organisations to become engaged in collective action for establishing a common service platform.*
> **Supported**

Interviewees also discussed that resource heterogeneity has created interdependencies in the platform ecosystem [W1, BC, TT, WU, LV], because no one organisation has all resources and can do all and each partner focuses on a specific part. An interviewee from Wuhan University added that interdependencies are inevitable, especially to address different customer requirements, expertise and resources of different parties are required [WU].

> *P3) The resources heterogeneity in a platform ecosystem causes interdependencies in the platform ecosystem.*
> **Supported**

Interdependencies in the platform ecosystem are not related to platform development per se. In fact, we found different types of interdependencies between partners in the project. Generally, Wuxin and Wuhan University depend on ALV and Aalto University for the platform technology, and on assistive device providers for devices and technology [W2]. Assistive device providers need Wuxin to market their products and access to customers in China [TT, BC, W1, W2]. Care service providers need Wuxin to access the platform and assistive devices, especially as there are not many e-healthcare technology providers in China [BC, LV]. Tech-Top needs Wuhan University's expertise in research and design of assistive devices [TT]. Wuxin needs its partners (both Finnish and Chinese partners) to provide the platform and address customers' needs [W1, W3]. Finally, all Chinese partners depend on the government for funding and approval for the project [W2].

According to two interviewees, such interdependencies demand collective action [WU, W1]. Nevertheless, interdependencies in the platform ecosystem are loose and, besides Wuxin, Wu and ALV, the other parties in the ecosystem are replaceable [TT, W3].

The findings from interviews suggest that interdependencies between the initiators of the project have encouraged their initial decision for collective action. For care service providers the need for the technology to reduce costs and improve service offerings has inspired the decision for collective action. The fact that at the moment e-healthcare technologies are rather uncommon in China increases care providers' dependency on this project, which in return encourages participation in the project.

P4) The interdependencies in a platform ecosystem positively influence decisions of organisations to become engaged in collective action for establishing a common service platform.

Supported

Platform Leadership

The project was initiated by Wuxin when they found out about the platform concept which was initially developed by Aalto University and ALV in Finland through personal contacts. According to interviewees, Wuxin plays a critical role in enabling this project as it defines the main goal for the project [W1, WU], selects partners [WU, ALV2], brings parties together [W2, LV, WU, ALV2] and acts as an intermediary between them [W1, W2, W3, LV, WU, BC]; supports Finance [TT, LV]; supports business and marketing parts of the project [TT, W1, LV, BC, WU]; defines the platform requirements [TT, W1, W3, WU, ALV2, BC]; operates the platform [W1, W2, TT, BC, LV] and supervises the data exchange legitimacy on the platform [BC, LV, W1]. In fact, Wuxin was established for this platform project and as put by an interviewee without Wuxin all parts of the project would have fallen apart [W2].

Despite the marketing and business skills, Wuxin lacks technical expertise for developing the platform and thus it outsources the technology part to WU and Tech-Top [WU, TT]. Such a lack of technical expertise can create disagreements with Wuhan University and Tech-Top as Wuxin may demand specific functions for the platform or assistive devices which cannot be easily implemented.

We also asked interviewees about hierarchy in the platform ecosystem. Although interviewees put that all partners are treated equally and no one imposes ideas on others [W1, W3, TT, BC, LV], responsibilities of Wuxin in the project suggest that tasks such as defining goals, selecting partners to address the project's goal and defining requirements of the platform put Wuxin in a higher position than other partners in the project. Wuhan

University (as a shareholder of Wuxin) also has a similar power position. Therefore, it can be reflected that equality is especially the case between Wuhan University and Wuxin collaborating for developing the platform. Although service providers also see themselves treated as equal in the network, they do have to follow certain rules set by Wuxin in their service offerings and they are not involved in decision makings for the platform. As such, the service providers are not in a dominant position.

Regardless of the dominating position of Wuxin in the project, and also a lack of technical skills for the platform development, all interviewees agreed that collective action between Chinese and Finnish companies for the project would not have been started without Wuxin initiating the project and encouraging companies to become engaged in the project.

P5) Platform leadership in a platform ecosystem influences decisions of organisations to become engaged in collective action for establishing a common service platform. **Supported**

Selective Incentives

From the interviews, we found that the Chinese government aims to solve the aging issue in China [W3, BC]. However, as they are not able to solve this issue by themselves, they support elderly care projects which address this issue by means of providing funding or approval for the project [BC, LV, TT, W1, W2, W3, WU]. Nevertheless, the government only supports collaborative projects as collaboration gives credibility to projects [W2]. There are a number of factors that increase the chance of getting funding from the government. According to interviewees from Wuxin and Tech-Top [W1, TT], the government provides funding for projects that 1) address a market necessity; 2) have a good service concept and 3) involve well-reputed organisations rather than just start-ups.

The project meets the first two conditions as it offers a promising platform concept which has already been developed in Europe and addresses a major problem (i.e., care services for aging population) in China [TT]. With regard to the third condition, we heard many times from interviewees that in China involvement of universities adds credibility as it shows research and technical abilities of the team. Wuhan University is a well-reputed trustworthy organisation, which has technology knowledge and credit in the society, and thus involvement of Wuhan University gives the project credits and makes it more likely to get financial support from the government [TT, LV, BC]. All these conditions increase the chance of getting fund from the government and thus serve as selective incentives for technology and care service providers to become engaged in the platform project.

The funding was not yet in place during the course of the case study. Therefore, we cannot conclude if it has influenced initial decisions of organisations for collective action. However, we especially heard from interviewees that involvement of Wuhan University as a well-reputed organisation has been an important factor that has encouraged organisations to join the project [TT, BC, W3]. Therefore, in this case, reputation of a partner rather that financial incentives has encouraged organisations for collective action, especially that the reputation of Wuhan University also guarantees funding from the government.

P6) The presence of selective incentives in a platform ecosystem positively influences decisions of organisations to become engaged in collective action for establishing a common service platform.

Supported

Beside the critical role of the government in providing funding for the project, Wuxin also plays an important role in receiving the governmental support for this project. One of the shareholders of Wuxin is Wuhan University and behind the Wuhan University is the City of Wuhan. Therefore, the local government background of Wuxin to some extent ensures support from the government for the project. The financial supports from the local government then enable Wuxin to support the finance of the project, especially for the pilot. As a result, care service providers are more willing to participate in the pilot. Therefore, without Wuxin and involvement of WU, it would have been more difficult to get financial supports from the local government and attract companies to the project.

P7) The presence of platform leadership is required to deploy selective incentives in a platform ecosystem.

Supported

Technical Platform Openness

All interviewees stated that decisions regarding platform interfaces and openness are made by Wuxin. Three interviewees from Wuxin identified three interfaces on the platform: 1) one interface for assistive device providers to connect their devices to the platform; 2) one interface for care service providers to access to services and information on the platform and 3) one interface for end users to access to and customize services on the platform [W1, W2, W3]. In other words, HSC is a multi-sided platform. The platform interfaces are based on open industry standards to encourage assistive device providers to connect different devices to the platform [W2]. Interviewees from Wuxin and Tech-Top pointed out that enabling assistive device providers to connect to the platform is critical to collect more data on the platform [TT, W3], especially in the internet era where more and more devices are being connected to the internet [W1]. The more the assistive devices are connected to the platform the more care service providers will be attracted to the platform (i.e., network effects in multi-sided platforms).

Nevertheless, the platform does not yet provide an Application Programming Interface (API) for application developers to use services on the platform and develop new applications for end-users. According to an interviewee, Wuxin will decide about APIs later when the platform is evolved and commercialized [W2].

The findings imply that by opening the platform interfaces to assistive device providers, the platform provider (i.e., Wuxin) aims to achieve a critical mass of assistive device providers in the beginning. In this way, the platform realizes direct network effects by encouraging more assistive device providers to the platform, which is critical for collecting data on the platform [TT]. In addition, the diversity of assistive devices and services positively influence the decision of care service providers to use the platform and assistive devices (i.e., indirect network effect).

P8-A) The degree to which a platform is technically open towards complementary providers influences decisions of organisations to become engaged in collective action for establishing a common service platform.
Supported

Organisational Platform Openness

While the platform is closed to application developers (i.e., no API) [W2, W3], it is open to third party service providers to access and use the platform services and data for service offerings [W1, W2, TT, BC, LV]. However, the platform is closed to applications developers to develop and offer new applications on the platform. The reason to open up the platform to different third party service providers is to address diverse customer needs [W1, W2, TT, WU]. The diversity of care service providers also results in competition around the platform [W1], which is expected to improve service quality and reduce price for customers [W1, W2].

While the platform is generally said to be open to any third party service providers to join and utilize the platform, according to most interviewees, Wuxin makes the decision about which companies can join the platform [W1, W2, W3, TT, ALV2, BC, LV]. Wuxin selects companies based on the market needs (i.e., what devices or services are demanded in the market) and the service quality of interested companies (i.e., the required service quality is included in the contract) [W2]. The selection criteria imply that the platform is not open to any new companies to join and Wuxin control the ecosystem around the platform. Wuxin also consults with Wuhan University if it is technically possible to connect certain devices to the platform (i.e., compatibility and connectivity issues) [WU]. This means that, to a certain extent, organisational decisions can also be related to technical issues (i.e., interaction effect between organisational and technical openness).

The platform is also not open to other companies to join during the development of the platform. Wuxin started the development of the platform and assistive devices with a few partners (i.e., WU, Tech-Top) that they could trust, as put by an interviewee from Wuxin [W2]. The trust was described as a mixture of interpersonal trust (personal relationships) and inter-organisational trust (reputation of an organisation). According to the interviewee, many businesses in China are established based on personal trust. Moreover, typically companies do not start collaboration with several parties, especially in the beginning of a project. While two other interviewees from Wuxin agreed that trust plays an important role in the start of a business, the project leader from Wuxin explained that only inter-personal trust does not influence collaboration.

To join the project, new partners need to sign a contract to follow a set of rules (set by Wuxin) [W1, W2, W3, TT] with regard to standards, protocols and quality of services (QoS) [W2, TT, LV]. If a partner cannot meet the requirements or customers provide Wuxin with negative feedback about devices or services, based on the contract terms Wuxin could stop working with the company [WU]. This suggests that Wuxin strictly controls quality of technical services on the platform as well as quality of care services. Such a strict authority-based governance structure has created quite strong dependencies between Wuxin and other partners (i.e., an interaction effect between interdependency and platform organisational openness). However, we did not hear from any service providers that the dependency on Wuxin reduces their willingness to participate in collective action for the platform. Figure 4.9 summarizes the findings for platform organisational openness.

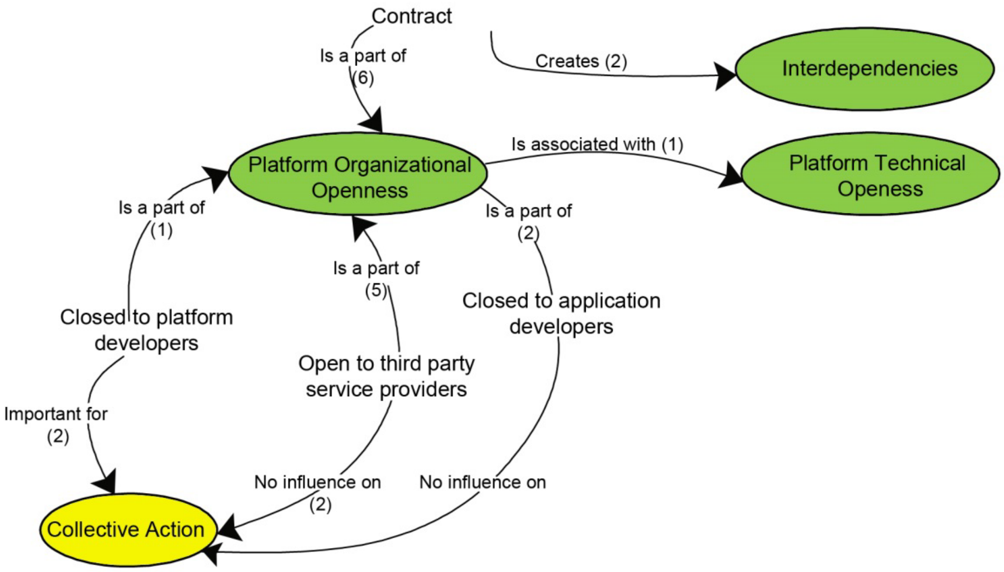

Figure 4.9 Platform Organisational Openness

With regard to the impact of organisational openness on collaboration, interviewees from service providers did not have any opposition against new partners to join the platform. One interviewee stated that he would have preferred the platform to be closed to other care service providers. However, he added that as China is quite a large market, it is impossible for one company to address the market individually and thus they do not mind other companies to join the platform [LV]. Nevertheless, participation of new platform developers in the development of the platform was not favoured by Wuxin and Wuhan University as they want to have control over the platform architecture and ecosystem. Based on these findings, we can speculate that depending on the role of organisation in the project, their preferences for openness differ. While opening the platform towards third party service providers does not influence decision of platform providers (Wuxin and Wuhan University)f or collective action, openness towards application developers can negatively influence their decisions for collaboration.

P8-B) The degree to which a platform is organisationally open towards complementary providers influences decisions of organisations to become engaged in collective action for establishing a common service platform. **Partially Supported**

Alternative explanations

From the interviews, we found that inter-organisational relationships between organisations have largely influenced their participations in the project [W2, ALV2]. The fact that Wuhan University has partially funded Wuxin and Tech-Top suggests that the organisations were actually not fully independent.

The importance of government involvement in Chinese projects should not be underestimated. The relation of main players (i.e., Wuxin and Wuhan University) with the government ensures credibility, support and approval of the government. The government involvement in the project encourages third party service providers to participate because if a project is commercialized the government selects service providers in the project. Therefore, involvement of service providers in the project from the beginning may increase their visibility and chance of being selected by the government also for other projects.

One issue that slows down collaboration with Finnish partners in this project is that Finnish assistive device providers are concerned with copyright issues in China, (i.e. they fear that their devices will be copied). To solve this, Wuxin is promoting close collaboration between Finnish assistive device providers and Chinese companies, such as Tech-Top, to develop localized products together and reach a competitive price in China. In this way, Wuxin wants to ensure Finnish partners and encourage their participation in the project. Moreover, by involving Wuhan government in meetings with Finnish partners, Wuxin and Wuhan University aim to establish trust relations with Finnish partners

These additional findings suggest that in addition to eight propositions, other factors of equity relations, connection with the government and copy right issues can explain collaboration in this project.

4.4 *West Orange*

Amsterdam Smart City foundation

West Orange is a Dutch project carried out in the *Amsterdam Smart City* (ASC) program. ASC is a foundation funded by *Liander* and *Amsterdam Innovation Motor* (AIM) (50/50) with the aim of reducing emissions by focusing on Sustainable Living, Working, Mobility and Public Space enabled by smart technology. Liander is a grid provider, a part of Alliander Network (grid) Company, and is responsible for providing and managing network infrastructure for transportation of electricity and gas to millions of households in the Netherlands. AIM aims to promote collaboration between companies, research institutions and the government to stimulate innovative and knowledge-intensive businesses. AIM is financially supported by the European Regional Development Fund (ERDF) of European Commission.

The goal of the ASC program is to enable cooperation between companies to exchange information and best practices in the areas of sustainability and energy reduction. The program consists of several projects with private and public partners. The projects are sometimes initiated or approached by ASC and sometimes ASC is approached by companies for dissemination purposes: the first holds for the West Orange project.

West Orange Project

West Orange (WO) is one of the projects under the ASC umbrella and was initiated by Nuon, IBM and Cisco. The project consisted of four phases. Here, we use the name of phases as described in the project documents.

The first phase was *Inception phase* (January until October 2008): setting up the project plan and agreeing on the “Teaming Agreement” between Nuon, IBM and Cisco (i.e., agreements on the project plan). In the beginning of this phase, in addition to the initiators, a telecom company and a technology provider were also involved (on request of interviewees, we cannot disclose the names). In the beginning of this phase, the plan was to develop a home gateway to offer a range of Smart Living services by different service providers to households. However, this plan was not carried out because partners could not agree upon who would provide the home gateway [N3]. As a result, the telecom company and the technology provider left the project and the scope was narrowed down from a Smart Living platform to a Home Energy Management platform (HEM). The objective became to develop, design and optimize technology and all the operational processes needed for a large scale roll out of HEM platforms. At this phase the project still did not have a name.

The second phase was the *Design phase* (October 2008 until September 2009): addressing technical and functional design; planning communication with stakeholders; setting out the detailed business case; planning a pilot implementation and raising funding for the pilot. During this phase, Nuon was asked by AIM to join ASC program. The project would improve visibility of the ASC program because it was a large project with large known organisations (i.e., IBM, Cisco and Nuon) [N3]. Through ASC, the project could get partial funding (48%) from ERDF for the pilot. The rest of the cost was covered by private funding of the partners in the form of cash contribution or working hours. This phase took longer than expected by the initiators because it took time to get the funding approval from the city of Amsterdam [N3]. The project officially started, with the name West Orange, in July 2009, when the funding was approved by the city of Amsterdam. Then, from July until September 2009, the design phase was completed.

The third phase was the *First wave Implementation phase* (October 2009 until March 2011). While the initial plan was to finish this phase by June 2009, it also took longer because of the delay in the previous phase and other reasons that are discussed later in Section 4.5.3. The aim of this phase was to do a pilot to verify the reliability and scalability of the technology, to survey customers' satisfaction and to test whether the usage of HEM services helped customers to save energy. Furthermore, the pilot would help partners to learn more about the operational issues of HEM service delivery for a large scale roll-out, to increase the attractiveness of the designed display based on the customer preferences and to assess the economic value of the platform. During this phase, 500 houses in Amsterdam were equipped with in-home displays, home controllers and smart meters (all parts of the HEM platform in the home). The measuring pilot program ran for almost a year to include seasonal effects on energy consumption behaviour.

After the first wave Implementation phase, the plan was to extend the functionalities of the platform and offered services in the *second wave Implementation phase* to verify the business case and the market introduction of the solution. Nevertheless, during the first wave Implementation phase, Nuon decided not to proceed to the next phase and the market (reasons are discussed later in Section 4.5.3). Therefore, the project was not commercialized with the partners in the consortium.

The provider of the in-home display (i.e., Home Automation Europe) and IBM have joint IPR with Nuon for their developed solutions in the project. Holding IPR, after the pilot, Home Automation Europe and IBM started working with new partners. Within a year after the pilot, Home Automation Europe developed and commercialized a new version of their solution (called Toon) with Eneco (i.e., a Dutch energy provider and competitor of Nuon) with an exclusive contract in the Netherlands [HAE].

In addition to the initiators (i.e., Nuon, IBM and Cisco), other partners got involved in the project during the Design and Implementation phases: Home Automation Europe (HAE), two housing Corporations (Farwest and Ymere) and Liander. The role of each partner and why new partners got involved in the project is described in Section 4.5.2 The University of Amsterdam was also involved to study users' behaviour in the project (Implementation phase).

4.4.1 West Orange Platform

The HEM platform in this project has a distributed IT architecture that consists of six parts: 1) e-wizard plugs, 2) a touch screen display with the size of a small photo frame, 3) a smart meter 4) a home controller (gateway), 5) E-thermostat and 6) a central cloud platform (See Figure 4.10).

The e-wizard is a portable plug combined with a software program that can jointly determine the actual usage of specific appliances at home and send the information to the in-home display via a z-wave connection. The display is wirelessly connected to the smart meter via the home controller. The display gives real-time insight into the overall energy consumption, the usage per appliance and insight into where energy is being wasted, for example due to standby usage. The user can also set an energy saving target (compared to the last year usage) to continuously be motivated to save energy. It is also possible to use (mobile) internet to turn appliances on/off.

The home controller is also connected to the E-thermostat at home which enables users to schedule the thermostat and control the central heating system via the Nuon portal. In addition to remote control of the heating system, the portal give advice to a user on the most energy efficient setting the user can set the thermostat.

The display transmits energy information to the central cloud platform via the home controller. The central cloud platform can be a private or public cloud depending on the requirements of the energy provider. The platform is connected to smart measuring devices connected to the internet (i.e., the smart meter, the home controller and the display) to collect, process, and report on the data on a daily basis. The customer information saved on the platform can be used for analysis by the energy provider. The cloud platform can also be extended to enable billing and call services for energy providers.

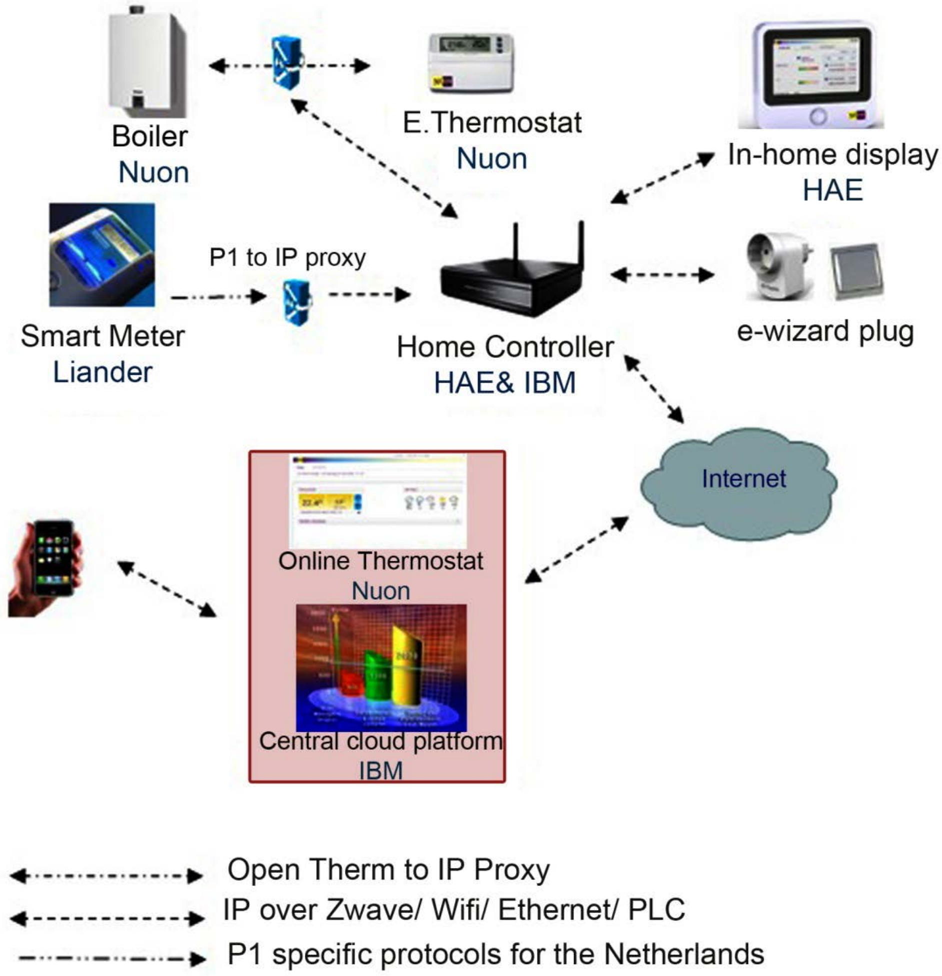

Figure 4.10 Platform Architecture (Adapted from project's documents)

The central cloud platform includes the following generic functional components:

1) **Data collection and control services**: collect and process measurements from smart devices
2) **Data warehouse services:** store and organize data for further processing
3) **Business intelligence services**: analyse the collected data and derive meaning from it
4) **Portal user access services:** Display the data to perform analysis on it (for energy providers)
5) **Service Management Tooling:** manages and maintains multitude of smart measuring devices

6) **Secure access services**: a security layer against inappropriate access from the internet.

The data on the cloud platform is sent to the corresponding system of the energy provider. The energy provider can directly access information on the platform through the portal for users' access.

4.4.2 Organisations and Roles in the Platform Ecosystem

Table 4.8 shows participating organisations and their roles in the project.

While the project initially started with Nuon, IBM and Cisco, other partners joined the project in later phases. Cisco was initially responsible for providing the display and the home controller but then Cisco was not able to deliver the gateway for the project. The interviewee from Cisco explained that the home gateway was in an early stage and not ready for the market [C1]. However, one interviewee from Nuon said that Cisco wanted to supply the home controller rather than to participate in an iterating process of developing and improving the whole solution [N3]. Because Cisco did not deliver the home controller, Cisco was asked by the partners to step down and their role became limited to consultancy on wireless technology at home (i.e., transmission of energy consumption's data between the in-home display and the internet [C1]. At the time, HAE was asked by Nuon to join the project to provide the display and the home controller together with IBM.

Nuon shares about 80% of its customers with the DSO (Distribution Systems Operators) Liander. For the First wave Implementation phase, smart meters were required and at the time the roll-out of smart meters was behind schedule, because of changes in regulations and standards of smart meters. As only the grid provider (i.e., Liander) can install smart meters at home, to proceed with the project and the pilot, Liander was asked to join the project and install smart meters in the houses for the pilot.

The housing corporations (Ymere, Far West), which are customers of Nuon, participated in the project to provide access to the households for installing smart meters and the displays.

Table 4.8 Participants and Roles

Organisations	Roles	Joined
Nuon	1) Project Initiator 2) Project management 3) Channel to the market and customers 4) In the lead for the subsidy 5) Installing displays and controllers at homes	Inception Phase
IBM	1) Project Initiator 2) Project management 3) Developing central cloud platform 4) Providing secured web services 5) Developing the home gateway together with HAE 6) Assisting Nuon in the process of the subsidy	Inception Phase
Cisco	1) Project Initiator 2) Providing know-how knowledge on wireless technology (i.e., between the display and the internet)	Inception Phase
Liander	1) Installing smart meters at home 2) Providing support services for smart meters	Implementation Phase
Home Automation Europe (HAE)	1) Developing the in-home display 2) Developing the home controller together with IBM 3) Assisting Nuon in installing displays 4) Providing helpdesk services for the displays	Design Phase
Housing corporations (Ymere, Far West)	1) Facilitating consumer selection 2) Providing access to households	Design Phase
Amsterdam Innovation Motor (AIM)	1) Knowledge from earlier projects 2) Access to larger ASC ecosystem	Design Phase
University of Amsterdam	1) Studying users' behaviour in the pilot	Implementation Phase

Figure 4.11 shows roles and resources exchanges between the partners in the project.

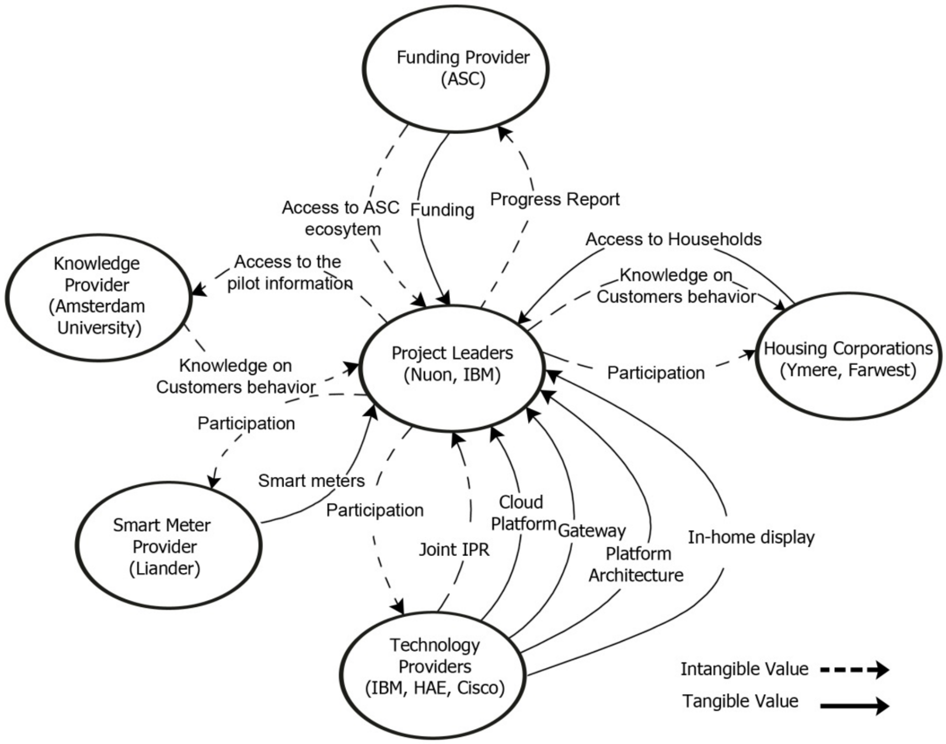

Figure 4.11 West Orange's Platform Ecosystem in Pilot phase

4.4.3 Findings

Heterogeneity of interests

Interviewees expressed different reasons for participating in the project. Table 4.9 summarizes main interests of each partner the projects.

According to interviewees from Nuon, the energy market is an oligopolistic market which is liberalized. This means that Nuon market's share is deteriorating because new entrants are coming to the market. Moreover, electricity and gas are commodity products and thus the only way energy companies can distinguish from each other is their brands and reliability. Therefore, to secure future revenue and profitability, Nuon is shifting their scope from an energy provider to 'a trusted energy advisor' which also provides value added services to their customers, including heating, installation, insulation (i.e., increasing energy efficiency and reducing heat transfer in buildings) and expert advice [N1, N2, N3]. Furthermore, Nuon wants to have a long term relationship with customers to retain the market share and differentiate from competitors in this market. One way to do this is to provide customers with home energy management solutions to help them to save energy.

Therefore, Nuon initiated the West Orange project to develop and test HEM solutions in a pilot and understand customer preferences and behaviour. In addition, Nuon wanted to gain experience and knowledge about the HEM solutions from a technical, financial and operational point of view. As the margin on electricity and gas are quite low, the project was also interesting for Nuon to see if they can modify their business model to also generate revenue in other segments (i.e., providing HEM services for their customers as value-added services).

Table 4.9 Interest Heterogeneity

Organisations	Interests
Nuon	Develop HEM platform Support sustainability and energy reduction Experiences with technologies, processes and market Understand customers' preferences and behaviour Pilot of the developed platform Shift their business model to providing value-added services
IBM	Commercial interests Support sustainability and energy reduction Experiences with the smart meter technology and processes Become a leader in the energy management field Understand customers' preferences and behaviour Pilot of the developed platform
Liander	Build a profile with customers Form strategic relations with the SMEs Support sustainability and energy reduction Prove the value of the smart meter infrastructure
Cisco	Visibility in Smart Living domain Collaborating with existing customers (i.e., Nuon) Knowledge on technologies and market Contribute to European projects Sell their solutions to energy providers
Home Automation Europe	Develop HEM platform Pilot of the developed platform Working with known companies Future business opportunities
Housing Corporations	Support reduction of CO_2 emissions Knowledge on customers behaviour Knowledge on new market models

IBM strives to be the first and in the lead for the development and deployment of Smart Living solutions, which includes energy management solutions [IBM1, IBM2, IBM3]. Moreover, IBM has interests in improving sustainability and also gaining experience with the smart meters technology [IBM1, IBM3]. However, above all, IBM is a listed company (i.e., shares are listed on a stock exchange for public trading) and had mainly commercial interests (i.e., generating revenue) in the project [IBM2, N1, N2, N3]. The cloud platform developed by IBM can be extended to provide different business processes for energy companies, (e.g., billing and call services).

According to the interviewee from Liander [L], the company as a grid provider is not known by customers and does not have a good image in municipalities because of interruptions due to installation and maintenance of cables. Therefore, Liander, was especially interested in these types of projects (also other projects under ASC umbrella), to build a profile with customers (including municipalities) and form strategic relations with the SMEs involved in the energy domain. Moreover, at the time of the project, there was a public debate on the added value of the smart meters for customers. Because the HEM platforms provide added value to the smart meters and thus increase societal impacts of the smart meters, Liander was also interested in the project to prove the value of the smart meter infrastructure.

One interviewee from Cisco said that visibility in the energy field, collaboration with existing customers (i.e., Nuon in this case) and contributing to European projects have been their main intentions to be involved in the project and other similar projects [C1]. Similarly, two interviewees from Nuon also explained that building their brand and visibility in smart city type of initiatives were the main reasons for Cisco to become involved in this project and any other possible projects in this field [N1; N3]. Another Interviewee from Cisco added that knowledge and experiences on technologies and market were important reasons for Cisco to participate in the project. Moreover, he said that transformation towards smart meters and smart grid in the energy sector will require IT. Therefore, Cisco as an IT organisation would like to bring value to this new area and if the project scales up, there is an opportunity for Cisco to sell their solutions to energy companies [C2].

For HAE as a start-up SME in the energy market, the project was an opportunity to develop their technology further and to test it in a large pilot. Moreover, working with large companies in the project was important for them to grow their future business [HEA1].

The project was interesting for the housing corporation to reduce CO2 emissions and help their customers to reduce their energy bills especially because most of their customers are from the low-income group. Moreover, they were interested in gaining experience and knowledge with new techniques and market models [IBM1, N1, HAE].

Looking at the interests expressed by the interviewees, there are many shared interests between the partners (e.g., gaining experience with the technology and market; knowledge on customers preferences and behaviour). The similarity of interests implies that interests of parties were aligned to some extent. However, there were also contradictory interests among the participating organisations. For instance, while IBM and Nuon both expressed interests in understanding customers' preferences and gaining experiences through the pilot, IBM as a listed company (serving its shareholders) "*would never step into a pilot project, if there is no perspective on making revenues*" [IBM2]. Apparently, the commercial aspect of the project was more central for IBM than Nuon.

While Nuon initially intended to commercialize the solution, during the pilot they decided not to go for commercialization because of two main reasons: 1) Delay in the pilot phase: as an energy provider with direct contact with customers, Nuon wanted to first ensure that the technology and processes around it will work and then they could decide about the commercialization. However, because the project took longer than expected and the market and technology were moving fast, Nuon decided not to wait for the results of the project and started another HEM project with Philips, which also did not work at the end [N1]; 2) Strategic fit and avoiding redundancy: during the project Nuon was going through a reorganisation (i.e., Nuon was becoming a part of Vattenfall) and there was uncertainty in the organisation. The representatives of Nuon in the project were waiting to learn if the project fits with the strategies of Vattenfall. Moreover, Nuon wanted to avoid redundancy, as it was unclear if Vattenfall was working on similar platforms [N3]. For these reasons, already in the pilot phase Nuon acknowledged that they may not commercialize the end result, while IBM still had commercial interests in the project [N3, IBM3].

Despite the mismatched interests between Nuon and IBM, interviewees did not discuss any conflict in the project. One interviewee from Noun put that *"conflict is a big word; I don't think that we really had conflicts but of course we had some tough discussion sometimes about the continuation of the project and the way we needed to continue*" [N2]. Another interviewee from Nuon said that *"these companies (i.e., IBM, Nuon, Cisco, Liander) are highly professional […] and the guys involved in the project are professional business developers and politically known. So, if there is a conflict, it will never come on* *the surface"* [N3]. This implies that unless there is a highly critical issue, they will strive not to disclose their conflicts and try to resolve it politically.

As put by most interviewees, in the *Inception Phase*, partners had a shared common goal (i.e., developing a HEM platform). Differences in their interests and expectations (e.g., gaining experience versus commercial benefits versus market visibility) from the project became evident in the later phases of the project. According to the documents of the project, even Nuon as the provider of the platform and services to end-users was initially interested in commercializing the solution as they were planning for the *second wave Implementation phase*. The findings show that interest heterogeneity was not apparent in the beginning and thus did not influence initial decisions' of the organisations about participating in collective action. Nevertheless, interest heterogeneity became noticeable in later phases of the project (i.e., design and first wave implementation) and hampered continuance of collective action for commercialization of the platform. According to interviewees, the project was a lesson learned for partners to ensure goals and interests clarity in the start of any project [N1, N2, IBM3]. Since our main interest is to explain the start of collective action, we conclude the following:

P1) The interest heterogeneity in a platform ecosystem negatively influences decisions of organisations to become engaged in collective action for establishing a common service platform.

Not Supported

Heterogeneity of Resources and Interdependency

Figure 4.12 shows the findings for resource heterogeneity in the project.

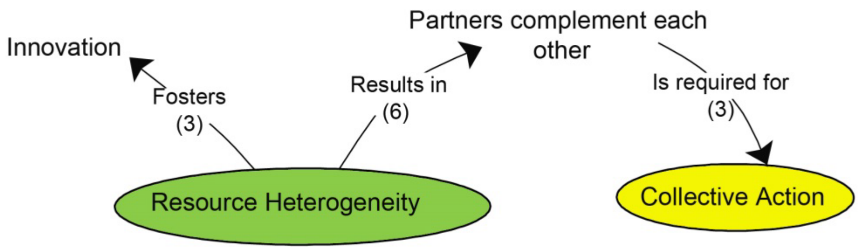

Figure 4.12 Resource Heterogeneity

A majority of interviewees put that the project consisted of a heterogeneous network of partners with different resources that were complementing each other [IBM1, IBM2, IBM3, N1, N2, L]. One interviewee from Nuon explained that each partner brought in expertise and knowledge that others did not have [N1]. Two interviewees from IBM added that there were different functional areas that needed to be covered and for each part a partner who has experience in that area was needed [IBM1, IBM3]. Three interviewees put that resource heterogeneity is required to enable this type of projects [N1, IBM1, IBM2]. One interviewee from IBM elaborated that *"I think a variety of organisations and companies, whether B2B or B2C, technically oriented, organisationally oriented or marketing oriented […] are required in the consortium to be successful. If you had only technical companies like Cisco and IBM which are B2B, I'm not sure if something nice comes up. I think a mixture type of organisations like small, large, technical, customer faced, international and local would be better."* This quote implies that it is not just the technical resource of partners that matters. In fact, organisational resources such as customers, capital assets and inter-organisational relations of an organisation are equally or even more important in this type of projects.

The resource heterogeneity was also discussed as an important factor to foster innovation in the HEM domain [IBM1, IBM2, IBM3, N1, N2, L] because each company has experience and knowledge about one or two parts of the total solution but not all [IBM3]. Therefore, the companies could enrich each other and bring something new together: *"it was a combination of various skills and strength that eventually led to this innovation (i.e., platform). I think none of us could have done it on our own*" [N3].

In general, interviewees discussed that in the presence of resource heterogeneity in the platform ecosystem, the partners could access complementary resources of each other to fulfil their goals (i.e., the project's goal and individual goals) and thus resource heterogeneity in the platform ecosystem has encouraged their participation in the project. One interviewee from IBM put that *"if either one of us would not have been there, the project was not possible"* [IBM1].

P2) The resource heterogeneity in a platform ecosystem positively influences decisions of organisations to become engaged in collective action for establishing a common service platform. **Supported**

According to most interviewees, each partner provided parts of required resources for the platform (e.g., in-home displays by HAE, central cloud platform by IBM, smart meters by Liander, customers by housing corporations, marketing and sales by Nuon). Therefore, the partners were dependent on each other's resources to provide the final platform solution for customers. For instance, on the one side, Nuon needed IBM's resources (i.e., hardware, software and IT architecture for the central platform) to provide the HEM platform for their customers. On the other side, IBM needed Nuon's customers' data to do the analysis [IBM2]. This indicates that resource heterogeneity in the platform ecosystem also causes interdependencies between partners during the project.

P3) The resources heterogeneity in a platform ecosystem causes interdependencies in the platform ecosystem.
Supported

Interviewees discussed two types of resource interdependencies between partners in the project: *Interdependencies for technical resources* and *interdependencies for organisational resources*. Interdependency for technical resources includes mutual needs of partners for technology and knowledge of each partner. Technical interdependencies were discussed as important for collective action and the platform development as companies complemented each other's resources for the platform development [IBM3, N1]. Nevertheless, most partners in the project could have been replaced with companies providing similar technologies or knowledge [IBM1]. Therefore, it can be speculated that technical interdependencies have not been very influential in decisions of organisations to participate in collective action.

Interdependency for organisational resources, on the other side, was found critical for companies to become engaged in collective action. Organisational resources include brand, position and reputation of an organisation in a field. One interviewee from Nuon put that Nuon has a top brand in the Netherlands and thus strategically Nuon is an interesting partner for IBM or Cisco to collaborate with in the HEM field. He added that the need for such organisational resources have been very influential in the start of collaboration in this project [N3]. This finding implies that the decision for collective action can be more influenced by dependency for an organisation's brand, customers or position in the market than for technology or knowledge.

In addition to technical and organisational interdependency, interviewees discussed a third type of interdependency in the project, i.e., financial interdependency. An interviewee from Nuon explained *"we were sometimes too dependent on the subsidy. We needed the subsidy and then we needed to do all the things [related to the administration] around it* *otherwise we couldn't get the money"* [N2]. Unlike technical and organisational interdependency, financial interdependency for subsidies is for accessing third party's resources (i.e., governmental funding). As the partners should continue collaboration to receive the subsidy, it can be posited that the financial interdependencies for the subsidy caused collective action to continue for the pilot even though Nuon already knew that they are not going to commercialize the products [N1, N3]. However, interdependency for subsidies in this case appeared once the project had already started. Moreover, according to an interviewee from Liander, interdependency on subsidies does not guarantee the outcome of collective action as many projects stop once the funding is over [L]. Therefore, financial interdependencies in the platform ecosystem did not influence the initial decision of companies to participate in collective action. Nevertheless, the findings on organisational interdependencies suggest that organisational resources of the partners are the main source of interdependencies in the platform ecosystem and have initially influenced the decision of companies to participate in collective action.

P4) The interdependencies in a platform ecosystem positively influence decisions of organisations to become engaged in collective action for establishing a common service platform.
Supported

Platform Leadership

According to all interviewees, the organisational setting in the project consisted of a steering committee (with the highest level representatives of IBM, Nuon, Cisco, Liander, Ymere and Far West in the Netherlands) with equal votes to make strategic decisions for the project. In fact, the project was organized in a decentralized way. In addition to the steering committee, there was a project management team for daily technical and operational processes in the project, including resource mobilization, design and development of the platform, public relations (PR), subsidy and cost calculations, pilot process design and research setup. The project team was also responsible for providing proposals and arguments to facilitate decision making by the steering committee [N3, IBM2].

IBM and Nuon were leading the project team because they had required resources to coordinate the project. Nuon was in the lead for the marketing part of the project and IBM was coordinating the project and communication among the partners [IBM3, N1, N2, N3].

More specifically, Nuon was the main contact with city of Amsterdam to get the subsidy and IBM assisted Nuon in managing the administrative process related to the subsidy [N3, HAE]. In addition, they were both in the lead to organize all the steps necessary to recruit participants in the project, i.e., finding customers willing to participate, installation of displays at home and to get customers to answer questionnaires. IBM and Nuon were also responsible for providing information for the steering committee for decision-making [IBM2; N3]. Considering efforts required for all these tasks, one interviewee explained that *"if Nuon and IBM had not taken that role, the project would have probably failed"* [N1].

Most interviewees believed that the leaders played an important role to push the project further [N1, IBM2, IBM3, L]. According to an interviewee from Liander, leadership is essential to control the project and ensure that parties are committed to their roles and to solve any issue before it misleads the project in a wrong direction [L]. Moreover, dealing with daily issues in the projects and making right and timely decisions are other important aspects of leadership [IBM3]. Nevertheless, a number of interviewees criticized leaders (especially Nuon) for being slow in the process of decision making in the project. One interviewee put that, the long process of decision making delayed the project for almost a year [HAE]. Another interviewee from IBM put that it was IBM who was pushing Nuon in the project. Interviewees discussed that typically decision making in large organisations takes longer than in small companies [IBM2, N2, TNO, C1]. One interviewee from IBM explained why Nuon was not very fast in the project. According to the interviewee in this type of projects *"if something goes wrong technically or just one customer's data ends up somewhere wrong, then the risk for Nuon is huge"* [IBM2]. Therefore, these types of risks, which are higher for large known organisations such as Nuon, can influence the pace of decision making in collaborative projects. In addition to the risk, the reorganisation in Nuon was another underlying reason for the delay caused by Nuon, because Nuon's representatives were waiting to see what the Vattenfall's strategy was in the field of HEM [N2].

The delay in the project was not merely due to the leadership of Nuon as two other reasons also delayed the project: 1) it was difficult and time consuming to align the interests and processes of many partners in the project [HAE, IBM3, N2] 2) the roll-out of smart meters was delayed because of changes in regulations and standards. Despite the delays in the project, most interviewees found the resources of Nuon and IBM (i.e., access to customers and market and arrangement of the subsidies) and their roles as necessary to facilitate collaboration in the project. Specifically, an important resource of organisations in collaborative projects is their representatives [N1, N2, N3, TNO, IBM2]. Having dedicated people as representatives was found especially critical for leading organisations as committed and enthusiastic people can significantly influence the progress of the project [N2, N3, TNO]. According to interviewees, initial representatives of IBM and Nuon have been very passionate and dedicated to the project which has been very influential to encourage companies to become engaged in the project [HAE, N2, N3, IBM2].

The findings from interviews show that Nuon has played an important role in initiating the project, inviting and convincing other organisations (through dedicated representatives) to participate in the project. Moreover, after initiating the project, Nuon together with IBM played a central role in coordinating the project and reaching consensus among partners (e.g., by providing required information for the steering committee).

P5) Platform leadership in a platform ecosystem influences decisions of organisations to become engaged in collective action for establishing a common service platform.
Supported

Selective Incentives

The ERDF provided a partial funding for the project (48%) and the rest of the funding was privately contributed in forms of cash contributions or working hours from the partners in the project. When we asked interviewees about the importance of funding in influencing their decisions to participate in the project, they held different opinions. On the one side, the subsidy was found very important and encouraging to get the project started as the project required quite large amount of money (i.e., about 2 million Euros) [N1, N2, IBM2, IBM3]. One interviewee from IBM put that *"without subsidies we wouldn't have started the project because the subsidy was a significant part [of the costs] and it was already quite a large investment that IBM needed to make, including the subsidy".* He added that *"the investment would have been higher without the subsidy and I don't think that I would be able to get it approved by IBM management. It gave us the last push that we needed and it also kept the reliability and the risk lower for IBM"* [IBM2].

On the other side, four interviewees discussed that subsidies are not really stimulating collaboration [HAE, C2]. For HAE, the subsidy was not important because even though they were paid for the implementation of the software, they still had to invest in the hardware (i.e., home controller). Therefore, funding has not been encouraging for them to become engaged in the project. In fact, being able to participate in a large pilot to test their system has been the main stimulus for HAE [HAE]. Also, larger organisations, such as Cisco, did not find funding important for their participation in the project because the prospect of the project in terms of gaining knowledge and future commercial opportunities have been much more important for them and they would have participated in the project even without any funding [C2]. However, based on the project's documents, Cisco's share of fund was quite small which is reasonable as they have not been largely investing in the project. Therefore, it can be speculated that the funding has been important for the organisations which have been investing largely in the project (i.e., Nuon and IBM).

A number of interviewees were concerned with the administration of subsidies which takes time and efforts [IBM3, N1, N2, HAE]. Another interviewee added that cash flow is not always aligned with the project and sometimes the money is received after the project is finished [L]. Therefore, small companies cannot rely on the money from the subsidy. One interviewee from Liander also discussed that administration organisations for subsidies are more concerned about the preciseness of the procedure. He added that subsidies' organisations are not result oriented and many projects are paid to make a good administration [L].

After all, it was also discussed that subsidies increase reliability and reduce risk for companies, especially when starting new developments and markets [IBM2, IBM3, TNO]. An external expert from TNO explained that sometimes the government needs to support and kick start a new market because otherwise it will not become a viable market on its own (due to high costs and uncertainties). Figure 4.13 summarizes the findings about selective incentive in this project.

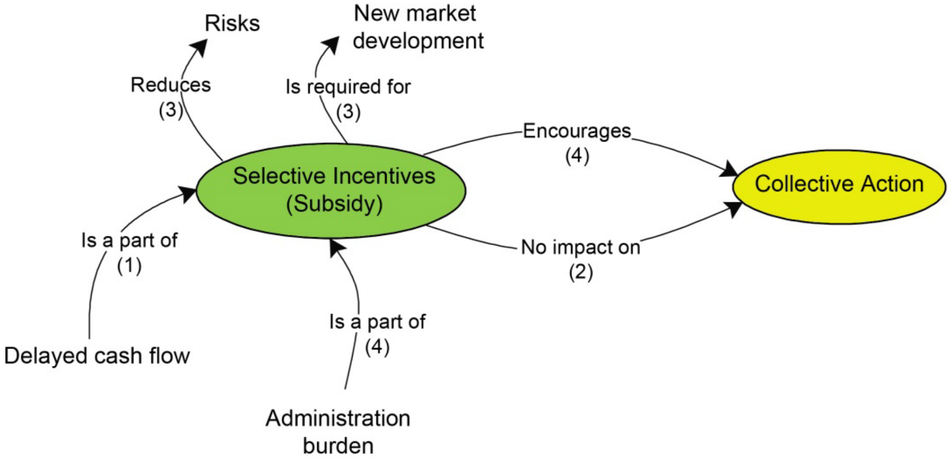

Figure 4.13 Selective Incentives

The findings show that the importance of subsidy depends on the investments of organisations in the project. For large organisation, such as Nuon and IBM, the subsidy was found important to reduce risk of their large investments in the project and to increase reliability of the project. Nuon and IBM had a large share of the subsidy comparable to their investments in the project. For companies such as HAE or Cisco, which has no or little share of the subsidy (and also investment), the subsidy was not influential on their participation in the project.

P6) The presence of selective incentives in a platform ecosystem positively influences decisions of organisations to become engaged in collective action for establishing a common service platform.
Partially Supported

According to an interviewee from IBM, during the initiation of the project by IBM, Nuon and Cisco, Nuon was invited by AIM to join ASC. Then, Nuon realized that they could apply for the subsidy from EU for the pilot. When the subsidy was approved, Nuon was the main contact with the municipality of Amsterdam (via AIM) for the subsidy's stream in the project [N1, N2, N3, IBM3]. In fact, the municipality of Amsterdam was providing Nuon with the subsidy which was then paid out to the other parties participating in the project. IBM was also assisting Nuon with the management of the subsidy processes in the project. The findings show that the leadership team has played the role in providing selective incentives (i.e., funding) in this project.

P7) The presence of platform leadership is required to deploy selective incentives in a platform ecosystem.
Supported

Technical Platform Openness

Interviewees discussed two aspects of platform technical openness: 1) Application Programming Interfaces (APIs) for the in-home display and 2) Communication interfaces between different parts of the platform.

Regarding APIs of the in-home display, an interviewee from HAE said that there is no APIs for application developers to interact with the display. The interviewee explained that Nuon was the customer of the display and because of security and privacy issues Nuon did not want developers to develop applications for the display [HAE]. According to the project's documents, there have been discussion between the partners about technical openness of the display and even how providing open source software can stimulate innovation around the display. However, the final decision was to have no APIs for the display. The main reasons were: 1) Nuon was concerned about privacy issues and 2) Nuon wanted to merely provide the in-home display as a value-added service to their customers [IBM3].

According to two interviewees from Nuon, the APIs of the display were closed because: 1) the question of API's openness was too early for the project as the technology was immature at the time (i.e., technology was changing and evolving), 2) the main focus of the project was to develop and test the display itself and 3) at the time of the project, openness was not very common and most platforms were proprietary [N1, N2]. An expert from TNO put that HEM is a relatively new field and many interfaces are still in their definition phase. Therefore, concerns about openness are expected by platform developers and energy companies [TNO].

An interviewee from HAE, who developed the display in this project, considered openness (in terms of open APIs) as a stimulus for innovation. From the perspective of the developer of the display (HAE), there are five reasons (i.e., technical, organisational and economic) why APIs of the display are currently closed: 1) the technology is immature and can be copied; 2) governing relations with developers is costly for a small start-up company like HAE; 3) there is not a critical mass of customers to attract developers and generate revenue; 4) opening the platform (display) during the development would have slowed down the process as there are more parties involved. Therefore, opening the APIs of the home display was not favoured by HAE. However, the interviewee added that they consider opening up the APIs once the display is mature and has a critical mass of customers.

The second perspective on platform openness was about communication interfaces between different parts of the platform architecture. Most interviewees discussed that security and robustness of architecture (in the house) is critical for HEM services and any malfunctioning can damage the reputation and the business case. Therefore, during the Design phase, there has been a lot of discussion on what communication standards should be used and if it can be based on open standards [N1, N2, N3, L]. The aim of the project was to enforce open standard communication interfaces between different parts of the platform and avoid proprietary protocols. One of the interviewees from IBM said that *"if you only allow [the platform] to communicate with certain devices then you narrow your market* *too much"* [IBM2]. Therefore, using proprietary communication technologies could have narrowed the range of devices communicating with the display and the platform. At the end, Wi-Fi was used between the display and the home controller because at the time it was only possible to make a secure VPN connection with Wi-Fi [N2]. Communication between the E-thermostat and switching plugs with the home controller was via Z-wave (i.e., a European communication standard for home automation).

In addition to communication interfaces at home, IBM also invested heavily in their cloud platform to make the platform based on open standards: 1) to be able to link the platform to systems of other energy companies or technology providers and 2) to build a community around their platform [IBM2, IBM3]. Figure 4.14 summarizes the findings for platform technical openness.

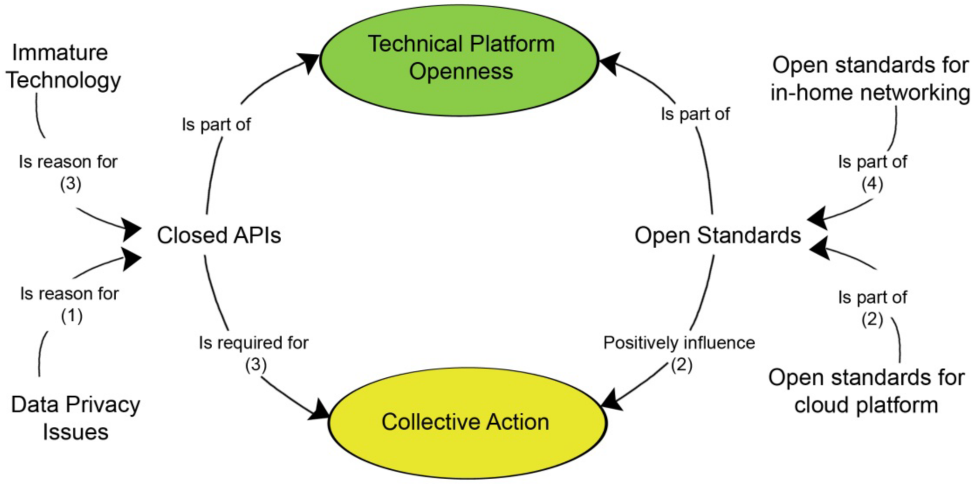

Figure 4.14 Platform Technical Openness

The findings show mixed impacts of platform openness on collective action. The findings suggest that open APIs for the display are not plausible for energy provider (i.e., Nuon) and the display developer (i.e., HAE) because open APIs may compromise data privacy of Nuon and revenue model of HAE respectively [N1, N2, HAE]. Therefore, Nuon and HAE would have not participated in the project if the APIs were open. However, platform openness in terms of using open communication standards seems to positively influence decisions of organisations to participate in the project because using open standards enables easy communication between different parts of the platform architecture (i.e., in-home display, e-wizard plugs, home controller, and thermostat) [N1, N2, N3, IBM2, L]. Moreover, once the platform is developed, open standards reduce barriers for new appliance or device providers to connect their devices to the display. As a result, the ecosystem around the platform will continue to grow.

> *P8-A) The degree to which a platform is technically open towards complementary providers influences decisions of organisations to become engaged in collective action for establishing a common service platform.*
> **Supported**

Platform Organisational Openness

All interviewees put that the project was organisationally closed (i.e., new partners could not join the project) because of different reasons. The first reason was that for the project with a large investment (around 2 million Euros), it is difficult to open it to new parties, especially because of legal requirements for the subsidy [HAE, N2]. For instance, to get the subsidy from the EU, the project had to be comprised of group members that have started the project. Therefore, as put by an interviewee from Nuon, *"it is not really easy to bring in new parties and sign new agreements"* [N2].

Beside the limitations with regard to the subsidy, four interviewees from IBM and Nuon argued that there was no need for new partners in the project [IBM1, IBM2, N1, N3]. An interviewee from Nuon explained that *"first we started with a lot of ideas, and then we had a clear direction and project plan and budget and clear output and Memorandum of Understanding (MoU). So, the project was quite directed towards the envisioned output. It was focused and resources were there, so we did not need a new partner"* [N3]. Another interviewee from IBM put that *"if a company would functionally contribute and could provide pieces of the puzzle, we would have let them join. But we didn't need another retailer or another screen provider"* [IBM1]. This also implies that the consortium was organized in such a way to avoid competitors.

However, according to the same interviewees there were legal agreements that when a new resource or function is needed, new parties could join; not to mention that the procedure to involve a new partner was very strict [IBM3]. For instance, Liander and HAE were the parties who joined the project after it was initiated by IBM, Nuon and Cisco. Liander joined the project because the project depended on the roll-out of smart meters and at that time the roll-out of smart meters was delayed. In order to speed up the pilot, the grid provider (i.e., Liander) had to be involved to install smart meters at homes because smart meters belong to the grid provider and legally only the grid provider can install the meter at home [IBM2, IBM3, N1, N2, N3, HAE]. HAE joined the project because Cisco did not provide the display and the home controller. Therefore, there was a need for a company to provide the display and home controller [IBM2, N3].

Three interviewees from Nuon and IBM also discussed that involvement of more parties usually creates complexities in coordination and alignment of interests. Moreover, new partners usually want to make investment which requires new agreements and contracts for roles, investment and the share of subsidy in the project [IBM2]. According to interviewees, the project was already quite complex with the existing partners [N1, N2, IBM2, HAE].

When we asked interviewees about the degree of formalization in the project, there were different opinions. While interviewees from IBM and Nuon said that there were formal contracts and agreements between partners in the project describing roles and responsibilities of all different parties, the interviewee from HAE stated that the relations were not formal and *"were mainly based on trust"* [HAE]. The cause of such different views was explained by an interviewee from IBM. He explained that initially the formal contract (i.e., Teaming Agreement in the Inception Phase) was between Nuon, IBM and Cisco. When the role of Cisco in the project changed, a provider for the display was needed. At this time, HAE was approached by Nuon and IBM as a supplier for the display and thus HAE never signed the consortium contract [IBM2]. However, we found in project's documents that there have been agreements (but not formalized) between Nuon and HAE containing general principles referring to the joint development of HEM products and services for the European market. As such, HAE has not been merely a supplier and they were involved in the iterative development process.

Two interviewees from IBM said that after the pilot was done there were joint IPR agreements between HAE, IBM and Nuon [IBM3, HAE]. Based on the agreements, IBM and HAE have IP right for the part they have developed in the project and they can reuse it in their future development or collaboration with other companies. It can be interpreted that IPR complexities has been another reason for keeping the project formal and closed to new partners. Figure 4.15 shows a summary of findings for organisational openness.

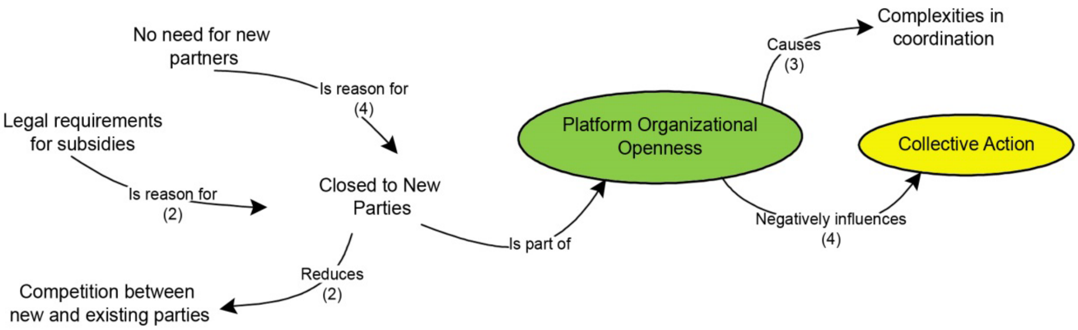

Figure 4.15 Platform Organisational Openness

The findings suggest that opening the project to new partners would have negatively influenced decision of the parties to participate in the project because 1) by opening the project to new companies, competitors may enter the project, which is not in the interests of the partners, 2) bringing in new partners increases the group size which in return increases complexities of IPRs, subsidies arrangement, alignment of interests and division of roles and investments in the project. Dealing with these issues may cause delays in the project which is not acceptable for the participating organisations. It can be speculated that organisational openness also depends on type of new partners and the phase of the project. While the partners were sceptical about accepting new members (as platform providers or developers) in the development phase of the project, if the platform became commercialized, the partners might have been willing to open up the platform to third-party service providers for complementary services and applications. Nevertheless, under certain conditions (i.e., need for a resource or changing roles in this case) new partners were able to join the project during the development phase.

P8-B) The degree to which a platform is organisationally open towards complementary providers influences decisions of organisations to become engaged in collective action for establishing a common service platform.

Supported

Alternative explanations

Other than findings for propositions, we found other explanations for collaboration in this project. One issue mentioned by an interviewee from IBM was the lack of trust from Nuon side [IBM2]. The interviewee explained that collaboration needs mutual trust. However, in this project, Nuon thought that IBM is focused too much on commercial aspect of the project while Nuon was concerned with the potential risk of the technology and platform [IBM2, N1]. This issue was one of the reasons for Nuon to hold back from proceeding with the project for commercialization. Although initially Nuon started collaboration with IBM in the project, the lack of trust disrupted the continuance of collaboration.

Two interviewees discussed that the market was new and immature and the technology (for smart meters and HEM solutions) was changing very rapidly while decision making to adapt to new technology took long [HAE, N1]. As a result, the final product was not ground breaking and in the middle of pilot phase, Nuon started another HEM project with Philips which also did not lead to commercialization [N1]. From this finding, we can speculate that being the first in providing a ground breaking technology is an advantage and may encourage organisations to participate in collective action. Nevertheless, immature rapid changing technology creates uncertainties, which may cause discontinuance of collaboration.

A number of interviews argued that with current technology there is no business case for HEM solutions. They explained that the level of influence of HEM solutions on households energy consumptions is too small and do not lead to significant energy reduction [IBM2, TNO]. Therefore, these services are merely a means for new energy companies to differentiate in the market and attract customers. Nevertheless, one interviewee added that there are potential business cases for commercial market and small businesses which pay high energy bills [IBM2]. From this finding, it can be speculated that perhaps the potential business case has not been significant enough to encourage Nuon to continue collaboration and commercialize the solution. However, Nuon started collaboration in the project to be active in this field, gain experience with technology and acquire knowledge about market and customers' feedback.

Finally, interviewees discussed difficulties in managing and coordinating parties in large groups. Although the project was meant to be done with initiators (IBM, Cisco, Nuon and housing corporations) later HAE and Liander joined the project and the group became larger. As a result, we heard from interviewees that dealing with aligning requirements of all parties, arranging meetings and administration of the subsidy were taking a lot of effort and time [HAE, N2, IBM3]. One interviewee put that they learnt from this project to be more critical in partner selections in future projects and start this type of development project with a smaller number of parties [N2]. From the findings, we can conclude that organisations preferred to start collaboration in a small group of parties. Nevertheless, the group size grew because of requirements in the project, which led to several difficulties and discontinuance of the project.

4.5 *Cross-case Analysis*

Table 4.10 shows a summary of factors and their impacts on decision for collective action..

Table 4.10 Summary of factors and impacts on collective action in each case

Factors	**Impact on decision for collective action**		
	Active Life Home	**Home-Based Senior Care**	**West Orange**
Interest Heterogeneity	ø	ø	ø
Resource Heterogeneity	+	+	+
Interdependency	+	+	+
Leadership	+	+	+
Selective Incentives	+	+	ø/+
Technical Openness	+	+	+/-
Organisational Openness	-	-/ø	-

(ø Neutral; + Positive; - Negative)

For the three factors *selective incentives*, *platform technical openness* and *platform organisational openness*, we found different impacts within cases. Although the table only shows how each factor influences decisions of organisations to become engaged in collective action (i.e., neutral, positive or negative impacts), the case studies revealed more details about factors in each case. In this section, we discuss and compare details across the cases. Table 4.11 summarizes the findings for each factor and sub-factors identified in the case studies.

Table 4.11 Summary of Findings in case studies

Factors	**Sub-factors**	**ALH**	**HSC**	**WO**
Interest Heterogeneity	Similar Interest (Common goal)	+	+	+
	Dissimilar interests	ø	ø	ø
Resource heterogeneity	Technical resource heterogeneity	+	+	+
	Organisational resource heterogeneity	+	+	+
Interdependencies	Technical interdependencies	ø	+	ø
	Organisational interdependencies	+	+	+
Selective Incentives	Funding	+/ ø	+	+/ ø
	Competitive edge	+	NA	NA
	Well-reputed partners	NA	+	NA
Platform Leadership	Non-profit organisation as platform leader	+	NA	NA
	For-profit organisation as platform leader	NA	+	+
	Centralized decision making	NA	+	NA
	De-centralized decision making	+	NA	+
Technical Platform Openness	Open industry standard interfaces	+	+	NA
	Open Application Programming Interfaces (APIs)	NA	NA	-
	Open communication standards	NA	NA	+
Organisational Platform Openness	Open to platform developers	-	-	-
	Open to device/service providers	+	+	+
	Open to application developers	NA	NA	-

(ø Neutral; + Positive; - Negative; NA Not Available)

Interest Heterogeneity

In all cases, *interest heterogeneity* was not recognized at the time when organisations were deciding to become engaged in collective action. Therefore, interest heterogeneity did not influence decisions of organisations on participating in the project. From the findings, it can be speculated that while organisations were initially interested in working on innovative solutions such as E-healthcare or home energy management, they did not have a clear idea of which gap to fill. Therefore, most organisations tend to start collaboration for a common goal, i.e., developing a common service platform, and then see how each one can contribute and fit in. This was especially the case in the *ALH* and *HSC* projects, where actors initially got involved because they were interested in the basic platform concept. Nevertheless, later interest diversity among partners became evident (e.g., research versus commercial interest in the *ALH* case). While the *HSC* project proceeded to the pilot phase, the *ALH* project stopped after the development was done because 1) Aalto University could only provide the prototype of the platform and as a research organisation they could not offer support services for the platform and 2) the leader, Active Life Village - a non-profit organisation, encountered financial problems while carrying out the pilot. Moreover, Active Life Village could not find a commercial player to substitute Aalto University for the platform development and support services.

Another aspect of interest heterogeneity is that while actors may initially come into certain agreements about their interests and roles in the project, uncertainties involved in new innovative fields tend to influence their interests over time. For example, in the *WO* project, initially partners knew their roles and expectations from the project. However, as a result of issues, such as delays in the project, uncertainties in technologies (because of rapid technological changes) and changes in the organisation’s strategy (i.e., re-organisation in Nuon), the platform leader, Nuon, lost their interest in commercializing the project and decided to stop the project after the pilot phase.

Overall, we found that interest heterogeneity would not influence the decision of organisations to become engaged in collective action because in new innovative fields, organisations are basically interested in the concept of a project and may not be aware of their conflicting interests in the beginning. Nonetheless, as they become involved and face uncertainties during the project, they tend to lose interest or realize contradictory interests in the platform ecosystem.

Resource Heterogeneity and Interdependency

Resource heterogeneity in all cases positively influenced decisions of organisations to become engaged in collective action generally because: 1) no single party had all resources (i.e., technical and organisational resources) for platform development and 2) having partners with complementing resources (rather than comparable resources) reduces competition between partners, which in return encourages collaboration in the platform ecosystem. Therefore, in all cases organisations were interested to collaborate in projects involving partners with complementary resources. Additional to the proposition targeting the impacts of resource heterogeneity on collective action, we found in the *WO* case that resource heterogeneity is also important to foster innovation as innovative projects require not only different resources but also perspectives of partners from different fields.

Resource heterogeneity also caused *interdependency* between partners in all the cases as partners needed technical (i.e., technology and knowledge) and/or organisational resources (i.e., strategic inter-organisational relations, brand, position and access to customers) of each other to provide the platform. Although the degree of interdependency for technical resources was low in all cases (i.e., partners were replaceable), we found that the interdependency for organisational resources initially encourages organisations to become engaged in collective action. For example, in the *ALH* case, partners were dependent on relations of the leader, Active Life Village, with the municipality of Espoo, i.e., a potential customer for the platform. In the *HSC* case, partners were dependent on the leader, Wuxin, and Wuhan University for their relations with the government, which also suggests that partners in the project are dependent on the government. In the *WO* case, the brand, position and customers of the initiator of the project, Nuon, were found important for other partners to become engaged in the project.

The findings suggest that organisational resources are harder to be substituted rather than technical resources. Therefore, interdependency for organisational resources of other partners positively influences the decision of an organisation to become engaged in collective action. Interestingly, in all cases, critical organisational resources were held by the leader(s) of each project. Apparently, organisational resources of leaders or initiators of a project are important to initially stimulate organisations to take part in the project.

Platform Leadership

In all cases, the presence and strategies of *Platform Leadership* positively influenced decisions of organisations to become engaged in collective action. In all cases, platform leaders were actors who initiated the projects, provided selective incentives (e.g., applied for funding, promoted a strategic vision of having a common service platform for partners, brought in well-reputed partners) to attract organisations to the project and coordinated communication between parties in the projects. However, the cases differ from each other in terms of the type of leading organisations (i.e., non-profit versus for-profit leaders) and decision-making processes (i.e., centralized versus decentralized decision-making).

In the *ALH* case, Active Life Village as a non-profit organisation did not have any interests against those of partners in the project and thus created a trustworthy environment for interested organisations to join. Moreover, Active Life Village decentralized the decision making process for the project to involve all partners in decision making on the platform technology and the ecosystem. Such strategies were found important for organisations to become engaged in the project. Nevertheless, because Active Life Village lacked financial resources to support the pilot, the project stopped for one year after the development phase until Active Life Village was transformed to a commercial organisation to proceed with the project. Therefore, while a non-profit organisation can positively influence decisions of organisations to initially become engaged in collective action, a non-profit organisation may lack financial resources to ensure continuance of the project and collective action.

In the *HSC* case, Wuxin, a commercial start-up organisation, as the platform leader make most of the decisions with regard to the platform technology and the platform ecosystem (i.e., centralized decision-making). From findings on the case, it appeared that Wuxin exerts control over the project and partners and has a dominant role in the platform ecosystem. Compared to Active Life Village in the *ALH* case, Wuxin had financial resources to continue the project from the development to the pilot phase. This suggests that financial resources of a platform leader compared to other organisations in the platform ecosystem may influence the leader’s relation with partners, especially with regard to having authority in the project.

In the *WO* case, IBM and Nuon as for-profit organisations were in the lead for organising the project. Unlike the *HSC* case, the decision making process in *WO* was decentralized and partners in the steering committee (i.e., Nuon, IBM, Cisco, Liander, Ymere and Far West) all had equal vote in decision making for the project. One possible reason is that compared to the *HSC* case where Wuxin was the main source of financial resource for the project, in the *WO* case the shares of contribution of partners were comparable to each other. Besides the platform leaders, IBM and Nuon, other partners such as Ymere and Farwest were providing a large part of investment. Therefore, compared to the *HSC* case, no one organisation had full authority because of providing the financial resources for the project.

From the cases, we found two types of platform leadership strategies: 1) de-centralized decision making promoting consensus among partners in *ALH* and *WO*, 2) centralized decision making exerting control over partners in *HSC*. Apparently, the platform leadership strategies in the projects have been influenced by 1) the type of leading organisation and 2) the level of investments by partners in the project. We found both strategies positively influenced the decisions of organisations to become engaged in collective action. Therefore, it can be suggested that there is no "one-size-fits-all" strategy for platform leadership. Nevertheless, we additionally found that while leadership strategies are important to initially encourage organisations to participate in collective action, platform leaders can also cause projects to stop (e.g., the *ALH* case: lack of financial resources of Active Life Village; the *WO* case: Nuon's decision to stop the project after the pilot).

Selective Incentives

Providing s*elective incentives* in all cases positively influenced decisions of organisations to become engaged in collective action. However, the type of selective incentives and their effects differ across and within the cases.

We found two types of selective incentives: tangible and intangible. The tangible incentives include funding for the development and pilot, which was found to be mainly important for universities (e.g., Aalto University in the *ALH* case) and large organisations (e.g., IBM and Nuon in the *WO* case). For universities, it is obvious that they need financial support to do research. Large organisations, such as Nuon and IBM, which invest heavily in new innovative fields, need funding to reduce possible risks and increase reliability of their investments. However, when organisations receive a small share of funding (e.g., the *ALH* case: assistive device provides; the *WO* case: HAE, Cisco), funding does not influence their decisions to become engaged in the project.

Besides tangible incentives, intangible incentives also influence decisions of organisations to join projects. In the *ALH* case, Active Life Village encouraged service providers by promoting a vision of having competitive advantage over other players in the market. In the *HSC* case, by involving Wuhan University as a well-reputed organisation in the project, Wuxin encourages service and technology providers to join the project.

In addition to findings about the effects of selective incentives on decisions of organisations for collective action, the results show that platform leaders play an important role in providing selective incentives for the projects. For instance, in the *HSC* case, most of the funding for the pilot was provided by the leader (i.e., Wuxin). In the cases of *ALH* and *WO*, though funding was provided by external organisations (i.e., Tekes and ERDF), the leaders, Active Life Village, Nuon and IBM, played an important role to obtain those funds. Other than the role of platform leader in providing selective incentives, we found that though important, funding can lead to organisationally closed projects because new partners cannot receive a share of the project's fund (e.g., in the *ALH* and *WO* cases, new organisations could not join for the platform development).

Platform Technical Openness

All three cases have different degrees of *technical openness* for the platforms. In the *ALH* and *HSC* cases, in which the platforms are cloud-centric, technical openness was operationalized as using open industry standard interfaces to allow new assistive device or service providers to connect their web services to the platform. The partners then could benefit from diverse services on the platform to attract customers. Therefore, developing an open platform (i.e., based on industry standard interfaces) positively influenced organisations' decisions to become engaged in the project.

In the *WO* case, in which the platform has a distributed architecture (i.e., consists of the smart meter, in-home display, e-wizard plugs and home controller), openness was operationalized as using open standards to ensure communication between different parts of the platform. Using open communication standards reduces barriers for new complementary providers (e.g., appliance providers) to connect to the platform. Although the *WO* project was closed to new organisations, using open standards was encouraging for the platform developers (HAE and IBM) to join the project because it enables them to use their developed solutions in other projects (they have joint IPRs with Nuon).

Apart from open industry standard interfaces and open communication standards, none of the cases provides APIs for the development of additional applications on the platforms. The reason in the *ALH* and *HSC* cases was that the projects were in the development phase and the platform providers first intended to develop and test the platform concept. However, they considered having APIs for application developers in future. In the *WO* project, APIs of the in-home display were intentionally closed because of concerns of Nuon and HAE about data privacy and the revenue model.

The difference with regard to API strategies between cases can also be attributed to the sector to which the platforms belong. The findings show that while in the health sector the opening of APIs and web interfaces is gaining momentum to enable service integration and new applications on platforms, in the energy sector the discussion of open APIs has been in an early stage (at the time of project). This is mainly because: 1) platforms that have only one main application area are not going to be open (i.e., HEM platforms are only used for energy management applications); 2) there are still concerns about technology and customers' data privacy and 3) SMEs developing home energy management platforms (i.e., HAE developing in-home displays in *WO* project) lack financial and organisational resources to manage third-parties in the platform ecosystems. Perhaps financial and organisational support of larger organisations, like Nuon and IBM, involved in providing the platform may reduce this barrier to openness. Nevertheless, in the *WO* case, due to security and privacy issues Nuon was not willing to open up the platform.

Platform Organisational Openness

With regard to the *organisational openness of platform*, in all cases complete openness was found to have a negative impact on decisions of organisations to become engaged in collective action. Only in the *HSC* project, we found neutral impact of organisational openness on care service providers which was explained by the fact that the Chinese market is so large that no single care service provider can target the whole market. Therefore, participation of other service providers would not create competition in the platform ecosystem or threat existing care service providers.

In each case, platform partners (i.e., organisations involved in developing the platform) tended to control the platform ecosystems, with varying degrees of organisational openness. The *ALH* case had a more open approach compared to the other cases, in which non-competitor complementary providers were able to join the project upon acceptance of at least half of the partners. However, new members would not be involved in the platform development and could not receive any subsidy. The *HSC* case adopts a closer approach compared to the *ALH* case. Although the *HSC* project is open to care service providers or assistive device providers to join, unlike the *ALH* case, the leader, Wuxin, decides who can join the project (centralized decision making). The *WO* case, compared to the other two cases, is the most closed platform, as it was closed to new members unless there is a need for resources of a new partner. According to interviewees, the reason was that tasks and roles in the project were precisely defined and assigned in the beginning and there was no need for new partners.

From case studies' results, we argue that organisations advocate different degrees of organisational openness based on three characteristics of the collaborative project: 1) phase of the project (i.e., R&D, Pilot and Commercialization) 2) type of project (i.e., precompetitive versus competitive projects) and 3) type of leading organisation (i.e., non-profit versus for-profit organisation).

With regard to the phase of the project, findings from the case studies suggest that when the R&D phase is already finished and the required resources and roles for the next phases (e.g., pilot or commercialization) are defined and assigned, new partners would not contribute to the project and can even become a competitor or threat to the existing partners. Therefore, in projects in the later phase of development in which objectives are defined and roles are assigned (e.g., *WO* case), partners tend to close the project to new parties. However, when the project is in the initial phase of development (e.g., *ALH* and *HSC cases*) and there are open questions about the business case and business model, partners tend to open the project to new parties to contribute to the project.

Regarding the type of project, we found that organisations deciding to join precompetitive projects (i.e., collaborative projects involving industry and academic partners aimed at creating and dividing benefits) with involvement of universities (i.e., *ALH* and *HSC* cases) are more open to new parties than organisations deciding to join competitive projects with large commercial players (i.e., *WO* case). One reason could be that typically precompetitive projects are in the early stages of development (i.e., *ALH* in R&D; *HSC*: R&D and start of the pilot phase) and the platform technology and concepts still need to be developed to become a commercial solution. Therefore, the precompetitive projects need to be open to new partners who can provide resources and contribute to final products whereas in competitive projects, which are in the later phases of development of technology (i.e., *WO* in pilot phase), new partners are often considered as competitors.

Beside the project's characteristics, in two cases (i.e., *ALH* and *WO*) we found that partners were concerned with complexity resulting from large group size and thus they were not willing to collaborate in projects that are completely open to new partners. In addition to the effects of organisational openness on decisions of organisations for collective action, we found a causal relation between the type of leading organisations and the degree of organisational openness in a project. It appeared that for-profit organisations (i.e., Wuxin, Nuon and IBM) who are interested in the commercial prospects of platforms more strictly control the platform ecosystems to reap most of the benefits and to retain a competitive advantage over other organisations without a common platform.

The findings on platform openness (i.e., technical and organisational openness) suggest that the technically open platforms (i.e., ALH and HSC: open industry standards interfaces) are also more organisationally open compared to the technically closed platform (i.e., the WO case). From this, we can infer that there is an interrelation between platform technical and organisational openness.

4.6 *Alternative explanations for cross-case differences*

The case studies show that platform innovation in the healthcare sector differs from platform innovation in the energy sector. From a platform ecosystem perspective, we found that actors in the healthcare sector are more diverse compared to the energy sector. In the healthcare sector, there are healthcare service providers, assistive device providers, government agencies, insurance companies and patients whereas in the energy sector the main players are energy providers, technology providers and end users. Therefore, it can be argued that interest heterogeneity in collaboration is much more expected in the healthcare sector than the energy sector. In addition, the complexity of starting an ecosystem and getting collaboration going is more complex in the healthcare sector. On top of this, requirements from regulation regarding security of patient data add to the complexity of joint e-healthcare platforms.

Moreover, results from the cases indicate that platform providers in each sector have different viewpoints on platform projects. The platform providers in the healthcare cases (i.e., Active Life Village in *ALH*; Wuxin in *HSC*) have long-term visions on the projects: 1) addressing future challenges of elderly and independent living services; 2) extending the platform with more application areas (e.g., safety and remote diagnosis) and 3) utilizing platform data for research purposes (i.e., the *HSC* case). While the platform provider in the energy case (i.e., Nuon) started with a broad vision on Smart Living services, later the project continued with a short-term vision to use the platform to offer value added services to customers and to differentiate from other energy providers in the market. Therefore, at the time of the project, the focus was no longer on broadening the platform into other application areas. We can argue that such vision on platforms also influences organisational and technical openness of the platforms as we found in the cases. While the platform cases in the healthcare sector are open to complementary care service and assistive device providers, the energy case depicted a closed approach towards third-parties.

From a technology perspective, we found that the platform projects in the healthcare sector (i.e., the *ALH* and *HSC* cases) are moving towards cloud platforms and integration of web services of different devices into common cloud platforms. Therefore, the main focus is on how to enable integration of web services and data of different assistive devices and services, using open industry standard interfaces, and later providing APIs for developing new applications. In the energy sector, while there are a few online applications for remote energy management (See Chapter 3), we found in the *WO* case that the main focus is still on the home level. The reason is that Nuon was concerned with data privacy issues and thus they were trying to first make a robust architecture at home. The orientation towards cloud platforms in the e-healthcare cases (i.e., the *ALH* and *HSC*) is possibly a reason for higher degrees of openness (in terms of open industry interfaces) compared to the energy case (i.e., the *WO* project).

In addition to differences between sectors and platform technologies, cultural differences between countries seem to influence collective action in the cases. Here, we use Hofstede's (1991) cultural lens to compare the cases. While cultural differences between Finland and the Netherlands are not significant, there are substantial cultural differences between China and European culture (i.e., Finland and the Netherlands), which seems to influence collaboration. One of the differences is that power distance (i.e., the degree to which members of a society accept that power is distributed unequally) is accepted in China and not in Finland and the Netherlands. Accordingly, we found that while *platform leadership* based on centralized decision making and control over partners is accepted in China (i.e., *HSC* case), it is not accepted in Finland and the Netherlands (e.g., *ALH* and *WO* cases). From findings on *interest heterogeneity*, it can be argued that in *collectivist cultures* such as China (i.e., a preference for a closely-knit structure that members look after each other for certain loyalty), it is more likely that collaboration sustained even in the presence of interest heterogeneity. The reason is that in collectivist societies people act in the interest of groups (i.e., common goal: developing a common platform) rather than individual interests (e.g., research or market interests). This could be an explanation of why mismatched interests in the *HSC* case did not hamper collective action from the development to the pilot phase. Another finding is that the pilot in HSC started while there were still open and unknown questions about the project and the platform. This can also be related to *ambiguity* in Chinese culture, in which people are comfortable with uncertainties while it is difficult for western culture (i.e., Finland or the Netherlands). Finally, we found longer-term future perspective on the platform in the China case (i.e., how to benefit from platform data? how to extend it in future and involve third parties?) compared to the other two cases. This is also a possible impact of long-term future oriented feature of Chinese culture.

Although the findings from interviews in each case provided sufficient basis to confirm or disconfirm the propositions, the depth and accuracy of the information varies across cases. For instance, while the information for the *ALH* and *WO* cases was in-depth, the information for the *HSC* case was not thorough, because of two reasons: 1) language issue: not every interviewee could speak English and thus a translator was hired for interviews. Therefore, there might be translator bias involved in the case; 2) disclosure of information: a number of interviewees, especially from the platform provider side (i.e., Wuxin), were quite cautious in revealing information about the strategy of the organisation and the project. Similar sensitivity in revealing information was also observed in the *WO* project, where a number of interviewees asked us to treat certain information confidentially. Moreover, as the *WO* project finished two years ago, interviewees had to recall what happened. Therefore, there is a chance that interviewees have forgotten details about the project over the time. However, we used project's documents and interviewed more than one representative from the initiators (i.e., Nuon, Cisco and IBM) to check for any inconsistencies or missing details in interviews.

5 Survey Study

The qualitative case studies in Chapter 4 elicited various factors of platform and ecosystem characteristics (see Figure 2.2) that can influence decisions of actors to participate in a collaborative platform project. However, it cannot be concluded from the case studies which factors are the most important. In this chapter, we prioritize the importance of propositions as developed in Chapter 2 with a quantitative method in order to increase the external validity.

As discussed in Chapter 4.5, differences were found across the cases on how platform and ecosystem characteristics influence collective action. For instance, in two cases technical interdependencies were not as important as organisational interdependencies for the decision to become engaged in collective action. Accordingly, the secondary objective of this chapter is to examine the conflicting findings from Chapter 4.

The chapter proceeds as follows. In Section 5.1, we discuss a decision-making analysis approach: Analytical Hierarchal Process (AHP). In Section 5.2, we present the research model. Sampling and operationalization are discussed in Section 5.3 and Section 5.4 respectively. Then, we present the results of the survey in Section 5.5 and discuss the results in Section 5.6. Finally, limitations and conclusions are provided in Section 5.7 and Section 5.8 respectively.

5.1 *Analytic Hierarchy Process (AHP)*

For decades, several multi-attribute utility techniques (MAUT) have been applied to a variety of business researches for quantifying respondents' opinions in multi-criteria decision making (MCDM) situations (Dyer et al., 1992; Money et al., 1989). MAUT can be classified into two groups: 1) de-compositional model; in which the researcher collects ratings on preferences from respondents (e.g., preferred projects) and then calculates the rating for each criterion (e.g., factors influencing decisions for collaboration). Popular examples of de-compositional model are Conjoint Analysis and Q-methodology/Q-sort; 2) compositional model; in which the researcher collects rating from respondents on criteria and then relates the rating to overall preferences. Common methods for compositional models are Analytical Hierarchy Process (AHP) and the Self-explicated (SE). Both compositional and de-compositional methods require explicit specification of criteria and levels of criteria. Typically, de-compositional models are used in marketing and consumer research to answer the main question of why consumers prefer a specific brand or provider over the others (Green et al., 2001). Compositional models, especially AHP, are commonly used in business and management research to identify priorities in multi-criteria decision problems (Bernasconi et al., 2010). As the objective of this research is to study decision-making criteria in the context of organisations, we opt for AHP as a compositional model.

The AHP method was introduced and developed by Saaty (1980). The method allows respondents to assess the relative importance of multiple criteria against a given multi-criteria decision making problem (i.e., the decision to participate in a collaborative platform project) by pairwise comparisons of criteria (i.e., characteristics of the platform and ecosystem). This results in a list of prioritized criteria. One advantage of AHP over de-compositional models such as conjoint analysis is that it enables simplifying a decision-making problem by decomposing the problem into levels of criteria (Macharis et al., 2004). This is especially important for large complex decision making problems, such as participating in collaborative platform projects (Yeo et al., 2004). Moreover, simplification of the problem makes the AHP method more appealing to decision makers compared to de-compositional models (Ramanathan, 2001). Another advantage of AHP is that there is no limitation on the number of respondents and the method can be applied even for one respondent (Abduh & Omar, 2012).

We are also aware of the criticisms on the method. One issue is that as the number of criteria increases, the number of pairwise comparisons also increases, which leads to respondent fatigue. Nevertheless, this is also an issue in de-compositional models, e.g., conjoint analysis (Macharis et al., 2004). Another issue in the AHP method is to ensure consistency of pair-wised comparisons. Typically, a modicum of inconsistency (i.e., < 0.2) for a respondent is acceptable because it shows that it is of little likeliness that the respondent answered questions randomly. Nevertheless, Saaty (2003, p. 86) argues that insisting on consistencies, “people would be required to be like robots unable to change their minds with new evidence and unable to look within for judgments that represent their thoughts, feelings and preferences”.

5.1.1 AHP Design and Analysis

The first step to design AHP model is to decompose a decision problem into primary parts (i.e., criteria and sub-criteria) and arrange all the parts in a hierarchical model. The criteria and sub-criteria in the model should simplify a complex problem situation for decision makers. Then, respondents (who are the decision makers) are asked to rate the relative priority for each pair of criterion i and criterion j in the model on a scale between 1 (i is equally preferred to j) and 5 (i is extremely preferred to j) (Beynon, 2002). The number of comparison is n(n-1)/2 where n is the number of criteria. Pairwise comparisons of criteria results in a reciprocal matrix A, where $a_{ij} = 1/a_{ji}$, and n = number of criteria.

$$A=\begin{pmatrix} a11 & a12 & \cdots & a1n \\ 1/a12 & a22 & \ldots & a2n \\ \vdots & \ldots & \ddots & \vdots \\ 1/a1n & 1/a2n & \cdots & 1/ann \end{pmatrix}$$

The weights of criteria can be obtained by different methods. Using Saaty's Lambda max technique, the priority vector $W= (W_1,\ldots,W_n)$ is the normalized eigenvector of matrix A corresponding to the largest eigenvalue of the matrix (λ_{max}). Therefore, for each matrix A, we have the following equation which should be solved to estimate the priority vector W.

$$A \times W= \lambda_{max} \times W$$

The final step is to measure the reliability of the estimation using Consistency Ratio (C.R.). A matrix A is consistence if $a_{ik}*a_{kj} = a_{ij}$ (Buckley, 1985). Nevertheless, in reality responses of respondents may lead to matrices that are not consistent (e.g., *a* is preferred to *b* and *b* is preferred to *c*, but then *c* is preferred to *a*). To measure C.R. first we need to calculate Consistency Index (C.I.) from the following formula:

$$C.I. = (\lambda_{max} - n)/(n-1)$$

Then Consistency Ratio can be measured by C.R. = C.I./R.I., where R.I. is Random Consistency Index (i.e., the consistency index of a pairwise comparison matrix which is randomly generated and it depends on number of comparisons, see Table 5.1). For C.R. < 0.2 the consistency of respondents' ratings is acceptable (Byun, 2001), otherwise the respondent should be excluded from the analysis.

Table 5.1 Random Index for n= 1,2,...10 adapted from Saaty (1980)

n	1	2	3	4	5	6	7	8	9	10
R.I.	0.00	0.00	0.58	0.90	1.12	1.24	1.32	1.41	1.45	1.49

All these steps need to be done for each respondent to measure Consistency Ratio and local weights of criteria for the respondent. The global weight of criteria and Consistency Ratio is the average scores of all valid responses (i.e., C.R. < 0.2).

5.2 *Research Model*

The first step in defining an AHP research model is to identify criteria and sub-criteria with regard to the decision problem (i.e., participating in a collaborative platform project). Figure 5.1 shows the hierarchy AHP research model.

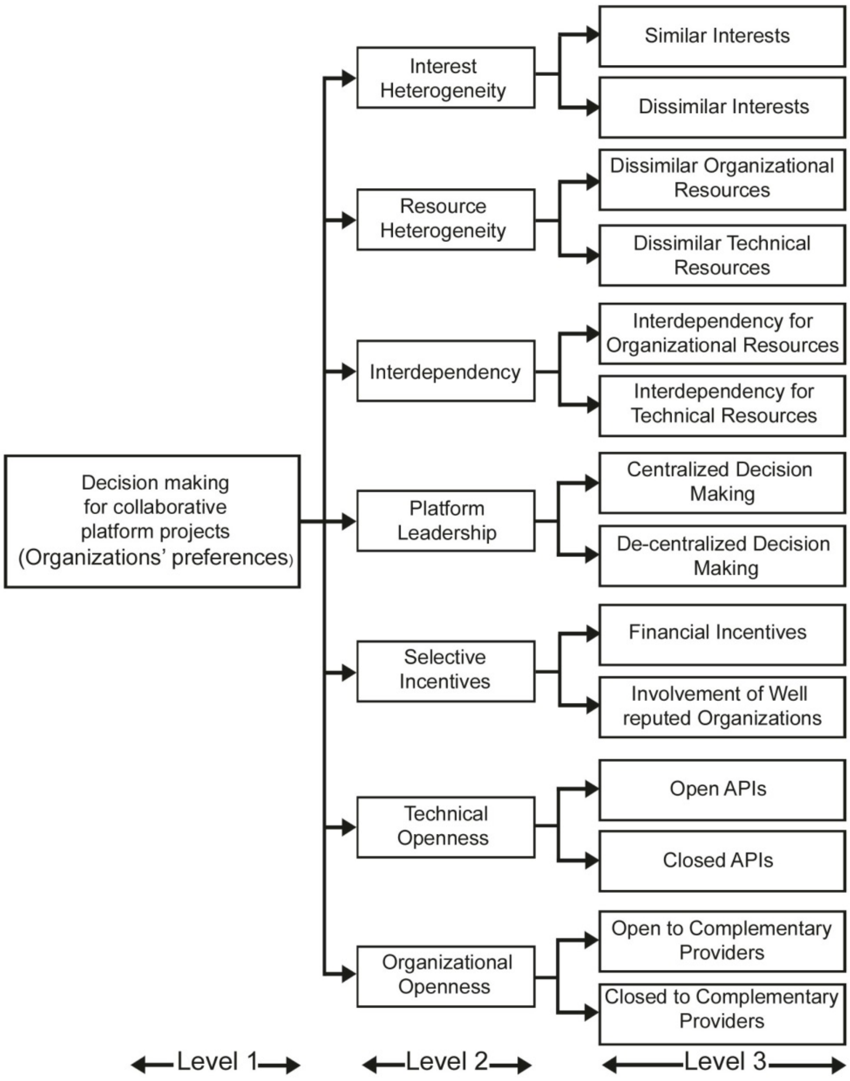

Figure 5.1 The AHP Research Model

The AHP model consists of three levels: Level 1) objective of the survey, Level 2) criteria and Level 3) sub criteria. The main criteria are directly derived from the propositions as developed in Chapter 2: 1) Interest heterogeneity, 2) Resource heterogeneity, 3) Interdependencies, 4) Platform leadership, 5) Selective Incentives; 6) Technical platform openness; and 7) Organisational platform openness. Based on the rich insights from the case studies in Chapter 4, we develop sub criteria for each main criterion. These sub-criteria are directly derived from Table 4.11 in Section 4.5.

As in any survey, operationalization of complex constructs requires specification and deduction.

With regard to ***interest heterogeneity,*** case studies suggested that <u>similar interests</u> of partners are always preferred over <u>dissimilar interests</u>.

For **resource heterogeneity**, the cases consistently suggest that dissimilar resources encourage collaboration. However, in some cases <u>organisational resource heterogeneity</u> is most important while in others <u>technical resources</u> matter most. Therefore, we distinguish these two types of resources as sub criteria in the model.

Concerning **interdependencies**, case studies suggest that partners can be interdependent for <u>organisational resources</u> or <u>technical resources</u> of each other.

For **platform leadership**, we found in case studies that both <u>centralized</u> and <u>de-centralized</u> leadership approaches positively influence collaboration.

As to **selective Incentives**, we found tangible (e.g., <u>financial incentives</u>) and intangible incentives (e.g., <u>involvement of well-known partners</u>) deployed in cases to encourage participation of organisations.

Platform technical openness was discussed in case studies in forms of industry standards interfaces, communication standards and Application Programming Interfaces (APIs). As the focus of this thesis is platform and not standards, we merely include <u>APIs openness</u> and <u>closedness</u> as relevant sub criteria for platform technical openness.

Platform organisational openness was described in cases as <u>openness</u> or <u>closedness towards complementary providers</u> (i.e., application and device providers).

5.3 *Sample*

The targeted population consists of decision makers and experts that work on service platforms, either in the area of e-healthcare or home energy management. The questionnaire was sent out to a sample of 401 practitioners and experts (180 from energy and 221 from e-healthcare domains) in the Netherlands in July 2013. After two follow-up reminders 69 people responded (29 responses from the energy sub-sample and 40 responses from the e-healthcare sub-sample), yielding a response rate of 17% (16% for the energy and 18% for the e-healthcare sub-samples). 61% of the respondents responded after receiving the first email, 23% after receiving a first reminder and 16% after receiving a second reminder. Of the 69 responses, 9 were excluded from analysis as consistency ratio of their responses in AHP model exceeded 0.2 (i.e., more than 20% chance that the respondent answered questions randomly).

Table 5.2 shows the background information for the sample. A majority of respondents in both sub-samples of energy and e-healthcare are in the 'Others' category, fulfilling roles as consultants, researchers and projects managers. The percentage of business developers in the energy sub-sample is more than the e-healthcare subsample. With regard to educations of respondents, more than half of the respondents hold a Master degree. The percentage of PhD holders is higher in the e-healthcare sub-sample.

Table 5.2 Background information

		Percentage energy (N=29)	**Percentage e-healthcare (N=40)**
Roles of respondents in organisations	Business developer	34%	17%
	Product manager	7%	7%
	Account manager	0%	2%
	Chief information officer	0%	7%
	Others	59%	66%
Educations	Bachelor	24%	12%
	Master	56%	58%
	PhD	10%	27%
	Others	10%	3%

5.4 *Operationalization*

A questionnaire was developed based on the research model from Section 5.3 (See Appendix B). The questionnaires were pre-tested by six researchers who were familiar with the survey method and/or the domain of the study. The pre-test was aimed to ensure the accuracy and also check for ambiguity in the questionnaire.

The questionnaire first explained what the service platforms and issues of collaboration for establishing common service platforms are. The respondents were asked to imagine that their organisation considers joining a collaborative platform project (with large and small organisations), which is led by a large organisation (as a control variable).

Then, the respondents were asked to do pair-wise comparison of the importance of criteria and sub-criteria when deciding to join such a project. It was explained to the respondents that the method may force them to compare criteria that they think are equally relevant or irrelevant. Introductory texts were adapted to the context of energy and e-healthcare domain (i.e., specifying the service platform into home energy management and e-healthcare service platforms). The operationalization and questions were identical for both groups which allow comparing findings. Table 5.3 shows how criteria were operationalized in the questionnaire. For main criteria (Level1 in Figure 5.1), respondents were presented a definition next to each criterion.

Table 5.3 Operationalization of criteria (Level 1)

Criteria (Level 1)	Label shown in questionnaire	Definition shown in questionnaire
Interest Heterogeneity	Interests of other partners	The strategic interests of other project partners
Resource Heterogeneity	Resources of other Partners	The resources brought in by project partners
Interdependencies	Interdependency among Partners	The extent to which project partners depend on each other (e.g. for technologies, know-how or access to customers)
Platform leadership	Leadership structure	How decision making is organized in the project
Selective Incentives	Incentives offered in the Project	Whether financial or other incentives are offered to project partners.
Technical Platform Openness	Technical openness of the platform	How open the technologies in the platform are towards application providers
Organisational Platform Openness	Organisational openness of the platform	How open the project is for third-parties to join

On the first page of the questionnaire, respondents were asked to in pairs compare and rate the importance of each criterion with the other ones. Table 5.4 shows an excerpt of how this page appeared to respondent.

Table 5.4 Questionnaire excerpt: pair-wise comparison of criteria (Level 1)

Please pair-wise compare the importance of the following criteria for your organisation with respect to deciding whether to join a HEM platform project										
	Extremely important		Strongly important		Equally important		Strongly important		Extremely important	
Technical openness (How open the technologies in the platform are towards application providers)	⑨	⑦	⑤	③	①	③	⑤	⑦	⑨	**Organisational Openness** (How open the project is for third-parties to join)
Interest Heterogeneity (The strategic interests of other project partners)	⑨	⑦	⑤	③	①	③	⑤	⑦	⑨	**Resource Heterogeneity** (The resources brought in by project partners)

Table 5.5 show how sub-criteria (Level 2 in Figure 5.1) were operationalized in the questionnaire.

Table 5.5 Operationalization of sub-criteria (Level 2)

Criteria (Level 1)	Sub criteria (Level 2)	Label shown in questionnaire
Interest Heterogeneity	Dissimilar interests	Partners have dissimilar strategic interests in the project
	Similar interests	Partners have similar strategic interests in the project
Resource Heterogeneity	Dissimilar organisational resources	Partners have different organisational resources e.g. brand, customer base
	Dissimilar technical resources	Partners have different technical resources e.g., technology, know-how knowledge
Interdependency	Technical interdependencies	Partners interdependent for technical resources
	Organisational interdependencies	Partners interdependent for organisational resources
Platform leadership	Centralized decision making	Single organisation makes decision
	Decentralized decision making	All organisations have equal votes
Selective Incentives	Financial incentives	Your organisation receives funding or subsidy for participating in the project
	Involving well-reputed partners	Project partners are well-known in the industry
Technical Platform Openness	Open APIs	Open Application Programming Interfaces
	Closed APIs	Closed Application Programming Interfaces
Organisational Platform Openness	Open to complementary providers	Application providers are allowed to offer services on the platform
	Closed to complementary providers	Application providers are not allowed to offer services on the platform

On the second page of the questionnaire, respondents were asked to in pairs, compare and rate the importance of each sub-criterion, Table 5.6 shows an excerpt of how this page appeared to the respondent.

Table 5.6 Questionnaire excerpt: pair-wise comparison of sub-criteria (Level2)

We will now zoom into the criteria from the previous question, and ask you which alternative your organisation would prefer for each criterion (in Bold).

With respect to deciding to join a collaborative platform project, please indicate for each pair of alternatives which alternative is more preferred by your organisation? And by how many times?

	Extremely important		Strongly important		Equally important		Strongly important		Extremely important	
Technical openness Open Application Programming Interfaces (APIs)	⑨	⑦	⑤	③	①	③	⑤	⑦	⑨	**Technical Openness** Closed Application Programming Interfaces (APIs)
Organisational Openness Application providers are allowed to offer services on the platform	⑨	⑦	⑤	③	①	③	⑤	⑦	⑨	**Organisational Openness** Application providers are not allowed to offer services on the platform

5.5 *Results*

The AHP analysis assigns a weight to each criterion. The sum of the weights of all criteria on the same level equals 1. A weight can thus be interpreted as the relative importance of that criterion as compared to the other criteria on that level.

Energy domain

Table 5.7 shows the relative importance of each criterion on level-1 for the energy domain. The criteria are ranked by the highest weight.

Table 5.7 Ranking and weight of main criteria in energy sub-sample

Ranking	Criteria	Weight
1	Technical openness	.216
2	Interests of other partners	.154
3	Organisational openness	.146
4	Selective incentives	.132
5	Interdependencies	.127
6	Resources of partners	.121
7	Leadership	.104

There is not much difference between the weights of criteria in the energy sub-sample. Only *technical openness* is clearly preferred to other criteria followed by *interests of other partners* and *organisational openness*. Surprisingly, the least important criterion is *platform leadership*.

Table 5.8 shows the weights for the sub-criteria, i.e., the specific choices that can be made on the main criteria.

Table 5.8 Ranking and weight of sub-criteria in energy sub-sample

Ranking	Sub-Criteria	Weight
1	Open API	.172
2	Open to application providers	.113
3	Dissimilar interests	.089
4	Well-known partners	.070
5	Technical resources	.066
6	Similar interests	.066
7	Technical interdependencies	.065
8	Organisational interdependencies	.063
9	Financial incentives	.062
10	Decentralized leadership	.058
11	Organisational resources	.055
12	Centralized leadership	.046
13	Closed API	.044
14	Closed to application providers	.033

As seen in the table, within sub-criteria, there are strong preferences for platforms with *open APIs* and *open to application providers.* Platforms with *Closed APIs* and *closed to application providers* are the least preferred. For other sub-criteria, the weights are evenly distributed, suggesting that overall the respondents do not have a profound preference.

E-Healthcare domain

For respondents from e-healthcare sub-sample, weights for level-1 criteria are given in Table 5.9.

Table 5.9 Ranking and weight of main criteria in e-healthcare sub-sample

Ranking	Criteria	Weight
1	Interests of other partners	.171
2	Selective Incentives	.165
3	Technical openness	.164
4	Organisational openness	.146
5	Interdependencies	.122
6	Leadership	.115
7	Resources of Partners	.115

Table 5.9 shows that *interests of other partners, selective incentives* and *technical openness* are almost equally important for respondents in e-healthcare sub-sample. Similar to the energy sub-sample, *platform leadership* and *resources of partners* are the least important criteria. Table 5.10 shows the importance of the sub-criteria for the e-healthcare sub-sample.

Table 5.10 Ranking and weight of sub-criteria in e-healthcare sub-sample

Ranking	Sub-Criteria	Weight
1	Open API	.121
2	Dissimilar interests	.111
3	Open to application providers	.108
4	Financial incentives	.102
5	Technical interdependencies	.065
6	Well-known partners	.064
7	Similar interests	.060
8	Centralized leadership	.059
9	Organisational resources	.058
10	Decentralized leadership	.058
11	Organisational interdependencies	.057
12	Technical resources	.056
13	Closed API	.043
14	Closed to application providers	.039

The table shows that there is not much difference between the weights of other criteria and the weight is evenly divided between the criteria. Within sub-criteria, *open API*, partners with *dissimilar interests, openness to application developers* and *financial incentives* are the most important ones. *Closed APIs* and *closedness to application providers* are again the least preferred sub-criteria.

Across the two sub-samples, *platform leadership* is more important for e-healthcare respondents than for the energy respondents. While in the energy sub-sample, *decentralized leadership* is slightly preferred over *centralized leadership*, in the e-healthcare sub-sample, *centralized* and *decentralized leadership* are equally preferred. Consistent across two groups is the importance of *technical openness* and *partners' interests*. Nevertheless, *partners' interests* are more important for the e-healthcare group. Respondents in both groups strongly preferred *openness* over *closedness*, from both technical and organisational views. Striking is the preference for working with partners with *dissimilar interests*. Selective incentives, especially *financial incentives* are more important for respondents in the e-healthcare sub-sample than for the energy sub-sample. *Technical resources* and *technical interdependencies* were found more important than *organisational resources and organisational interdependencies* in the energy sub-sample. In the e-healthcare sub-sample, while *organisational resources of partners* are *preferred to technical resources,* the respondents preferred *technical interdependencies* to *organisational interdependencies.*

5.6 *Discussion*

In this section, we discuss the findings for each core concept in the propositions (See Chapter 2).

Interest Heterogeneity

With regard to interests of other partners, striking is that respondents from both sub-samples prefer to work with partners with dissimilar interests. It can be explained that starting collaboration with partners having dissimilar strategic interests may ensure that partners are not direct competitors of each other.

Resource Heterogeneity and Interdependencies

Surprisingly, we found that the respondents in the e-healthcare sub-sample preferred technical interdependencies to organisational interdependencies while they considered organisational resources of partners more important than technical resources. A possible reason is that organisational resources, though more important than technical resources, are more difficult to replace. Therefore, in cases of disagreements, organisational interdependencies (e.g., for operational processes) might be a limiting factor and thus partners tend to avoid that. For the energy sub-sample, technical resources and technical interdependencies were preferred to organisational resources and organisational interdependencies. It can be speculated that for the energy domain, technology is more critical not only to address privacy issues of home energy management services but also to complement the platform with grid technologies to address demand response and energy efficiency.

Platform Leadership

Platform leadership in terms of centralized and decentralized decision-making was found unimportant for respondents in both sub-samples. It can be speculated that platform leadership is much more than simply decentralized or centralized decision-making approach. Platform leadership is also about reputation and position of the leader in the market, technical and organisational resources hold by the leader as well as whether and how the leader acts in the interest of other partners or can resolve conflicts among partners. Nevertheless, these aspects of leadership cannot be quantitatively measured in a survey.

Selective Incentives

Selective incentives and especially *financial incentives* were found more important for respondents from e-healthcare sub-sample. It might be the case that energy companies have sufficient money to start such platform projects. Another explanation could be that collaboration in e-healthcare has more materialistic purposes. It can be inferred that financing is a bigger issue in the e-healthcare domain as all platform projects in the e-healthcare domain are started for a cost saving purpose. Therefore, financial incentives are required to reduce collaboration costs for actors in the e-healthcare domain and encourage their participations.

Platform Openness

Clearly, organisations prefer open platforms. One explanation is that they are aware of benefits of open platforms, such as flexibility to extend or integrate services or building a community around the platform. The preference for openness could also be an artefact of the survey method in a way that respondents may give socially-desirable answers regardless of their content. Nevertheless, such possibility is unlikely in this case considering educational backgrounds of respondents and their interests in the survey results. Comparing the weight of *technical openness* across sub-samples indicates that technical openness is especially more important for respondents from energy sub-sample. One explanation could be that providing a wide range of home energy management services require the platform to be connected to several devices and services, otherwise the platform cannot provide a valuable package of services. Therefore, technical openness is preferred to make the platform more appealing by complementing it with additional products and services.

5.7 *Limitations*

We focused on the Netherlands to control for regulatory and cultural differences between respondents. Further studies should examine whether the importance of criteria differs when other countries are included in the population. Cultural, institutional, regulatory and industry differences may be alternative explanations that influence the order of priorities for platforms collaborations.

5.8 *Conclusions*

The main conclusion of this chapter is that generally platform technical openness, interests of other partners, selective incentives and organisational openness are the most important criteria for organisations at the time when deciding to join collaborative platform projects. Nevertheless, we still found differences regarding the choice of sub-criteria across sub-samples. Respondents in the e-healthcare domain preferred financial incentives while respondents in the energy domain preferred well-reputed partners in the project. Moreover, respondents in the e-healthcare domain preferred technical resources of partners while respondents in the energy domain preferred organisational resources of partners. These findings indicate that while the importance of criteria is identical across energy and e-healthcare domains, the choice of sub-criteria differs across energy and e-healthcare groups.

6 Discussion and Conclusions

This research set out to answer the following question and provide understanding of which criteria encourage collective action for establishing common service platforms in the Smart Living domain.

> **What characteristics of service platforms and platform ecosystems influence organisations' decisions to become engaged in collective action for developing common service platforms for Smart Living services?**

In this chapter, we present the main findings of the study regarding the research question in Section 6.1. Then, we discuss the findings and alternative explanations in Section 6.2. We present the theoretical contribution of this study in Section 6.3. Next, implications for the Smart Living domain and recommendations for practitioners are presented in Section 6.4 and Section 6.5 respectively. Finally, we point out challenges and limitations of the study in Section 6.6 and recommend avenues for future studies in Section 6.7.

6.1 *Main Findings*

The findings of this study show that the initial decision of organisations to participate in collaboration for a common service platform is influenced by characteristics of the platform (i.e., platform leadership, platform openness) and the platform ecosystem (i.e., interest heterogeneity, resource heterogeneity, interdependencies and selective incentives) (See Figure 6.1).

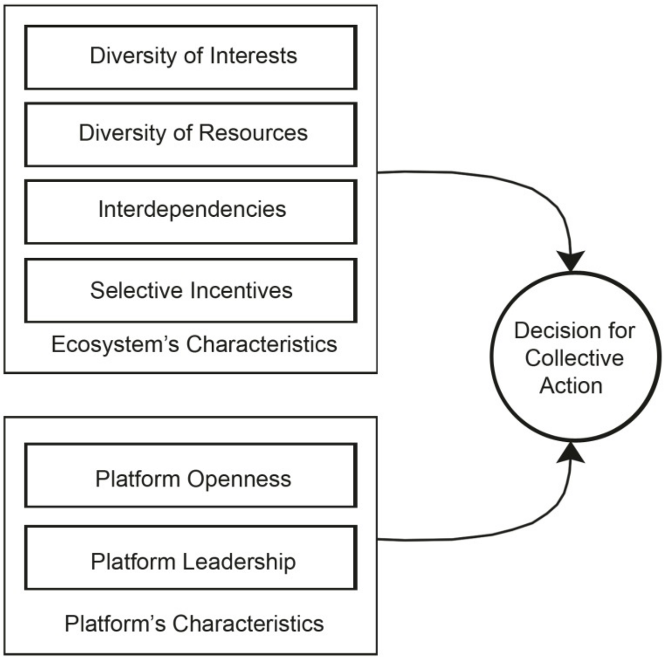

Figure 6.1 Factors Influencing Decision for Platform Collaboration

In the remainder of this section, findings with regard to factors in Figure 6.1 are discussed.

6.1.1 Findings from the Case Studies

Diversity of Interests

We expected, based on previous studies, that when partners in a project have different interests in the project, it is less likely that they reach agreements because of conflicting interests (Klein & Schellhammer, 2011; Markus et al., 2006). Nevertheless, the case studies revealed that dissimilarity of interests does not influence the initial decision of organisations for participation in collaborative platform projects. The findings indicate that organisations start collaborating without considering diversity of partners' interests as a potential source of conflicts.

Diversity of Resources

The case studies indicated that having partners with dissimilar complementary resources, whether organisational resources (e.g., power position in the market, customer base, and inter-organisational relationships) or technical resources (e.g., technology and know-how knowledge) is an important factor in decision-making for collective action. Resource diversity is especially important to ensure accessing resources of each other and preventing competition around the platform. This finding confirms earlier studies on collective action that suggest collaboration is more likely to happen among partners having dissimilar resources (Klein & Schellhammer, 2011; Markus et al., 2006). Moreover, the finding is in line with platform studies which discuss that having partners from incomparable markets reduces competition around the platform (Gawer & Cusumano, 2002; Huang et al., 2009a).

In addition to confirming previous studies, this study extends the theoretical notions in existing literature on collective action. Specifically, we showed that *the type of resources* being offered makes a large difference. Findings from the case studies indicate that organisational resources are more important than technical resources in Smart Living platform projects. For instance, in the *Active Life Home* case, the leader’s relationship with a potential customer (i.e., Espoo municipality) or in the *Home-based Senior Care* case the leader’s relationship with the government and Wuhan University were valuable organisational resources, which encouraged other partners to participate in the project. Interestingly, the study revealed that the leaders of the platform projects often held such organisational resources in the case studies. This is especially important, as a platform leader should be able to stimulate collective action.

Interdependencies

Our findings indicate that the need for complementary resources of other organisations creates interdependencies among partners in Smart Living platform projects. While there are typically no technical interdependencies among partners in the beginning of platform projects, technical interdependencies appear later as a side effect of platform collaboration. In fact, once a platform is developed, the platform ties partners to each other (i.e., the *Active Life Home* case).

Strong interdependencies among partners for organisational resources initially encouraged organisations in all cases to be engaged in platform collaboration. For instance, in the *West Orange* case, Nuon’s customer base and reputation were found to be important factor for partners to participate in the project. These findings confirm previous research which discusses the importance of interdependencies for the start of collaboration (Marwell et al., 1988; Oliver et al., 1985; Sheppard et al., 1990). Our contribution is that distinctions should be made with regard to the type of interdependencies in platform ecosystems.

Platform Leadership

Our study revealed that platform collaboration in the Smart Living domain would not start without a central actor which initiates a platform project, encourages other organisations to join (e.g., by means of financial support) and coordinates communication between partners. This finding is consistent with earlier studies on collective action theory (Olson, 1971; Sandholtz, 1993) and platforms (Garud et al., 2002; Gawer & Cusumano, 2002; Gawer & Henderson, 2007; Perrons, 2009) which stress the importance of leadership to encourage collaboration (by providing incentives) and leverage participation around platforms.

A contribution of this study beyond the previous research is the finding that *the type of leading organisations* can influence collaboration in platform projects. The case studies show that a non-profit organisation as the leader of a platform project (i.e., the *Active Life Home* case) could create a trustworthy environment and encourage other organisations to join the project. Nevertheless, such a leader lacked financial resources to support the continuance of collaboration. Although the lack of financial resources of non-profit organisations can be remedied by European or national innovation subsidies, it is often difficult to evaluate the costs of innovative projects. We found that subsidies cover a small part of development cost (e.g., the *Active Life Home* and the *West Orange* cases) and the cash flow is often delayed (e.g., the *West Orange* cases). Therefore, the combination of non-profit organisations and public administration innovation budget may not be always the best platform leadership structure for stimulating Smart Living services.

Another finding with regard to the leadership is that platform leaders tend to adopt centralized (i.e., the *Home-based Senior Care* case) and decentralized (i.e., the *Active Life Home* and *West Orange* cases) decision making strategies to organize activities in platform projects. Surprisingly, both strategies seemed to work well in different platform projects. These new insights with regard to different types of leading organisations and their strategies in organizing the project suggest that there is no single recipe for platform leadership and depending on the contexts of platform projects (e.g., type of platforms and involved organisations), different leadership structure may facilitate initiation of platform projects.

Incentives

Considering high costs of Smart Living projects, usually a set of incentives (e.g., subsidies, funding) should be provided to stimulate organisations to join the projects. In line with earlier studies (Oliver, 1980; Olson, 1971), our research reveals that provision of incentives for platform projects encourages participation of organisations. Additionally, we found that typically platform leaders provide or facilitate incentives in platform projects (i.e., the *Active Life Home, Home-based Senior Care* and *West Orange* cases).

A novel insight is that platform leaders may deploy tangible (e.g., funding) and/or intangible incentives (e.g., involving well-reputed organisations to attract parties or promoting the platform as giving a competitive advantage over other players in the market) to encourage organisations to become engaged in platform collaboration (i.e., the *Active Life Home* and *Home-based Senior Care* cases). Our case studies revealed that financial incentives (i.e., funding, subsidies) are especially encouraging for large organisations to reduce possible risks and increase reliability of investments (i.e., the *West Orange* case).

A new finding is that financial incentives may lead to organisationally closed projects. Typically, administrative processes require that a project to be carried out with the members which started the project. Therefore, adding new partners increases administration complexity with regard to subsidies. Moreover, new partners may not be able to receive a share of funding (i.e., the *Active Life Home* and *West Orange* cases). Therefore, development projects with a share of subsidies are often closed at least during the development phase. This finding suggests an intermediary relation between financial incentives in platform projects and the degree to which the projects are open for participation of third parties.

Platform Openness

This study extends previous studies on platform openness as it shows that the degree to which a platform is open to third parties influences the decision of organisations to collaborate for development of the platform. This finding complements previous studies on platform openness which mainly examine how openness affects complementary providers rather than platform providers (Boudreau, 2010; Eisenmann et al., 2008; Yoo et al., 2012).

The case studies reveal that organisations are willing to collaborate for platforms based on open standards (i.e., open communication standards or open standards interfaces) to ensure interoperability with complementary devices or services. Nevertheless, openness in terms of open Application Programming Interfaces (APIs) was not favoured by organisations, especially when the platform is in the development stage (i.e., the *Active Life Home, Home-based Senior Care, West Orange* cases). Consistent with an earlier study, (cf., Boudreau, 2010), closed APIs in the cases (i.e., the *Active Life Home* and *West Orange* cases) were aimed to avoid coordination costs and ensure margins for platform providers.

From an organisational perspective, our study indicates that typically complete openness towards new partners has a negative impact on initial decisions of organisations for participating in platform collaboration (i.e., the *Active Life Home* and *West Orange* cases). This is especially critical when a new partner competes with existing partners (i.e., the *Active Life Home* case). Typically, organisations prefer to participate in platform projects where they can control the ecosystem around the platform to retain competitive advantage over other market players. Nevertheless, we found that the decision about platform openness may change over time as interviewees in all three cases put they may consider open APIs once the platform is established in the market (i.e., in the commercialization phase). This finding is consistent with previous studies which indicate a dynamic rather than a static nature for platform openness (Boudreau, 2006; Gawer & Cusumano, 2012; Parker & Van Alstyne, 2008). We contribute to literature on platform openness by relating it to the phases of platform projects (i.e., closed to new partners in the development phase and open to complementary providers in the commercialization phase). It should be noted that we only studied the initiation of platform projects and additional insights about decisions for later phases of projects are based on what interviewees discussed as their plan for the platforms.

6.1.2 Findings from the Survey Study

The findings from in-depth case studies show that factors in the framework explain initial decision making of organisations for platform collaboration. We conducted a survey to prioritize the importance of factors for organisations to join collaborative platform projects. We included respondents from energy and e-healthcare domains of Smart Living.

The results show that organisations clearly prefer to collaborate on establishing open platforms. We found that *platform openness* (i.e., open APIs and openness to application developers), *interests of partners* and *incentives* provided in platform projects are the most important factors for respondents in energy and e-healthcare sub-samples.

Comparing factors across the energy and e-healthcare sub-samples, the results show that *technical openness* (i.e., open APIs) is of more significance for respondents in the energy sub-sample. In the e-healthcare sub-sample, *interest of partners* was identified as the most important factor. *Incentives* were found more important in the e-healthcare sub-sample and *organisational openness* (i.e., openness to application developers) was found equally important for respondents in both sub-samples. The way platform projects are organized (i.e., centralized or decentralized) was found as the least important factor for platform collaboration in both energy and e-healthcare sub-samples.

Although the importance of the main factor is almost identical across energy and e-healthcare sub-samples, the importance of sub-factors differs. With regard to interests of partners in the project, the results show that respondents from both energy and e-healthcare sub-samples prefer to start collaboration with partners having dissimilar interests in the project. In addition, respondents in the e-healthcare sub-sample prefer organisational resources of partners to technical resources while in the energy sub-sample, technical resources are preferred. Respondents in both sub-samples preferred technical interdependencies to organisational interdependencies. We found almost equal preferences for centralized and decentralized decision-making approaches across two sub-samples. Apparently, strategies adopted for organizing platform projects do not influence decisions of organisations for collaboration. Respondents in the energy sub-sample preferred well-reputed partners over financial incentives in platform projects. Finally, we found that platform projects with closed APIs and closed to application developers are the least preferred by respondents in both sub-samples.

6.2 *Discussion of Findings*

In this section, we discuss differences of findings between the two methods (i.e., survey and case studies) and two sub-domains of Smart Living (i.e., energy and e-healthcare).

6.2.1 Differences between the survey and case studies

We found a number of differences between findings of the case studies and the survey. Partly these differences may be explained by the nature of the two methods. For instance, case studies allow a rich specification of core concepts while AHP requires a rather strict specification of factors.

Diversity of interests

One of the striking findings from the survey is that initially organisations prefer to collaborate with partners having different interests in a platform project. In the case studies, having different interests was not an important factor for the decision to become engaged in collective action. It should be noted that we even found in the case studies that such differences of interests might later lead to conflicts and discontinuance of collaboration. One possible explanation is that when partners have different interests in a project (i.e., benefit from the platform project differently) it means that they do not need to compete with each other. Therefore, this makes it easier for them to collaborate. However, as the project proceeds, such diversity of interests may cause difficulties in reaching agreements on different aspects of the project (e.g., business models or deciding on whether to proceed to a next phase) and in the worst case, the project may be discontinued.

Platform Leadership

In the case studies, we found that a platform leader plays an important role in initiating, enabling and coordinating platform collaboration. As we found strongly different approaches to centralized and decentralized decision making, in the survey we focused on this trade-off. Interestingly, respondents indicated that this trade-off was the least important of the factors leading to the decision to engage in a collaborative platform project. Apparently, other issues related to leadership are more important: reputation, position and resources of the leading organisation as well as whether and how the leader acts in the interest of other partners, keeps an eye on mutual interests or resolves conflicts to encourage collaboration. Future research should test these leadership issues across other empirical settings.

Incentives

In the case studies, we found financial incentives more critical for large organisations in the home energy management field (i.e., the *West Orange* case). Nevertheless, in the survey, financial incentives were identified important for the e-healthcare domain while in the energy domain the reputation of partners was considered as an important incentive for collaboration. It can be speculated that one of the main objectives of e-healthcare platform projects is the need for saving in service costs. Therefore, bearing the cost of collaboration might be even more difficult for organisations in this domain, which needs to be rewarded with financial incentives. It can also be inferred that energy companies have sufficient money to start platform projects and for partners working with energy companies, the reputation and market position of energy companies are more important (as found in the survey) to ensure access to a customer base.

Platform Openness

Despite the absence of open APIs and openness to application developers in the case studies, surprisingly we found a strong preference for platform openness (open APIs and openness to application developers) in the survey study. On the one hand, the preference for openness in the survey can be considered as an artefact of the survey method as respondents may tend to give socially-desirable answers regardless of their contents (e.g., openness is often considered as a desirable characteristic for platforms). On the other hand, differences between findings of the case studies and the survey can be an artefact of the period of the studies. We studied the *Active Life Home* and *Home-based Senior Care* cases during the development phase in 2011 and 2012, respectively. The *West Orange* project, though studied in 2013, was started in 2008 and ended in 2011. The survey study was conducted in 2013. Therefore, it can be speculated that perhaps openness is gaining momentum lately and organisations are becoming more aware of benefits of open platforms, including flexibility to extend or integrate services or building a community around the platform.

As the focus of case studies was on the initial phase of platform projects, the scepticism to openness (in the case studies) can be related to the phase of the projects. It seems that organisations are now realizing that while closed platforms can provide a favourable experimentation environment, they are not feasible on the long term because open platforms will grow quicker. Therefore, once the platform is developed and commercialized, platform openness (open APIs and openness to application developers) ensures the market growth and diversity around the platform. We can also posit that the time horizon of platform projects influences platform openness strategies. Platforms with long-term strategies for expansion and growth are more likely to open up to third parties (e.g., *the Active Life Home* and *Home-based Senior Ca*re cases). Nevertheless, when the objective of the platform provider is to provide merely value-added services to its existing customers, openness becomes less relevant (e.g., the *West Orange case*). Table 6.1 summarizes the main differences in findings between the case studies and the survey.

Table 6.1. Main differences between the case studies and the survey

Factors	**Case studies**	**Survey**
Heterogeneity of interests	Not an important factor	Important factor
Leadership	Important factor that influences decision for collective action	The specific trade-off between centralized and decentralized leadership is not important
Incentives	Financial incentives are important	Financial incentives are most important in e-health but not in the energy domain
Platform openness	No strong prominence of open platforms	Strong preference for open platforms

6.2.2 Differences between the energy and e-healthcare sub-domains

We found differences between the energy and e-healthcare sub-domains of Smart Living. We found preferences for organisational resources of partners in the e-healthcare domain and technical resources in the energy domain. Apparently, in the energy domain technological resources and in the e-healthcare domain organisational resources for establishing common service platforms are missing. Moreover, the energy domain is more technical compared to the e-healthcare domain. The need for technological resources in the energy domain was also found in the case studies (i.e., the *West Orange* case) as we heard from interviewees that proven technologies are needed to ensure security and privacy of data on home energy management platforms. On the other hand, in the e-healthcare domain (i.e., the *Active Life Home* and *Home-based Senior Care* cases), interviewees more discussed the need for support from healthcare organisations and/or the government for the implementation of e-healthcare service platforms.

Respondents in both energy and e-healthcare sub-samples preferred to be interdependent on each other for technical resources rather than organisational resources. It can be speculated that organisational resources (e.g., market position, customer base) are scarce and harder to be substituted in the Smart Living projects. Therefore, interdependencies for organisational resources limit the flexibility in partner selection in platform projects, which is not favoured by organisations.

We found in the survey that technical openness is slightly more important in the energy sub-sample than in the e-healthcare sub-sample. One explanation could be the privacy and sensitivity of e-healthcare data makes control and closedness more favourable in this domain. It is also possible that actors in the energy domain started to understand that home energy management platforms are not attractive enough for customers as merely value-added services. Therefore, they intend to realize potentials of these platforms by opening them up to third parties to complement the platforms with additional services. Such approach may not only make the platforms more appealing to customers, it may become a new line of business for energy companies or providers of these platforms.

6.2.3 Generalization to other domains

The findings of this research are generalizable outside the Smart Living domain. Findings with regard to issues of diversity of interests or limited financial incentives for development projects are generalizable to other technology development projects. In addition, the importance of organisational resources for collective action as well as the fact that platform projects tie partners together holds for other platform domains. For instance, similar collective action issues are happening in the mobile payment domain where parties such as banks and telecom should collaborate for establishing common platforms for mobile payments (De Reuver et al., 2014). The issue in platform collaboration is primarily about the clash between Information Technology (IT) and other sectors.

6.3 *Theoretical Contributions*

This research is the first to apply collective action theory to common platforms and ecosystems. In the following, we explain how this study contributes to existing literature on collective action theory, platforms and business ecosystems.

Contributions to collective action theory

The primary contribution of this thesis is a validated theoretical framework, which explains what factors influence the initial decision of organisations to engage in collective action to establish a common platform. The framework was developed by integrating the theory of collective action with the theory on platforms. While the theory of collective action has been previously applied to the adoption and diffusion of information systems (Markus, 1987; Rogers, 1991), it has hardly been applied to analysing the providers of common platforms (Exceptions: Klein & Schellhammer, 2011; Markus et al., 2006). Our framework provides a basis for further study of collective action for common platforms.

This study reveals that factors influencing collective action for common platforms differ from other information systems. Specifically, collective action for common platforms also involves challenges with regard to platform openness, platform leadership and two-sided markets. Therefore, this study contributes by differentiating collaboration for traditional information systems and collaboration for emerging platforms.

In this study, we focused on the start-up rather than continuance phase of collective action (Markus, 1987; Markus et al., 2006) . Our results show that interest heterogeneity does not influence organisations' decisions for the start of collective action. These findings on the start-up phase of collective action complement existing studies that typically focus on issues of continuance of collective action (cf., Klein & Schellhammer, 2011; Markus et al., 2006).

Furthermore, in line with previous studies in collective action literature (cf., R. Hardin, 1982; Oliver et al., 1985; Sheppard et al., 1990; Walter et al., 2012), our study shows that interdependencies encourage collective action and is required to overcome the start-up issues. We propose to distinguish technological interdependencies (i.e., the need for technology and know-how knowledge of partners) and organisational interdependencies (i.e., the need for a customer base, financial resources, market position, reputation and organisational relations of partners) to overcome the start-up issue in collective action. We contribute to collective action literature by showing that organisational rather than technological interdependencies create stronger bonds between organisations and thus can solve the start-up problem in collective action.

Consistent with earlier studies on selective incentives, our findings show that financial incentives can be deployed by leaders to solve the start-up issue of collective action (Olson, 1971; Von Hippel & Von Krogh, 2003). We contribute to the concept of selective incentives in collective action literature by linking it to platform openness. We found that typically development projects partially funded by the government or funding organisations are closed to new partners, because of complexity of administration process of involving new partners. Furthermore, we put forward the notion of a marquee actor (i.e., a well-reputed actor which encourages participation of others in collective action), borrowed from literature on multi-sided platforms, as an intangible incentive which can initially encourage collective action for common platforms. We thus contribute by showing the importance of financial and non-financial incentives for collaborative provision of Smart Living services.

Contributions to platform literature

Platforms are becoming increasingly important in the field of IS, as modular architectures (e.g., Service Oriented Architecture (SOA)) can transform legacy information systems into flexible platforms (Tilson et al., 2012). This study responds to calls from IS scholars for research on development, governance and evolution of service platforms (Tilson et al., 2010; Yoo et al., 2010). The theoretically grounded framework developed and tested in this thesis theorizes collaboration for the development of common platforms. The framework shows that the initial decision for collaboration in the development of common platforms depends on a range of technical and organisational factors (i.e., interest heterogeneity, resource heterogeneity, interdependencies, platform leadership, selective incentives and platform openness). We thus contribute the initial decision factors for platform collaboration to platform theory.

This thesis has been one of the first to study platforms from a perspective of *multiple* platform providers (i.e., when several actors jointly participate in the development of a common platform). Empirical research on platforms jointly developed by multiple organisations is scarce. Most studies on platforms focus on cases where there is one single platform provider rather than when multiple organisations collectively develop a platform (Gawer & Cusumano, 2002, 2012; Perrons, 2009; West & Wood, 2013). Therefore, our study helps to distinguish collaboration between multiple actors for developing a common platform (the start-up phase) and collaboration between a platform provider and complementary providers (the continuation phase). In this way, we pave the way for studies on collaboration between multiple platform providers, which is not dealt with in current platform theory.

Our study extends existing theorizing on platform openness by showing that platform openness does not merely influence innovation opportunities or collaboration between a platform provider and complementary providers (Boudreau, 2010; Eisenmann et al., 2008; Na, 2008). In fact, this study shows that platform openness also influences decisions of multiple platform providers for joint development of a platform. The concept of platform openness should thus be extended towards the collaboration between platform providers

In contrast to the general assumption that platform leaders should be the provider of platform technology (cf., Gawer & Cusumano, 2002), we found that platform leaders in the Smart Living domain are not necessarily the providers of platform technology. In fact, we found that platform leaders in the Smart Living domain often hold organisational resources and capabilities (rather than technology) which are critical for technology providers. We therefore suggest extending the concept of platform leadership to not just the technology provisioning but also the organisational relationships. In addition, we contribute to literature on platform leadership by revealing the special role of non-profit organisations in stimulating platform collaboration.

Finally yet importantly, this thesis contributes to literature concerning business ecosystems by applying the concept of business ecosystems to collective action theory in order to explain how ecosystems' configurations influence the likelihood of collaboration among members. Our study shows that characteristics of business ecosystems (i.e., heterogeneity of interests and resources of partners, interdependencies among partners, organisational openness towards new parties and leadership) can be used to explain collaboration among members of business ecosystems. Our results pave the way to move from the typically descriptive towards more explanatory approaches to analysing business ecosystems.

6.4 *Contributions to the Smart Living Domain*

Beside theoretical contributions, this study provides insights into platform collaboration in the Smart Living domain. Such insights can inform organisations which trade-offs to take into account when formulating strategies for their platforms. In this section, we discuss implications with regard to the Smart Living platforms and ecosystems.

6.4.1 Implications for the Smart Living Platforms

From the domain study (see Chapter 3), we found several Smart Living service platforms offering a range of services (e.g., home energy management, e-healthcare, surveillance and entertainment services). We found that where a platform is located (i.e., in the home, on the cloud, over a network or distributed across them (hybrid)) can influence the degree to which the platform is open to third parties. For instance, we found that most home-centric service platforms are closed to third parties, meaning that the platforms do not provides facilities (e.g., APIs, SDKs) for application developers to provide applications and services on the platforms. On the other hand, we found a greater degree of openness for network-centric service platforms (e.g., telecommunication networks used by third parties for audio/video services) and cloud-centric service platforms (e.g., Microsoft HealthVault, Google Health platforms) (see Chapter 3). Considering the increasing number of IP-enabled devices and online services (which are economical, scalable and easily accessible), we predict that cloud platforms take over the Smart Living market. In that case, openness will also gain momentum.

While initially we found a large number of closed home-centric service platforms, indicating intense competition for dominancy in the Smart Living market (see Chapter 3), during the course of research, we observed trends towards developing open software platforms (e.g., ‘Android@Home’ by Google; ‘the Lab of Things’ by Microsoft). Such platforms, which can be installed on a variety of mobile and computer devices, aim to provide a centralized dashboard for connecting multiple devices and appliances at home (plug and play). Such attempts from international companies for developing more flexible and open platforms show an increasing awareness of the need for openness in the Smart Living domain. Our findings from the survey study also confirm the growing awareness for openness in the Smart Living domain (see Chapter 5). Accordingly, we expect trends towards development of new business models to exploit the potentials of open platforms (Abduh & Omar, 2012; Chesbrough et al., 2013).

The development of new business models for open platforms is especially important as unlike the traditional stovepipe architecture for products or services, open platforms enable engagement of third parties in the development of value on the platform. As a result, customer acquisition, monetization and management of open platforms are different from typical products and services. While open platforms may facilitate further extension of the platforms with additional value and may urge widespread adoption of the platforms, they involve typical the two-sided market issue, i.e., the chicken and egg problem. We found such a two-sided market issue for open Smart Living service platforms provided by large international IT companies (e.g., Microsoft Hohm and Google Health platforms) (See Chapter 3). Solving such an issue requires business models, which ensure specific value generation for each group of participants in the platform ecosystem. Such business models should also address technical aspects of platforms (i.e., standards, interfaces, APIs) to ensure integration of systems and services of multiple parties in platform ecosystems.

After all, whether an open or closed platform is beneficial highly depends on the context. A closed service platform may lead to high installation costs, lack of interoperability and hassle for end-users. On the other hand, closed platform strategies may be beneficial as well when it means more control over application developers and service providers in prevention of malicious contents, enforcement of security and privacy arrangements and more leverage over content providers in building the platform ecosystem.

6.4.2 Implications for Smart Living Ecosystems

The domain study (see Chapter 3) shows that Smart Living is indeed a cross-sector industry consisting of numerous small and large, private and public, for-profit and non-profit organisations from diverse sectors of industry. While a number of these actors are more established with commercialized products and/or services, a majority of them are SMEs with limited resources addressing niches in this market (e.g., providing technologies, devices and appliances for Smart Living services). Establishing Smart Living platforms requires collaboration among all these actors.

For instance, looking at the e-healthcare domain of Smart Living, actors such as care service providers, government, insurance companies as well as technology providers are involved. Considering different objectives of each actor in platform projects, it is therefore critical to first ensure alignment of interests among parties. This study reveals that alignment between actors in Smart Living platform projects and support for the development and implementation of platforms require a leadership with resources such as inter-organisational relationships, a power position in the market and access to customers (see Chapter 4).

We found that platform leadership in the Smart Living domain differs from platform leadership in other industries. While providing a platform technology is the core of leadership in ICT, mobile or computing industries, providing organisational resources and capabilities to organize a network of actors is far more important for the leadership role in the Smart Living domain. For instance, in the energy domain, energy providers are the leading actors while they are not the provider of technology. Similarly, in the e-healthcare domain, the leading actors are often healthcare organisations or local or national governments stimulating e-healthcare platform projects.

Although large players such as telecom operators, energy providers (utilities) and surveillance service providers have a key asset (i.e., network connectivity to households) to position themselves in the Smart Living domain, we found that the domain is mainly driven by start-up SMEs providing (closed) niche technologies and services (see Chapter 3). Although telecom operators have been trying to offer Smart Living platforms for years, they have not yet provided commercialized solutions. For utilities and surveillance service providers, providing Smart Living services is a way to increase customers' loyalty and/or extend their businesses. Nevertheless, they lack domain knowledge of health and/or energy. This situation reflects the need for collaboration among large market players for open platforms to boost the market for Smart Living services in coming years.

6.5 *Recommendations to Practitioners*

Although we found a number of technical and organisational factors influencing the initial decision of an organisation for collaboration in the Smart Living domain, the findings of this research do not suggest a specific recipe for platform collaboration in the Smart Living domain. However, based on our findings, we can recommend a number of possible courses of actions to be taken into account by practitioners in the Smart Living domain when planning to collaborate for common service platforms.

Our first recommendation to practitioners is to explicate their interests in platform projects as well as their joint and individual business models from the very beginning. Special care should be given to reaching agreements on future interests and strategies (e.g., with regard to business models, platform openness and governance) in the initial stage of platform projects. Our study shows that typically organisations in Smart Living platform projects initially agree on higher-level goals (e.g., developing a common platform or doing a pilot project) without clarifying their individual interests in the project. However, later clashes of short-term interests (e.g., research, knowledge gaining) and long-term interests (e.g., commercialization, extending platform functions) or changes of interests during the projects lead to discontinuance of the development projects. Therefore, we strongly recommend practitioners to spend a significant amount of time initially to carefully define interests, strategies and business models for platform projects to avoid later conflicts and failure of the projects.

Second, practitioners should ensure that the leader of a platform project also has technical capabilities (e.g., developing (a part of) the platform or having knowledge about the platform technology). This ensures that the leader can support the project both in the development as well as in the implementation phases. The lack of technical knowledge from the platform leader may create communication issues between the leader and technical partners (e.g., platform developers, application providers) in the project (See Chapter 4). Additionally important is to ensure that the leader has sufficient organisational capabilities (e.g., access to customers for the platform, inter-organisational relationships and financial resources) to support the project to proceed to the implementation phase. Starting a project with a leader which is not financially capable of supporting the project is not a viable long-term strategy. Moreover, due to rapid changes and uncertainties in innovative fields, such as Smart Living, capabilities of leaders in change management and conflict resolution are critical.

Third, ‘a leader wannabe’ in the Smart Living domain should first create trust relations with other parties (Gawer & Cusumano, 2002). One way to do this is to implement Intellectual Property Rights (IPRs) to ensure SMEs that their technologies are protected. Another way is to involve well-reputed organisations in the projects (e.g., the government) to earn trust of other parties. This is especially important as providing Smart Living services required several devices and services provided by SMEs. Attracting SMEs and developing trust relations is the first step to develop the ecosystem around the Smart Living platforms.

Fourth, with regard to the type of platform leader a trade-off should be made between for-profit organisations as leaders of Smart Living platform projects versus SMEs or non-profit organisations. While non-profit organisations are more easily trusted than for-profit organisations, they are constrained with regard to their financial resources to continue the projects. On the other hand, large commercial organisations have access to customers and can exploit network effects around the platforms. Nevertheless, the decision-making process in large organisations takes longer than in SMEs and this may constrain the speed of the projects.

Fifth, we recommend practitioners to start platform projects in small groups of partners with complementary resources. This lessens competition between partners and makes it easier to align interests of parties when the group is small. Our study shows that large groups face issues of communication and coordination. The cost of coordination and communication is especially detrimental in the beginning of platform projects, as the partners have already invested heavily for the development.

Sixth, while practitioners should implement positive incentives (e.g., funding) to initially attract partners to collaborative platform projects, negative incentives (e.g., fine) should also be implemented to prevent free-riding behaviours in the projects. We learned that even when organisations agree on their roles in a project, sometimes partners do not fulfil their roles (see Chapter 4). This causes costs for other parties because they have to look for alternative actors to fulfil the role, which also delays the project.

Seventh, funding may not be encouraging when the costs of innovative projects are much more than available funding. While it might be possible for large organisations to take some risks, for SMEs the risk would be much more damaging as they may lose their businesses. Therefore, to encourage collaboration in platform projects, it is important that the government or funding organisations perform a detailed costs analysis of platform projects, before they provide funding. This would provide a more realistic estimation of costs in innovation projects.

Eighth, we recommend practitioners to involve governments in Smart Living platform projects. The government can play triple roles in these projects: 1) (partially) sponsoring the project by means of funding or subsidies; 2) supporting implementation and launching of platforms once developed; 3) developing regulations or policies regarding offering Smart Living services with the aim of increasing market competitions while encouraging collaboration. In addition, involving the government as an influential partner may encourage organisations to join the project, i.e., network effects.

Ninth, we strongly recommend practitioners to avoid copying strategies of similar platforms, for instance with regard to openness. Practitioners should be aware that in platform businesses, similar strategies would have different outcomes in different contexts (Tee & Gawer, 2009). Therefore, it is important to take into account the context, regulatory frameworks and standardization dynamics when developing strategies and business models for Smart Living platforms.

Finally, practitioners should be aware that they might need to formulate dissimilar strategies for different phases of platform projects. For instance, while a platform can be closed to third-party application developers during the development phase, it might provide open APIs once it is established in the market.

6.6 *Limitations*

This study, similar to any other study, involves a number of limitations. In this thesis, we studied several technical and organisational factors that could influence collaboration among organisations for joint platforms. Nevertheless, other factors could also influence organisations' decisions to become engaged in collaborative platform projects. For instance, group size, future adoption of the platform and services, profitability of the services, support or involvement of governments and mutual trust between platform providers are other relevant explanatory factors for joint platform collaboration.

In the case studies, we showed if and how each factor influences decisions for collaboration for establishing joint platforms. Then, in the survey study, we prioritized the importance of factors in decision-making. Nevertheless, from the survey we found out that there is much to prioritize because the weights of factors were quite similar. In addition, we were limited with regard to the choice of sub-factors in the survey model. Although including all relevant sub-factors would provide more insights, the length of the survey and operationalization of concepts were limiting factors.

This study focuses on the start-up of collective action. The relevance and importance of factors studied in the case studies and the survey might differ when studying platforms in other phases, e.g., commercialization. For instance, one may wonder if collaboration is a sufficient condition to launch a common service platform and if not what other necessary conditions should be in place to launch a profitable platform. Moreover, the case studies and the survey study were focused on the energy and e-healthcare domain of Smart Living. Although, home energy management and e-healthcare platforms often provide other Smart Living services, such as security or entertainment, studying other types of Smart Living platforms could provide additional insights into the domain.

Our pragmatic approach in selecting cases in this thesis resulted in diverse cases from different countries and domain of Smart Living, which bring spuriousness in cross-case comparison. Moreover, we only studied cases in which collective action came about. However, we did not consider cases where collective action did not initially arise. Studying such failure cases of platform collaboration could reveal insights as to what inhibit the start of platform collaboration.

Lastly, we did not examine how cultural differences between Finland, China and the Netherlands had an influence on the start of collective action in the case studies. It is likely that using a cultural lens (e.g., Hofstede et al., 1991) as a theoretical framework to study platform collaboration could explain or predict other explanatory factors for platform collaboration in different countries.

6.7 *Recommendations for Future Research*

The limitations discussed in the previous section provide avenues for future research to build upon this study.

The propositions developed in the framework can be tested using other quantitative methods, e.g., Structural Equation Modelling (SEM), or experiments, e.g., serious gaming. For instance, SEM enables testing the framework against the obtained measured data to confirm or reject causal relations in the framework. Serious games not only can be used to validate the framework, but also to study network dynamics to identify actions and strategies needed to achieve a desired outcome with regard to collaboration. The theoretical framework could also be further developed to include additional factors. Using the Hofstede cultural lens (1991), for instance, future research may study whether and how cultural factors can influence platform collaboration across countries. For instance, power distance (i.e., the degree to which members of a society accept that power is distributed unequally) may influence the type of platform leadership strategies across countries. In addition, one could argue that platform collaboration is more likely in countries with collectivism culture (i.e., a preference for a closely-knit structure that members look after each other for certain loyalty). Similarly, as innovative projects involve uncertainties and long-term vision, a question would be if long-term future oriented cultures perform better in collaboration in innovative fields, such as Smart Living.

In this research we cover the impacts of technical factors (i.e., technical openness of platforms), network structure (i.e., interest heterogeneity, resource heterogeneity and interdependencies), and governance factors (i.e., incentives, organisational openness and leadership) on the decision for collective action. Nevertheless, it is likely that the internal culture of organisations as well as their business processes are limiting factors in collaboration. For instance, governmental organisations with isolated internal processes and less collaboration focus might find it more challenging to collaborate with external parties. Therefore, the framework can be complemented by including factors on an organisation level.

Future studies can also explore how governmental actors or institutions can influence independent factors in the framework to stimulate collective action. For instance, in the e-healthcare and energy management domains, governments can have a catalysing impact in the development and deployment of services.

Another area for future studies is to replicate this research for common service platforms in other domains. For instance, exploring if the framework will hold for collaboration for home automation, entertainment or surveillance platforms will increase validity of the framework. Considering that ecosystems of other Smart Living platforms may include less diversity of actors, studying such platforms will reveal if there are domain-specific issues involved in Smart Living platform collaboration.

Future studies can explore if impacts of independent factors in the framework are different for different types of collective action (e.g., alliances versus consortiums). Although we study decisions for the start-up of collective action as the dependent factor, one could also look into depth, longevity and performance of collective action as dependent factors. Moreover, the moderating effects of factors in the framework can be further explored. For instance, platform openness can be considered as a mediator factor (between other factors and collective action) or as an outcome of collective action. This is especially interesting as our study shows that decisions with regard to technical openness of platforms are not clearly defined in the beginning of collective action. Therefore, it is worthwhile to study if collaboration will actually lead to more technically open platforms or not.

While we studied the initiation (start-up) phase of platform collaboration, future studies can explore how to ensure the continuance of collaboration among members of such platform ecosystems (i.e., platform providers and complementary providers) in the commercialization phase. The results of such studies can inform if and how factors influencing collaboration differ across different phases of platform collaboration. This is especially important as the commercialization phase of platforms involves issues of adoption and diffusion. Methods such as Social Network Analysis (SNA) can be used to study what attributes of platform ecosystems change over time (in different phases of platforms) and how such changes influence the continuance of collective action among members of the ecosystems.

Establishing a platform is the first step of a platform business. How to create an ecosystem of organisations around the platform is another step. As such, further research is required to explore two-sided market issues of common platforms and study if and how strategies required to urge the adoption of common platforms are different from platforms with a single provider.

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Appendix A: Interview Questions

Questions	Related Concepts
1. Please tell me about the role of your organisation in this project.	Background Information about the organisation
2. With what companies are you actually collaborating on a daily basis?	Network Structure
3. What were the main drivers for your company to start collaborating in this project? And what do you consider now as added value of this collaboration for your organisation? (e.g., new resources, customers, partners, insights, publicity)	Motivations - Heterogeneity of Interests
4. Are there any interdependencies between partners in this project? How does it affect your decision for collaboration?	Dependency
5. In how far were the partners in this project different? How do these differences influence your decision for collaboration? (think of differences in (a) resources (b) sectors (c) size (d) type (private/non-profit/public)	Heterogeneity of Resources
6. Have you encountered any difficulties during the collaboration? How did it resolve (e.g., useful for clarifying different expectations or harmful for project)?	Conflicts of Interests
7. Do you provide the technical information of the platform for third-parties to develop services/applications? How and why? Does that influence your decision for collaboration?	Technical Openness
8. Is the project open for new parties to join? Are there any rules or agreements for that? How did that influence your decision for collaboration?	Organisational Openness & structure
9. How the cooperation is coordinated and how did it influence your decision for collaboration?	Platform leadership
10. Are there any subsidies or funding available for partners? how did it influence your decision for collaboration?	Selective Incentives
11. How do you see the future of the service platform in terms of adoption by customers or energy providers? 12. Who is the owner of the platform? Who utilize the platform, who will benefit from it, who will pay for it?	Background Information about the future of project

Appendix B: Questionnaire

Instruction

For the questionnaire, please imagine that your organisation is considering to join a project on e-healthcare/independent living (Home energy management) solutions. The project aims to develop a service platform on which various e-healthcare services (home energy management services) can be offered to households. There are large, small organisations involved in the project, and the project is led by a large organisation.

You are asked to pair-wise compare a number of criteria when deciding to join such a project. Sometimes you may be forced to compare criteria that you think are both equally relevant and/or irrelevant, but this is part of the method.

First, we would like to ask you to pair-wise compare the importance of the following criteria for your organisation with respect to deciding whether to join a platform project for e-healthcare (home energy management) services.

Project criteria	**Definitions**	**Examples**
Leadership structure	How decision-making is organized in the project.	Centralized or decentralized decision making
Technical openness of the platform	How open the technologies in the platform are towards application providers	Open or closed interfaces
Organisational openness of the platform	How open the project is for third parties to join.	Open or closed to other application or technology providers
Resources of other partners	The resources brought in by project partners.	Technologies, brands, access to customers
Interests of other partners	The strategic interests of other project partners	Different or similar interests
Interdependency among partners	The extent to which project partners depend on each other (e.g. for technologies, know-how or access to customers)	Dependencies on technologies, brands, access to customers
Incentives offered in the project	Whether financial or other incentives are offered to project partners.	Subsidies, funding

1) When deciding to join a collaborative platform project, please indicate for each pair of criteria which criterion is more important for your organisation? And by how many times?

	5 Extremely Important		3 Strongly Important		1 Equally Important		3 Strongly Important		5 Extremely Important	
Leadership Structure (How decision making is organized in the project)	○	○	○	○	○	○	○	○	○	Technical openness of the platform (How open the technologies in the platform are towards application providers)
Leadership Structure	○	○	○	○	○	○	○	○	○	Organisational openness of the platform (How open the project is for application or technology providers to join)
Leadership Structure	○	○	○	○	○	○	○	○	○	Resources of other partners
Leadership Structure	○	○	○	○	○	○	○	○	○	Interests of other partners (The strategic interests of other project partners)
Leadership Structure	○	○	○	○	○	○	○	○	○	Interdependency among partners (the extent to which partners depend on each other)
Leadership Structure	○	○	○	○	○	○	○	○	○	Incentives offered in the project (Whether subsidies or other incentives are offered to partners)
Platform Technical Openness	○	○	○	○	○	○	○	○	○	Platform Organisational Openness
Platform Technical Openness	○	○	○	○	○	○	○	○	○	Resources of other partners
Platform Technical Openness	○	○	○	○	○	○	○	○	○	Interests of other partners
Platform Technical Openness	○	○	○	○	○	○	○	○	○	Interdependency among partners
Platform Technical Openness	○	○	○	○	○	○	○	○	○	Incentives offered in the project

2) When deciding to join a collaborative platform project, please indicate for each pair of criteria which criterion is more important for your organisation? And by how many times?

	5 Extremely Important		3 Strongly Important		1 Equally Important		3 Strongly Important		5 Extremely Important	
Platform Organisational Openness (How open the project is for application or technology providers to join)	○	○	○	○	○	○	○	○	○	Resources of other partners
Platform Organisational Openness	○	○	○	○	○	○	○	○	○	Interests of other partners (The strategic interests of other project partners
Platform Organisational Openness	○	○	○	○	○	○	○	○	○	Interdependency among partners (the extent to which partners depend on each other)
Platform Organisational Openness	○	○	○	○	○	○	○	○	○	Incentives offered in the project (Whether subsidies or other incentives are offered to partners)
Resources of other partners	○	○	○	○	○	○	○	○	○	Interests of other partners
Resources of other partners	○	○	○	○	○	○	○	○	○	Interdependency among partners
Resources of other partners	○	○	○	○	○	○	○	○	○	Incentives offered in the project
Interests of other partners	○	○	○	○	○	○	○	○	○	Interdependency among partners
Interests of other partners	○	○	○	○	○	○	○	○	○	Incentives offered in the project
Interdependency among partners	○	○	○	○	○	○	○	○	○	Incentives offered in the project

4) We will now zoom into the criteria from the previous questions, and ask you which *alternative* your organisation would prefer for each criterion (in Bold).

With respect to deciding to join a collaborative platform project, please indicate for each pair of alternatives which alternative is more preferred by your organisation? And by how many times?

	5 Extremely Preferred		3 Strongly Preferred		1 Equally Preferred		3 Strongly Preferred		5 Extremely Preferred	
Leadership structure Single organisation makes decision	○	○	○	○	○	○	○	○	○	**Leadership structure** All organisations have equal votes
Platform Technical Openness Open Application Programming Interfaces/open communication standards	○	○	○	○	○	○	○	○	○	**Platform Technical Openness** Closed Application Programming Interfaces/proprietary communication standards
Platform Organisational Openness Application providers are allowed to offer services on the platform	○	○	○	○	○	○	○	○	○	**Platform Organisational Openness** Application providers are not allowed to offer services on the platform
Incentives offered in the project Your organisation receives funding or subsidy for participating in the project	○	○	○	○	○	○	○	○	○	**Incentives offered in the project** Project partners are well-known in the industry
Interests of partners Partners have dissimilar strategic interests in the project	○	○	○	○	○	○	○	○	○	**Interests of partners** Partners have similar strategic interests in the project
Resources of partners Partners have different technical resources e.g., technology, know-how knowledge	○	○	○	○	○	○	○	○	○	**Resources of partners** Partners have different organisational resources e.g. brand, customer base
Interdependency Partners interdependent for organisational resources	○	○	○	○	○	○	○	○	○	**Interdependency** Partners interdependent for technical resources

4) What is your role in your organisation?

- ◯ Business developer
- ◯ Account manager
- ◯ Product manager
- ◯ Chief information officer
- ◯ Other________________________________

5) I am involved with (more answers possible)

- ☐ Strategic management and policy
- ☐ Technology
- ☐ Operational management
- ☐ Other________________________________

6) My highest education level is...

- ◯ Bachelor Degree/ Polythechnic / HBO
- ◯ Master Degree / WO
- ◯ PhD / Dr
- ◯ Other________________________________

7) The organisation I work in belongs to...

- ◯ Energy Sector
- ◯ ICT Sector
- ◯ Healthcare Sector
- ◯ Research/Consultancy Sector
- ◯ Other________________________________

8) Do you have any comments on the survey?

9) If you would like to receive the results of this survey, please leave your email address below.

10) If you know someone who would be interested to fill in this survey, please leave his/her email address below.

Summary

Problem Statement The term Internet of Things (IoT) is used to envision networks of interconnected sensors, devices and appliances on the internet which are enabling a wide range of application areas, including Smart Living. We define Smart Living as ‘a bundle of internet-based services offered to households, accessible within and outside the house that combine value drivers of health, energy, safety and entertainment services to facilitate comfort living for households’. Smart Living is about using Information Communication Technology (ICT) in the home environment especially to solve the grand challenges of healthcare and energy. In the health domain, due to the growing ageing population, there is an increasing need for innovative healthcare solutions to provide elderly care services with less cost as well as improving the quality of life for elderly people. In the energy domain, realizing energy reduction requires home energy management services which enable households to manage their energy consumption.

Despite the considerable potential of Smart Living services in solving societal challenges, technical issues such as interoperability of devices as well as the rise of proprietary service platforms for service offerings are the main bottlenecks in enabling the vision of Smart Living. Although a lot of attention is paid to standardizing technologies to solve interoperability issues between devices and services, there is a lack of attention to using shared platforms to run Smart Living services. A platform can be viewed as hardware, software, a network infrastructure or a combination of these on which a number of services run. Recently, there is a trend towards modularization and platformization (i.e., to use a platform architecture to provide various services to customers) in the ICT industry. Although platformization has also been started in the Smart Living domain, existing Smart Living service platforms, each addressing a niche in the market, are often non-interoperable. This fragmented nature of the market with non-interoperable service platforms not only makes it difficult for Smart Living service providers to share data and to bundle services and products from different device or service providers, it also increases the time and costs to develop and implement new services.

While common service platforms are suggested to solve technical issues, several collaboration issues need to be dealt with. A service platform provides a set of technical and operational functions. On a technology level, a service platform gives access to a

range of (non) interoperable sensors and devices and also stores, shares and maintains data. Furthermore, a service platform provides a communication infrastructure, a user interface and authorization services to access, manage and personalize services on the Internet. On an operational level, a service platform should include a billing process and a help desk for customer support.

Establishing common service platforms for Smart Living services involves technological and organisational challenges. While many scholars study technological issues regarding common service platforms, organisational issues are typically overlooked. From an organisational point of view, establishing common service platforms for Smart Living services requires resources and expertise across disparate sectors of consumer electronics, Information Technology (IT), telecommunications, energy and healthcare. For instance, enabling a common service platform for offering energy management services requires a telecommunication infrastructure from telecom companies, smart metering systems from energy companies and expertise on system architecture from IT companies. Since organisations from distinct sectors have different ways of doing business, different roles, expectations and motives arise, as well as several potential sources of conflicts. Thus, the first and foremost organisational issue is how collaboration for establishing common service platforms for Smart Living services may arise. It is important to understand the motivation and criteria, which organisations take into account when deciding to join a collaborative project for establishing a common service platform. Moreover, organisations collaborating for setting up a common service platform may later compete with each other in offering services on the platform. Therefore, equally important is to strike a balance between collaboration and competition (Brandenburger & Nalebuff, 1997) and build up trust and commitment between those parties to maintain collaboration and deal with power struggles (De Reuver, 2009; Hoffmann et al., 2010; Volz et al., 2011).

Research Objective The objective of this study is to explain why and how collective action for establishing common service platforms for Smart Living services arises among organisations in platform ecosystems. Service platforms and platform ecosystems have characteristics that can influence the intention of organisations to collaborate for the platform. Therefore, we study what characteristics of service platforms and platform ecosystems influence organisations' decisions to become engaged in collective action for developing common service platforms for Smart Living services.

Research Approach Building on theories of collective action, platforms and business ecosystems, six characteristics of platform and ecosystem characteristics were identified to influence the decision of organisations for collective action (See Figure 1).

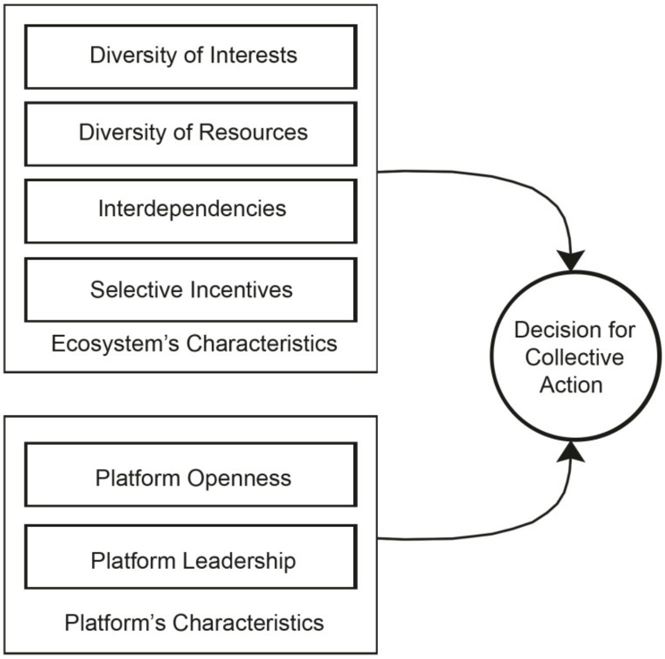


Figure 1. Factors influencing decision for collective action

The impact of each factor on decision for collective action was tested in three qualitative case studies in the domains of e-healthcare and home energy management. In the case studies, we were especially interested in the reasoning of organisations about how each factor influence their decisions to become engaged in a collaborative common service platform project.

In a next step of the research, the specified findings for each factor were used as a basis for the survey study. In the survey, we prioritized the importance of specified factors, by a large-scale expert validation in the Smart Living domain.

Findings from the Case Studies From the case studies we found all factors in the framework, except diversity of interests, influence the decision of organisations to participate in platform projects.

Interest Diversity: Dissimilarity of interests does not influence the initial decision of organisations for participation in collaborative platform projects. The findings indicate that organisations start collaborating without considering diversity of partners' interests as a potential source of conflicts.

Resource Diversity: This study shows that dissimilar complementary resources of partners, whether organisational resources (e.g., power position in the market, customer base, and inter-organisational relationships) or technical resources (e.g., technology and know-how knowledge) is an important factor in decision-making for collective action, especially that diversity of resources prevent competition in the platform ecosystem.

Interdependencies: We found that the need for complementary resources of other organisations creates interdependencies among partners in Smart Living platform projects. While there are typically no technical interdependencies among partners in the beginning of platform projects, technical interdependencies appear later as a side effect of platform collaboration.

Incentives: Our findings indicate that providing incentives for platform projects encourages participation of organisations. We found financial incentives (i.e., funding, subsidies) are especially encouraging for large organisations to reduce possible risks and increase reliability of investments. However, we also found that financial incentives may lead to projects which are closed to new parties to join.

Platform Leadership: We found the role of platform leadership of special importance to initiate a platform project, encourage other organisations to join (e.g., by means of providing incentives) and coordinate communication between partners. Our findings show that *the type of leading organisations* (i.e., for-profit and non-profit) as well as centralized and decentralized *decision making strategies* of platform leaders can influence collaboration in platform projects.

Platform Openness: Our study shows that organisations are willing to collaborate for platforms which are based on open standards (i.e., open communication standards or open standards interfaces) to ensure interoperability with complementary devices or services. Nevertheless, openness in terms of open Application Programming Interfaces (APIs) was not favoured by organisations, especially when the platform is in the development stage. From an organisational perspective, our study indicates that typically complete openness towards new partners has a negative impact on initial decisions of organisations for participating in platform collaboration.

Findings from the Survey In the second empirical part of this research, we conducted a survey to prioritize the importance of factors for organisations to join collaborative platform projects. We included respondents from energy and e-healthcare domains of Smart Living.

The results of the survey study show that organisations clearly prefer to collaborate on establishing open platforms. We found that *platform openness* (i.e., open APIs and openness to application developers), *interests of partners* and *incentives* provided in platform projects are the most important factors for respondents in the energy and e-healthcare sub-samples.

Comparing factors across the energy and e-healthcare sub-samples, the results show that technical openness (i.e., open APIs) is of more significance for respondents in the energy sub-sample. In the e-healthcare sub-sample, interest of partners was identified as the most important factor. Incentives were found more important in the e-healthcare sub-sample and organisational openness (i.e., openness to application developers) was found equally important for respondents in both sub-samples. The way platform projects are organised (i.e., centralised or decentralised) was found as the least important factor for platform collaboration in both energy and e-healthcare sub-samples.

Based on the findings from the case studies, for each factor in the survey we considered two sub-factors and asked respondents to also indicate the importance of sub-factors. Although the importance of main factors is almost identical across energy and e-healthcare sub-samples, the importance of sub-factors differs. With regard to interests of partners in the project, the results show that respondents from both energy and e-healthcare sub-samples prefer to start collaboration with partners having dissimilar interests in the project. In addition, respondents in the e-healthcare sub-sample prefer organisational resources of partners to technical resources while in the energy sub-sample, technical resources are preferred. Respondents in both sub-samples preferred technical interdependencies to organisational interdependencies. We found almost equal preferences for centralised and decentralised decision-making approaches across two sub-samples. Apparently, strategies adopted for organising platform projects do not influence decisions of organisations for collaboration. Respondents in the energy sub-sample preferred well-reputed partners over financial incentives in platform projects. Finally, we found that platform projects with closed APIs and closed to application developers are the least preferred by respondents in both sub-samples.

Conclusions

Theoretical contributions: The primary contribution of this thesis is a validated theoretical framework, which explains what factors influence the initial decision of organisations to engage in collective action to establish a common platform. The framework was developed by integrating the theory of collective action with the theory on platforms. While the theory of collective action has been previously applied to the adoption and diffusion of information systems (Markus, 1987; Rogers, 1991), it has hardly been applied to analysing the providers of common platforms (Exceptions: Klein & Schellhammer, 2011; Markus et al., 2006). Our framework provides a basis for further study of collective action for common platforms.

This study also responds to calls from IS scholars for research on development, governance and evolution of service platforms (Tilson et al., 2010; Yoo et al., 2010). The theoretically grounded framework developed and tested in this thesis theorizes collaboration for the development of common platforms. This thesis has been one of the first to study platforms from a perspective of *multiple* platform providers (i.e., when several actors jointly participate in the development of a common platform). Our study helps to distinguish collaboration between multiple actors for developing a common platform (the start-up phase) and collaboration between a platform provider and complementary providers (the continuation phase). In this way, we pave the way for studies on collaboration between multiple platform providers, which is not dealt with in current platform theory. This thesis contributes to literature concerning business ecosystems by applying the concept of business ecosystems to collective action theory in order to explain how ecosystems' configurations influence the likelihood of collaboration among members. Our results pave the way to move from the typically descriptive towards more explanatory approaches to analysing business ecosystems.

Recommendations to Practitioners: Our main recommendations to practitioners in platform projects are to give special care to 1) reaching agreements on future interests and strategies (e.g., with regard to business models, platform openness and governance) in the initial stage of platform projects; 2) selecting a platform leader which has both technical (e.g., developing (a part of) the platform or having knowledge about the platform technology) and organisational capabilities (e.g., access to customers for the platform, inter-organisational relationships and financial resources) for both development and implementation for the platform; 3) creating trust relations between parties in the ecosystems, for instance by means of implementing Intellectual Property Rights and/or involving well-reputed organisations in the projects (e.g., the government); 4) lessening competition between partners as well as reducing communication and coordination costs by starting a platform project with a small group of parties; 5) implementing both positive incentives (e.g., funding) to initially attract partners to collaborative platform projects as well as negative incentives (e.g., fine) to prevent free-riding behaviours.

Recommendations for Future Studies: There are several areas which can be explored by future research including: 1) extending the framework by including additional factors (e.g., cultural factors) and testing it using other quantitative methods or experiments; 2) exploring the moderating effects of factors in the framework. For instance, platform openness can be considered as a mediator factor (between other factors and collective action) or as an outcome of collective action; 3) exploring the role of governmental actors or institutions in stimulating collective action in different domains of Smart Living (e.g., e-healthcare and energy management domains); 3) replicating the research for common service platforms in other domains to find if there are domain-specific issues involved in Smart Living platform collaboration; 4) studying factors influencing platform collaboration in different phases of development and implementation; and 5) investigating two-sided market issues of common platforms to see if and how strategies required to urge the adoption of common platforms are different from platforms with a single provider.

Samenvatting

Probleemdefinitie De term Internet of Things (IoT) wordt gebruikt om netwerken te beschrijven van sensoren, apparaten en toestellen die onderling zijn verbonden via het internet. Deze netwerken worden onder meer toegepast in het Smart Living domein. We definiëren Smart Living als 'een bundel van op internet gebaseerde diensten die worden aangeboden aan huishoudens, die zowel binnen- als buitenshuis bereikbaar zijn en die tevens het leefcomfort verhogen'. Meer specifiek gaat Smart Living over het gebruik van informatie- en communicatietechnologie (ICT) in de thuisomgeving en is bedoeld om de uitdaging met betrekking tot gezondheidszorg en energie aan te gaan. Door de vergrijzing is er een toenemende behoefte aan innovaties voor ouderen in het gezondheidsdomein en is er behoefte om met lagere kosten toch een verbeterde kwaliteit van leven te kunnen realiseren. Daarnaast is energiebeheer nodig om het energieverbruik van huishoudens terug te kunnen dringen

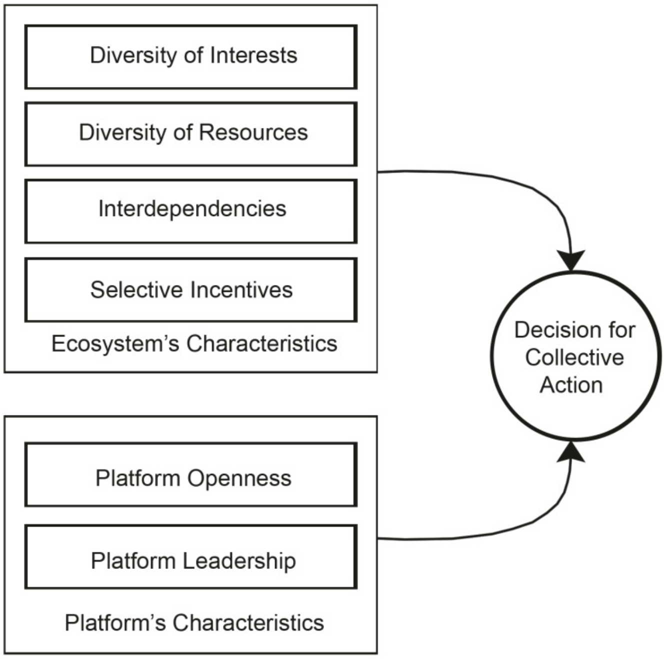
Ondanks de potentie van Smart Living diensten voor het oplossen van maatschappelijke problemen zijn er belangrijke knelpunten waardoor deze visie niet wordt verwezenlijkt. Het betreft onder meer de interoperabiliteit van apparatuur en de opkomst van gesloten dienstenplatformen. Hoewel er veel aandacht wordt besteed aan de standaardisatie van technologieën die interoperabiliteit tussen apparaten en diensten faciliteren, is er een gebrek aan aandacht voor het gebruik van gedeelde platformen voor Smart Living diensten. Zulke platformen kunnen worden gezien als hardware, software, een netwerkinfrastructuur of een combinatie daarvan en waarop diensten opereren. In de ICT-industrie is een trend zichtbaar richting modularisatie en `platformisatie' (d.i. een platformarchitectuur gebruiken om verschillende diensten aan klanten aan te bieden). Alhoewel platformisatie zijn oorsprong vindt in het Smart Living domein, zijn de bestaande Smart Living diensten vaak niet interoperabel omdat zij afzonderlijk opereren in een andere marktniche. Deze fragmentatie van de markt maakt het niet alleen moeilijk voor Smart Living dienstverleners om gegevens te delen, maar ook om diensten en producten van verschillende apparaat of dienstverleners te bundelen. Daarnaast verhoogt dit de doorlooptijd en de kosten voor het ontwikkelen en implementeren van nieuwe diensten.

Daarom zullen voor het tot stand komen van dienstenplatformen verschillende samenwerkingsaspecten moeten worden behandeld. Allereerst biedt een dienstenplatform op technologisch niveau toegang tot een scala aan (niet-) interoperabele sensoren en apparaten en zorgt het voor opslag, deling en onderhoud van gegevens. Verder biedt een dienstenplatform een communicatie-infrastructuur en gebruikersinterface voor de autorisatie van toegang met betrekking tot beheer en personalisatie van de diensten via het internet. Op operationeel niveau kan een dienstenplatform facturatieprocessen en klantondersteuning bieden.

Het tot stand brengen van dienstenplatformen voor Smart Living omvat verschillende technologische en organisatorische uitdagingen. Wetenschappers hebben deze kwestie veelal vanuit het technische kader bestudeerd terwijl organisatorische kwesties veelal over het hoofd worden gezien. Vanuit organisatorisch oogpunt vereist het tot stand komen van dergelijke platformen middelen en expertise vanuit verschillende sectoren. Deze sectoren behelzen de consumentenelektronica, informatietechnologie (IT), telecommunicatie, energie en gezondheidszorg. Het beschikbaar stellen van een gemeenschappelijk dienstenplatform voor energie-management diensten vereist een telecommunicatie-infrastructuur van telecombedrijven, slimme meters van energiebedrijven en expertise op het systeem van de architectuur van IT-bedrijven. Aangezien deze organisaties uit diverse sectoren komen, verschillen deze organisaties in de manier van zaken doen en de rol die zij spelen binnen een samenwerking. Deze organisaties verschillen daardoor ook in hun verwachtingen en motieven, wat weer effect heeft op het ontstaan van potentiële conflicten. Allereerst is onderzocht hoe samenwerking voor het tot stand komen van gemeenschappelijke dienstenplatformen voor Smart Living kan ontstaan. Het is hierin belangrijk om te begrijpen wat de motivaties en criteria zijn die organisaties hebben om toe te treden tot een samenwerkingsproject voor de oprichting van een dergelijk platform. Dit is met name belangrijk omdat ze later met elkaar kunnen concurreren in het aanbieden van diensten op dit platform. Hierdoor is het belangrijk om een evenwicht te vinden tussen samenwerking en concurrentie (Brandenburger & Nalebuff, 1997), het opbouwen van vertrouwen en betrokkenheid tussen deze partijen om zo de samenwerking te waarborgen en om te gaan met de strijd om de macht (De Reuver, 2009; Hoffmann, Neumann & Speckbacher, 2010; Volz, Petendra, Schilcher & Anderl, 2011).

Doel van het onderzoek Het doel van dit onderzoek is een beschrijving te geven hoe en waarom samenwerking voor een gemeenschappelijke dienstenplatformen voor Smart Living tussen organisaties binnen platform ecosystemen ontstaat. Dienstenplatformen en platform ecosystemen hebben kenmerken die de intentie van de organisaties om samen te werken kan beïnvloeden. Daarom bestuderen we welke kenmerken van de dienstenplatformen en platform ecosystemen beslissingen beïnvloeden van organisaties om betrokken te zijn bij samenwerking voor het ontwikkelen van gemeenschappelijke dienstenplatformen voor Smart Living diensten.

Onderzoeksaanpak Voortbouwend op theorieën van onder meer samenwerking, platformen en ecosystemen, worden hier zes kenmerken van platformen en ecosystemen geïdentificeerd die invloed hebben op het besluit van organisaties om tot samenwerking te komen (zie figuur 1).



Figuur 1. Factoren die de beslissing tot collectieve actie beïnvloeden

In dit onderzoek is de impact van elke factor op de beslissing voor samenwerking getest in drie kwalitatieve case studies op het gebied van e-health en huishoudelijk energiebeheer. In de case studies waren we met name geïnteresseerd in de redenering van de organisaties over hoe elke factor invloed heeft op hun beslissing om betrokken te zijn in project dat is gericht op een gemeenschappelijke diensten platform.

Bevindingen uit de case studies Uit de case studies zijn alle factoren gevonden die voorheen beschreven waren in het raamwerk. Alleen de factor 'diversiteit van belangen', bleek niet van invloed te zijn op de beslissing van organisaties om deel te nemen aan platform projecten.

Diversiteit van belangen: ongelijkheid van belangen blijkt geen invloed te hebben op de initiële beslissing van organisaties om deel te nemen aan samenwerkingsprojecten. De bevindingen wijzen erop dat organisaties een samenwerking beginnen zonder rekening te houden met de diversiteit van belangen die een potentiële bron van conflicten zouden kunnen vormen.

Diversiteit aan bronnen: de studie toont aan dat ongelijke complementaire middelen of partners een belangrijke factor vormen bij de besluitvorming tot samenwerking. Dit kunnen organisatorische middelen (bv., machtspositie in de markt, het klantenbestand en onderlinge relaties) of technische middelen (bv, technologie en kennis) omhelzen. Dit is met name omdat diversiteit aan bronnen de concurrentie op het platform ecosysteem voorkomt.

Onderlinge afhankelijkheden: uit het onderzoek blijkt dat de behoefte aan aanvullende middelen van andere organisaties onderlinge afhankelijkheden creëert tussen partners in Smart Living platform projecten. Hoewel er in het begin van het project meestal geen technische afhankelijkheden zijn tussen partners, ontstaan deze technische afhankelijkheden vaak later, als een neveneffect van het samenwerkingsplatform.

Selectieve prikkels: onze bevindingen wijzen erop dat het verstrekken van prikkels voor platform projecten de deelname van organisaties hierin stimuleert. Financiële prikkels (waaronder financiering en subsidies) zijn vooral bemoedigend voor grote organisaties om mogelijke risico's te verminderen en de betrouwbaarheid van de investeringen te verhogen. Maar ook blijkt dat financiële prikkels kunnen leiden tot organisatorisch afgesloten projecten.

Platform leiderschap: Het onderzoek toont aan dat platform leidershap van bijzonder belang is om een platform project te starten, om andere organisaties aan te moedigen mee te doen (bijvoorbeeld door middel van het verstrekken van prikkels) en voor de coördinatie van de communicatie tussen de partners. Onze bevindingen tonen aan dat de aard van de toonaangevende organisaties (dat wil zeggen, for-profit of non-profit), alsook gecentraliseerde en gedecentraliseerde besluitvormingsstrategieën van platformleiders de samenwerking in platform projecten kan beïnvloeden.

Platform openheid: Onze studie toont aan dat organisaties bereid zijn om samen te werken aan platformen die gebaseerd zijn op open standaarden (dat wil zeggen, open communicatie standaarden of open standaard interfaces) voor de compatibiliteit met complementaire apparaten of diensten. Echter, openheid in termen van de open Application Programming Interfaces (API's) werd niet geprefereerd door organisaties, met name wanneer het platform zich in de ontwikkelingsfase bevindt. Vanuit organisatorisch oogpunt blijkt uit de studie dat volledige openheid voor nieuwe partners meestal een negatief effect heeft op de initiële beslissingen van organisaties voor deelname aan een samenwerkingsplatform.

Bevindingen van de enquête In het tweede empirische deel van dit onderzoek hebben we een enquête onderzoek uitgevoerd om de volgorde van factoren vast te stellen voor organisaties om mee te doen aan een samenwerkingsplatform. We hebben respondenten uit de energie- en e-health sector ondervraagd binnen het domein van Smart Living.

De resultaten van het enquête onderzoek tonen aan dat organisaties duidelijk voorkeur hebben om samen te werken voor het oprichten van open platformen. We vonden dat platform openheid (dat wil zeggen open API en openheid voor applicatieontwikkelaars), belangen van partners en incentives op platform projecten de belangrijkste factoren zijn voor respondenten in de energie-en e-health subgroep.

Na vergelijking van de factoren in de energie-en e-health subgroep, laten de resultaten zien dat technische openheid (open API) van meer betekenis is voor respondenten in de energie subgroep. In de e-health subgroep is het belang voor de partners als meest belangrijkste factor geïdentificeerd. Prikkels bleken belangrijker in de e-health subgroep en organisatorische openheid (voor applicatieontwikkelaars) is even belangrijk voor de respondenten in beide subgroepen. De manier waarop platform projecten worden georganiseerd (centraal of decentraal) werd in zowel de energie- als de e-health-subgroepen als de minst belangrijke factor voor samenwerking aangeduid

Gebaseerd op de bevindingen van de case studies hebben we voor elke factor in het onderzoek twee subfactoren afgewogen en vroegen we de respondenten het belang van deze subfactoren aan te geven. Hoewel het belang van de hoofdfactoren vrijwel identiek is voor zowel de energie en e-health subgroepen, blijkt toch dat het belang van subfactoren verschilt. Op het gebied van de belangen van de partners in een project geven de resultaten aan dat respondenten uit zowel de energie- en e-health subgroepen eerder willen samenwerken met partners die ongelijke belangen hebben in het project. Daarnaast blijkt dat respondenten in de e-health subgroep organisatorische middelen van partners prefereren boven technische middelen, terwijl in de energie subgroep technische middelen de voorkeur hebben. Respondenten in beide subgroepen blijken de voorkeur te hebben voor technische afhankelijkheden in plaats van organisatorische afhankelijkheden. We vonden vrijwel gelijke voorkeuren voor gecentraliseerde en gedecentraliseerde besluitvormingsbenaderingen in twee subgroepen. Blijkbaar beïnvloeden strategieën voor het organiseren van platform projecten niet de besluitvorming van organisaties voor samenwerking. Respondenten in de energie subgroep prefereerden partners met een goede reputatie in plaats van financiële prikkels in platformprojecten. Tenslotte vonden we dat platform projecten met gesloten API's en zij die gesloten zijn voor applicatieontwikkelaars, het minst de voorkeur hebben van de respondenten in beide subgroepen.

Conclusies

Theoretische bijdrage: De primaire bijdrage van dit proefschrift is een gevalideerd theoretisch kader, waarin wordt uitgelegd welke factoren invloed hebben op de aanvankelijke beslissing van organisaties om deel te nemen aan samenwerking en zo een gemeenschappelijk platform op te richten. Het kader is ontwikkeld door het integreren van de theorieën van Collectieve Actie met de theorieën op platformen. De theorie van Collectieve Actie is eerder toegepast op de adoptie en verspreiding van informatie systemen (Markus, 1987; Rogers, 1991), maar het is nauwelijks toegepast voor het analyseren van de aanbieders van gemeenschappelijke platformen (Uitzonderingen:. Markus et al., 2006; Klein & Schellhammer, 2011). Ons raamwerk biedt een basis voor verdere studie van Collectieve Actie voor gemeenschappelijke platformen.

Deze studie reageert verder ook op verzoeken van IS wetenschappers voor onderzoek naar ontwikkeling, bestuur en evolutie van dienstenplatformen (Tilson et al., 2010; Yoo et al., 2010). Het theoretisch onderbouwde kader dat ontwikkeld en getoetst is in dit proefschrift, beschrijft samenwerking voor de ontwikkeling van gemeenschappelijke platformen. Dit proefschrift is een van de eerste die platformen bestudeert vanuit het perspectief van verschillende platform aanbieders (dat wil zeggen wanneer verschillende actoren gezamenlijk participeren in de ontwikkeling van een gemeenschappelijk platform). Onze studie helpt om de samenwerking tussen verschillende actoren voor de ontwikkeling van een gemeenschappelijk platform (de opstartfase) en samenwerking tussen een platformaanbieder en complementaire aanbieders (de voortzettingsfase) te onderscheiden. Op deze manier effenen we de weg voor onderzoek naar de samenwerking tussen verschillende platformaanbieders, die niet is behandeld in de huidige platform theorie.

Daarnaast draagt dit proefschrift bij aan de literatuur met betrekking tot zakelijke ecosystemen door het toepassen van het concept van zakelijke ecosystemen om de Collectieve Actie theorie uit te leggen hoe ecosysteem configuratie de kans op samenwerking tussen de leden beïnvloed. Onze resultaten maken de weg vrij om in plaats van een typisch beschrijvende benadering, een meer verklarende benadering voor het analyseren van zakelijke ecosystemen te geven.

Aanbevelingen voor de praktijk: Onze belangrijkste praktische aanbevelingen voor platformprojecten zijn om speciale zorg te geven aan 1) het maken van afspraken over toekomstige belangen en strategieën (bijvoorbeeld met betrekking tot verdienmodellen, platform openheid en bestuur) in de eerste fase van het platform project; 2) selecteren van een platform leider die zowel technische (waaronder het ontwikkelen van (een deel van) het platform of het hebben van kennis over de platformtechnologie) als organisatorische capaciteiten heeft (waaronder toegang tot klanten voor het platform, onderlinge relaties en financiële middelen) voor de ontwikkeling en implementatie van het platform; 3) het creëren van vertrouwen tussen partijen in de ecosystemen, bijvoorbeeld door middel van de implementatie van intellectuele eigendomsrechten en/of met organisaties met een goede reputatie in de projecten (bijvoorbeeld de overheid); 4) het verminderen van concurrentie tussen partners alsmede het verminderen van communicatie- en coördinatiekosten door het starten van een platformproject met een kleine groep partijen; 5) implementeren van zowel positieve prikkels (bijvoorbeeld financiering) om in de eerste instantie partners aan te trekken als negatieve prikkels (bijvoorbeeld een boete) om 'free-riding' gedrag te voorkomen in het samenwerkings project.

Aanbevelingen voor toekomstige studies: Er zijn verschillende gebieden die kunnen worden verkend binnen toekomstig onderzoek, waaronder: 1) de uitbreiding van het raamwerk met extra factoren (bijvoorbeeld culturele factoren) en het testen van het gebruik van andere kwantitatieve methoden of andere experimenten; 2) het verkennen van de matigende effecten van factoren in het raamwerk. Zo kan bijvoorbeeld platform openheid worden beschouwd als een bemiddelende factor (tussen andere factoren en samenwerking) of als resultaat van collectieve actie; 3) het verkennen van de rol van overheidsactoren of instellingen in het stimuleren van samenwerking in verschillende domeinen van Smart Living (bijvoorbeeld e-health en energiebeheer domeinen); 4) het reproduceren van het onderzoek voor gemeenschappelijke dienstenplatformen in andere domeinen om zo te ontdekken of er mogelijk domein specifieke problemen zijn binnen Smart Living samenwerkingsplatformen; 5) het bestuderen van factoren die van invloed zijn binnen verschillende fasen van ontwikkeling en uitvoering van samenwerkingsplatformen en, 6) het onderzoeken van de tweezijdige markt vraagstukken van gemeenschappelijke platformen om zo te ondervinden of en hoe de strategieën die nodig zijn voor de adoptie van gemeenschappelijke platformen verschillen van platformen met slechts een enkele aanbieder.

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Curriculum Vitae

Fatemeh Nikayin was born on 29 August 1982 in Tehran, Iran. She graduated in 2005 with a Bachelor in Computer Engineering from Azad University of Tehran, majoring in Hardware Engineering. After graduation, she worked as a computer engineer in a construction company, where she was responsible for the internal network and information systems of the company.

In 2007, she began a Master program in Computer Science at University of Malaya, in Kuala Lumpur, Malaysia. She graduated with honour in 2009, with a major in Management Information Systems (MIS). For her Master thesis, she developed a theoretical framework regarding the development of Service-Oriented Information Systems (SOIS).

In 2010, Fatemeh Nikayin began as a PhD researcher at the ICT section of the faculty of Technology, Policy and Management, Delft University of Technology. During the four years of conducting PhD research, she studied several collaborative platform projects in the fields of e-healthcare and home energy management, in different countries of the Netherlands, Finland and China. Beside research, she also supervised several Master thesis projects and lectured in courses like E-business and Service System Engineering. Currently, she is continuing as a postdoctoral researcher at the ICT section focussing on the e-healthcare domain.

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