

SUSTAINABLE BUSINESS MODEL
FOR FACILITATING PUBLIC VALUE CREATION
OF LIVING LAB INNOVATION ECOSYSTEMS

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SUSTAINABLE BUSINESS MODEL
FOR FACILITATING PUBLIC VALUE CREATION
OF LIVING LAB INNOVATION ECOSYSTEMS

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The design described in this thesis has been carried out in accordance with
the TU/e Code of Scientific Conduct

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To my parents

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Abstract

The public sector is increasingly relying on living lab innovation ecosystems to facilitate processes of public value creation. Therefore, sustainability and viability of public living lab innovation ecosystems is growing in importance, and, turning into the focus of increased efforts, in both theory and practice.

Based on an extensive literature review on living labs combined with business models from an innovation ecosystem perspective, we identified two gaps that contribute to the lack of sustainability and viability in living lab innovation ecosystems:

- 1 There appears to be no sustainable business model that considers **ecosystem** as the unit of analysis.
- 2 There is limited knowledge about **how** to align and coordinate the efforts of multiple heterogeneous stakeholders involved in living lab innovation ecosystems.

To address these two gaps, we employed the Zott & Amit framework for business model design and extended it from firm-level to ecosystem-level.

As a result, we were able to design an **ecosystem-centric sustainable business model** for innovation ecosystem of public living labs. Our results contribute to living lab, ecosystem, and innovation management literature by introducing **high potential investment solutions through meaningful processes** as collaborative value propositions of public living lab innovation ecosystems.

As such, changing the perspective from firm-level to ecosystem-level resulted in exploring **business partners** as a new actor-group which is a component missing

in existing firm-centered living lab anatomies. By exploring the potential of this actor-group, it is clear that business partners have a key role in scalability of living lab innovation ecosystems.

We also introduce solid practices and explain **how** these practices and their generated mechanisms can facilitate the process of value cocreation, and therefore, support orchestrating the efforts of the heterogeneous stakeholders in living lab innovation ecosystems. Furthermore, we contribute to living lab, business model and innovation management literature by introducing **lock-in** as dominant source of value creation in ecosystem-centric sustainable business models.

In addition to our contributions to the body of literature, we offer a practical application in the form of an interactive prototype (of a digital platform) to support implementation of the proposed sustainable business model.

Keywords: Sustainable Living Lab; Ecosystem-centric Business Model; Innovation Management; Public Value; Design Science Research; Artefact.

Table of Contents

Acknowledgments.....	vi
Abstract.....	x
Table of Contents	xiii
1 Introduction	16
2 Theoretical Background.....	21
Ecosystem; Innovation Ecosystem; Living Lab Innovation Ecosystem.....	21
Business Model; Sustainable Business Model	24
Ecosystem’s Value Proposition	26
A Framework for Business Model Design	28
3 Research Steps and Operationalization	30
Steps 1 & 2: Identify Problem & Define Objectives of a Solution.....	31
1. Exploratory Interviews, Literature Scanning, Discussion Group.....	31
2. Literature Review	31
Step 3: Design and Development.....	32
1. Research Technique (Case Study).....	32
2. Case Selection.....	33
3. Data Collection	34
4. Data Analysis and Design.....	35
Step 4: Demonstration	37
1. Within our research cases	37
2. Beyond our research cases.....	37
Step 5: Evaluation.....	38
1. Within our research cases	38
2. Beyond our research cases.....	38
Step 6: Communication.....	39
4 Value Proposition of Living Lab Innovation Ecosystem.....	40
5 Business Model Architecture	42

BM Activities and Actors.....	42
Orchestrating the Ecosystem	47
1. Program Level.....	47
2. Transition Level	48
3. Project Level.....	49
BM Structure	52
6 Business Model Source of Value Creation	54
Source of Value Creation in Business Model Content.....	54
Source of Value Creation in Business Model Governance	56
Sources of Value Creation in Business Model structure.....	74
7 Concluding Discussion	76
Research Implications, Limitations and Future Directions.....	82
References.....	85
Appendices	92
A List of Interview Participants.....	93
B Interview Protocols	95
C Scheme of ENoLL DLLDs Workshop 2020	105
D Personas	109
E Activities @ Different Levels and Steps of Business Model	110
F From Results to Model	111
G ATLAS: A Support Tool to Implement The Business Model.....	112

1 Introduction

Innovation ecosystems and open innovation processes have attracted many scholars from diverse disciplines (Gascó, 2017; Radziwon & Bogers, 2019). The same is for living labs as type of innovation ecosystems that facilitate open innovation processes (Gasco-Hernandez, Sandoval-Almazan, & Gil-Garcia, 2017; Gascó, 2017; Gualandi & L. Romme, 2019; Mačiulienė & Skaržauskienė, 2020; Schuurman, De Marez, & Ballon, 2013). The public sector, as well, is increasingly employing open innovation processes to address citizens' emerging needs and create public value (Bakici, Almirall, & Wareham, 2013; Gascó, 2017).

In this regard, the public sector supports initiation and funds public living labs with regional or national policy objectives in mind (Katzy, 2012; Schuurman, Herregodts, Georges, & Rits, 2019) and to facilitate the process of public value creation as the most valuable deliverable of public living labs (Gualandi & L. Romme, 2019). Public value can be seen as opportunities to tackle societal and environmental challenges, boost innovation and annual economic growth of cities and companies within the cities, decrease unemployment rate, increase competitive advantage, increase welfare, health and wellbeing of citizens, etc. (Baccarne, Mechant, Schuurman, Colpaert, & De Marez, 2014; den Ouden, 2012).

Living labs as open innovation-based ecosystems are based on the quadruple helix model (among other Arnkil, Järvensivu, Koski, & Piirainen, 2010; Gascó, 2017). This indicates that the processes of value creation in a living lab innovation ecosystem will take place by active presence of all four actor groups of the quadruple helix model: users, firms, research organizations and public authorities (Arnkil et al., 2010). These actor groups may include citizens, research

communities, students, developers, start-ups, SMEs, commercial companies, universities, institutes, research centers, NGOs, municipalities, regional and local authorities, etc. (Grezes, Fulgencio, & Perruchoud, 2013; Nikolov & Antonova, 2012; Westerlund & Leminen, 2011).

Long-term engagement and orchestrated collaboration of these heterogeneous actors in the ecosystem is a key concern for the public living lab innovation ecosystem to succeed: to be viable and sustainable (Hossain, Leminen, & Westerlund, 2019; Verbeek, Zwakhalen, Schols, Kempen, & Hamers, 2020)

However, alignment and coordination of the efforts of these heterogeneous actors is not an easy task. Many authors have pointed out that public living lab innovation ecosystems are not viable and cannot provide the expected impact. In fact, these ecosystems cannot translate the created value into a viable and sustainable business model (Brankaert, den Ouden, & Grotenhuis, 2014). Presence of a viable and sustainable business model, including the practices and mechanisms which can support the intermediation and coordination processes between these heterogeneous actors, is missing in both practice and theory (Schaffers et al., 2016; Schuurman et al., 2019; Brankaert, den Ouden, & Grotenhuis, 2014; Gascó, 2017; Hossain et al., 2019; Osorio et al., 2019; Schaffers & Turkama, 2012; Leminen, Rajahonka, & Westerlund, 2017; Leminen et al., 2016).

The challenge is not limited to living lab innovation ecosystems. From a broader perspective, presence of a viable and sustainable business model which considers the *ecosystem* as the reference point and contributes to viability and sustainability of innovation ecosystems is still a gap in theory (Adner, 2017; Nosratabadi et al., 2019; Oskam, Bossink, & de Man, 2020; Radziwon, Bogers, & Bilberg, 2017; Van der Borgh, Cloudt, & Romme, 2012)

A sustainable business model comprises 3 main components: it supports multi-stakeholder management, holds a long-term perspective and creates both monetary

and non-monetary values (Geissdoerfer, Vladimirova, & Evans, 2018). This implies that a sustainable business model for living lab innovation ecosystem should 1) be holistic and multi-perspective, 2) support development of long-term engagements in the involved actors and 3) offer sustainable (both monetary and non-monetary) value propositions.

Such a holistic and multi-perspective business model is not firm-centered, rather ecosystem-centered: It equally considers the perspectives of all heterogeneous actors in the ecosystem throughout the processes of value creation and value capture. Moreover, it supports coordination of efforts and management of expectations of all the involved actors, until the ultimate ecosystem's value proposition is materialized.

Existing studies that combine business model with living labs and offer models (Grezes et al., 2013; Katzy, 2012) or tools for innovation management in the living labs (Schuurman et al., 2019) are mainly firm-centered not ecosystem-centric. These studies do not consider efforts and expectations of other actors involved in the collaboration as equal as the focal organization, the living lab.

Another stream of studies focusses on multiple stakeholder attribute of the living labs and see them as ecosystems, collaborative or strategic networks, public-private-people partnerships, open innovation platforms, multi-stakeholder innovation infrastructures, etc. (García-Guzmán, Fernández Del Carpio, De Amescua, & Velasco, 2013; Lai, Kuan, & Hu, 2009; Nikolov & Antonova, 2012; Palo & Tähtinen, 2013; Schaffers & Turkama, 2012; Verbeek et al., 2020). Even though these authors indicate that the business model of living labs as systems of multiple partners need a united aligned structure, with committed actors who collaborate in concert with each other, none of these studies explains **how**.

For example, the recent study by (Verbeek et al., 2020) recognizes motivational commitment of involved partners, reciprocity, trust, win-win perspectives and

foreseeing benefits of all the stakeholders and therefore stakeholders' long-term engagement as the key to the success, sustainability and viability of living lab innovation ecosystems. Their study shed light to current literature in the context of living labs for aging and long-term care, yet, it is descriptive in nature and leaves the reader without solid practices and mechanisms which can support realization of stakeholders' long-term engagement and accordingly the sustainability and viability of living lab innovation ecosystems. Presence of solid practices and their generated mechanisms which **considers the ecosystem as the level of analysis** and clearly elaborates on **how the efforts of all heterogeneous actors will be coordinated**, to facilitate the processes of collaborative value creation, is missing.

As such, despite the importance of **value proposition** as one of the main defining elements of any business model (and any ecosystem), the extant literature does not say much about the collaborative value proposition of a sustainable living lab innovation ecosystem.

Contributing to development of a business model which considers the *ecosystem* (not a focal firm) as the reference point and proposing a method including solid practices and their associated mechanisms that explain **how** to support actors' alignment and coordination in an innovation ecosystem is remarked as research gap not only in living lab literature (Hossain et al., 2019; Leminen, Nyström, Westerlund, & Kortelainen, 2016; Leminen, Rajahonka, & Westerlund, 2017) but also in ecosystem (Oskam, 2020; Adner, 2017; Raadziwon & Bogers, 2019 ; Van-der-Borgh et al., 2012), sustainable business model (Oskam, 2020; Nosratabadi et al., 2019), and innovation management (Leminen, Rajahonka, & Westerlund, 2017) literature and requires further research.

Current thesis targets this research gap by answering the following question:

What does the sustainable business model of a viable public digital living lab innovation ecosystem look like? (an ecosystem-centric perspective)

This perspective to the business model can facilitate coordination of multiple stakeholders and can result in value creation (and appropriation) for the ecosystem as a whole and over the boundaries of a single firm. It can also provide insights leading toward the answer to the second question:

How can the ecosystem-centric business model effectively support coordination of the efforts of multiple heterogeneous actors in the ecosystem, in order to facilitate the process of value co-creation at ecosystem level?

To answer these questions, we first, provide the theoretical background: we review the key concepts of the (public digital) living lab innovation ecosystem, which is the context of this study, sustainable business model and ecosystem-centric business model value proposition. In this section, we also explain Zott & Amit's framework for business model design, (2010). Next, we describe our research steps and operationalization of our methodology. Then, we share the results of the research in three sections: value proposition of living lab innovation ecosystem, business model architecture and business model source of value creation. Subsequently, we answer the research questions by discussing the key results. Finally, we remark theoretical and practical implications, research limitations and provide insights for future research extensions.

2 Theoretical Background

Ecosystem; Innovation Ecosystem; Living Lab Innovation Ecosystem

Over the past two decades the concept of **ecosystem** has become pervasive in both applied and scholarly debates. The term entails an ecology of meanings, amongst which ecosystem-as-structure (e.g. studies of Adner, 2000, 2006, 2013; Adner & Feiler, 2016; Adner & Kapoor 2010, 2016a, 2016b) versus ecosystem-as-affiliation (e.g. studies of Moore, 1996; Iansiti and Levien, 2004; Autio & Thomas, 2014; Jacobides, Cennamo & Gawer, 2015; Rong & Shi, 2014) or ecosystem-as-coevolution (the recent alternative classification by Hou & Shi, (2020)) represent the main general views.

This study refers to ecosystem as structure and the definition by Adner, (2017, p. 42): “the alignment structure of the multilateral set of partners that need to interact in order for a focal value proposition to materialize”. Based on Adner, the starting point of an ecosystem is a value proposition. Thereafter, 4 basic elements configure each ecosystem-as-structure: **activities** which are actions required to realize the value proposition, **actors** as the entities who accomplish that activities, **position** which shows the location of each actor in the flow of activities within the system, and **links** which specify transactions between the actors.

Building on the notion of ecosystem-as-structure, **innovation ecosystem** can be defined as an ecosystem whose value proposition is the result of synthesizing multiple actor’s novel offerings (Adner, 2006; Alexy et al., 2013). Therefore,

novelty can be perceived as the main component of an innovation ecosystem compared to an ecosystem.

This study focuses on the innovation ecosystem of public digital living labs. During the past two decades, the notion of **living lab** has growingly diffused amongst Europe and significantly interested scholars and policy makers, who aim to leverage open innovation processes to create public value (Gascó, 2017). However, newness and high heterogeneity of living lab cases makes it difficult to specify a widely recognized definition for the phenomenon (Dell’Era & Landoni, 2014; Hossain et al., 2019). Existing literature recognizes living labs as networks, environments, contexts, intermediaries, experimentation, business models, approaches, methodologies, communities and ecosystems (Bergvall-Kåreborn & Ståhlbröst, 2009; Hossain et al., 2019).

Despite the absence of a well-recognized definition, all living labs have two main elements in common: 1) they are a real-life experimentation (physical/ virtual) environment and 2) they co-involve aware users in innovation processes (Dell’Era & Landoni, 2014). Following these two elements, Dell’Era & Landoni, (2014, p. 139), define the living lab as “a design research methodology aimed at co-creating innovation through the involvement of aware users in a real-life setting”. Even though they define the living lab as a methodology, they also acknowledge the coexistence and gravity of the living lab’s environment. As well, they acknowledge living lab’s focus on managing development of complex solutions in a public-private (-people) partnership (PPPP) concept. In this concept the public sector works together with private parties and citizens to cocreate new solutions in real-life contexts, such as buildings, cities, city regions, rural areas, etc. (Dell’Era & Landoni, 2014; Grezes et al., 2013).

Similarly, in their study (Bergvall-Kåreborn & Ståhlbröst, 2009) indicate that several complementary perspectives exist on living labs. They can be identified as environments or milieus (e.g. studies of Ballon, Pierson, and Delaere 2005;

Schaffers et al. 2007), as methodologies or approaches (e.g. the study of Eriksson, Niitamo, and Kulkki 2005) or as enabling systems (CoreLabs. 2007). These perspectives are not contradictory and can co-exist and even enrich each other. These authors define a living lab as a milieu for orchestrating open and distributed innovation processes that focuses on cocreation of innovations in real-life context by engaging all relevant stakeholders including the users. Living lab's objective is to create sustainable value for all the stakeholders, particularly the users (Bergvall-Kåreborn & Ståhlbröst, 2009; Bergvall-Kåreborn, Ihlström, Ståhlbröst, & Svensson, 2009; Ståhlbröst, 2013).

The focus of our study is on **public digital living labs**. We conceptualize a 'digital living lab' as a living lab aiming for digital innovations. Satish Nambisan, Kalle Lyytinen, Ann Majchrzak, (2017) define 'digital innovation' as market offerings, business processes and models that are created (and evolved) by use of digital technologies and digitalized processes, while it is not required for the outcomes themselves to be digital.

By **public (digital) living labs**, we refer to (digital) living labs that support public sector open innovation processes and consequently enhance the process of public value creation (Gascó, 2017). Gascó (2017) identifies three common attributes for these types of living labs: 1) they intermediate between the public sector and the private sector and people and facilitate the process of collaborative public innovation (also identified by Bekkers et al., 2013), 2) their focus is mostly on the process of open-innovation rather than graduating successful innovation outcomes and 3) their sustainability, impact and scalability is constrained due to a lack of innovation outcomes. She announces the latter as the main problem of such living labs and calls for further qualitative research which can contribute to sustainability of these living labs. More specifically, insights on how to manage and coordinate the processes of intermediating between the heterogenous partners in the innovation ecosystem is required (Gascó, 2017).

The innovation ecosystem of a living lab is based on a quadruple helix model (Arnkil et al., 2010) or public-private-people partnerships (Westerlund & Leminen, 2011). In such ecosystems heterogeneous actors such as citizens, researchers, students, start-ups, SMEs, commercial companies, universities, institutes, research centers, NGOs, municipalities, etc. collaborate to create value. In remainder of this thesis, we often refer to the concept of a **public digital living lab innovation ecosystem** by way of the short-cut **ecosystem**.

Business Model; Sustainable Business Model

The concept of **business model** at different interest areas addresses different phenomena (Amit, & Massa, 2011). This thesis refers to the concept as a firm's plan or rationale to create and capture value through business activities (Adner, 2017; Zott, Amit, & Massa, 2011; Zott & Amit, 2010; Osterwalder, Pigneur, & Tucci, 2005). More explicitly, we adopt the definition by Zott & Amit, (2010), who conceptualize the business model as an (activity-) system of interdependence activities that transcends and spans a focal firm's boundaries and enables the focal firm, concordant with its partners, to create value and appropriate a portion of the created value. These value creation and capture activities are deliberately designed to deliver the business model's value proposition (Zott & Amit, 2010; Zott et al., 2011)

However, along of growing worldwide competitions, which are the result of internationalization and the surge of sustainable development goals, the conventional business models are suffering to deliver competitive solutions (Nosratabadi et al., 2019). Thus, the notion of **sustainable business model** has emerged as a source of competitive advantage. This competitive advantage could deliver the expected economic values to the companies by incorporating sustainable

value proposition, value creation and value capturing mechanisms (Nidumolu et al., 2009; Porter and Kramer, 2011, Geissdoerfer et al., 2018; Nosratabadi et al., 2019).

The notion of sustainable business model is built on the concept of business model and surpasses it by adding certain goals and characteristics to it. While literature entails various subcategories, archetypes and application areas for sustainable business models, we found the definition by Geissdoerfer et al., (2018) as the most relevant for this study.

They define a sustainable business model as a business model which integrates the three concepts of proactive multi-stakeholder management, sustainable (economic, environmental and social) value creation for a broad range of stakeholders and long-term perspective (Donaldson and Preston, 1995; Freeman, 1984; Post et al., 2002; Evans et al., 2014; Short et al., 2012; Geissdoerfer, Bocken, & Hultink, 2016; Geissdoerfer et al., 2018).

Finally, by integrating the aforementioned theories, we define a **sustainable business model for living lab innovation ecosystem** as following: activities, actors, positions and links, and the way by which they are aligned and coordinated to materialize a focal novel and sustainable value proposition; a novel value proposition which entails not only the economic values, but also environmental and societal values. The sustainable business model holds a long-term perspective. It considers the **ecosystem** as the reference point of analysis: it is holistic and multi-perspective.

Ecosystem's Value Proposition

In this thesis, we refer to living lab innovation ecosystem as an innovation ecosystem-as-structure (the definition by Adner, 2017). In this definition, the ecosystem is created with the aim to materialize a focal value proposition.

Lusch and Vargo, (2014, p.188) define value propositions as invitations for ecosystem's stakeholders to make them participate in processes of value creation. They see actors as resource integrators who themselves build up the ecosystem. Therefore, the ecosystem plays an intermediary role to enable the process of cocreation and capture of the value by the involved actors (Äyväri, 2017). This fact, as well, insists on the significance of the need for providing a holistic and multi-perspective view on the innovation ecosystem and mechanisms of creating and capturing value by different actors.

It is also important to keep in mind that the overall objective of the business will be reflected in its value proposition (Äyväri, 2017; Frow, Mccoll-kennedy, Hilton, & Payne, 2014). Sustainable business models offer sustainable value propositions which besides creating economic values, creates also environmental, societal (and psychologic) values (den Ouden, 2012; Evans, Jones, Karvonen, Millard, & Wendler, 2015; Hossain et al., 2019). In her book, (2012), den Ouden calls an innovation "meaningful" when it can introduce a holistic value proposition which can integrate the conflicting needs of heterogeneous stakeholders into one integrated value proposition.

Apart from thorough studies on value propositions and their definitions, there is not much information available in the literature that discuss living labs' value propositions: this is still a gap in existing literature. Schaffers & Turkama, (2012), imply this gap and argue that lack of a sustainable business model for living labs is one of its reasons.

One significant contribution in this topic is the study by Katzy, (2012a) who develops a business excellence model for living labs. However, this is a firm-centered model with living lab as the unit of analysis. He sees living labs as autonomous legal entities or distinct units within a larger organization with an intermediary role to enable collaborative innovation. Besides consultancy services that living labs can provide, he introduced “high potential investment opportunities”, which are mature enough that someone is willing to pay for them, as living lab value propositions. As such, despite the importance of **value proposition** as one of the main defining elements of any business model (and any ecosystem), the extant literature does not say much about the collaborative value proposition of a sustainable living lab innovation ecosystem.

A Framework for Business Model Design

Zott & Amit, (2010), conceptualize the business model as an (activity-) system of interdependent activities which are purposefully designed to realize the business's value proposition (Zott et al., 2011).

They introduce a framework for business model design, based on two sets of design parameters that characterize a business model: “design elements” that express the architecture of the business model and “design themes” that express the dominant source of value creation in the business model. Design themes refer to different configurations of design elements, they can orchestrate and connect design elements together.

Business model architecture is shaped by design elements: business model content, governance and structure. **Business model content** refers to all business functions (activities) which are required to fulfil the overall objective of the ecosystem.

Business model governance refers to who performs each activity (actors) and how the ecosystem's activities and actors are governed and coordinated to cocreate value (orchestrating the ecosystem). **Business model structure** describes how the activities and their associated actors are linked together. It can represent activities sequence and importance (e.g. core, supporting or peripheral nature of activities) with respect to the business model (Zott & Amit, 2010).

Dominant source of value creation in the business model is characterized by business model themes: novelty, complementarities, efficiency, and lock-in. These configurations can be reflected in any of the content, governance, and structure elements of the business model.

Novelty refers to innovative and new ways of doing the business.

Complementarities refers to design of the bundle activities to create more value.

Efficiency refers to design of the activity system to increase the efficiency by lowering the transaction costs. And finally, if a system is designed for **lock-in**, it

has the power to keep the third parties retained in the ecosystem (Zott & Amit, 2010). Locked-in participants are motivated to join the ecosystem and not to leave. (Van-der-Borgh et al., 2012).

Lock-in can be manifested as 1) positive network externalities and 2) high ecosystem's switching costs for the participants (Amit & Zott, 2001). Network externalities can be increased by enhancing ecosystem's attractiveness for the participants. Attractiveness of the ecosystem elevate the number of ecosystem's participants, and the more the number of the participants the higher the network externalities.

Ecosystem's switching costs can be increased when participants develop informal networks or strong bonds or communities in the ecosystem. It can also be increased when participants personalize or customize some facilities or services in the ecosystem. The time and effort that participants invest for building communities or for customization impedes them to switch the ecosystem easily (Amit & Zott, 2001; Van-der-Borgh et al., 2012).

3 Research Steps and Operationalization

To develop the business model, we employ Design Science Research Methodology (DSRM), and the framework proposed by Peffers et al. (2007). DSRM is appropriate for this work, since it can produce multi-disciplinary and multi-perspective knowledge and solve complex field problems (Van Aken, 2005). It embeds the research contribution into a design by creation and evaluation of an artefact (Baldassarre et al., 2020; Peffers et al., 2007). DSRM is already applied in similar fields; such as entrepreneurship (Romme & Reymen, 2018), management (Van Aken & Romme, 2009), and process design research (van Burg, de Jager, Reymen, & Cloudt, 2012). Table 1 demonstrates Peffers’ framework (top), which is a meta-methodological process and can contain several other research techniques (Collatto, et al., 2018). Table 1 also indicates the operationalization for our research (bottom).

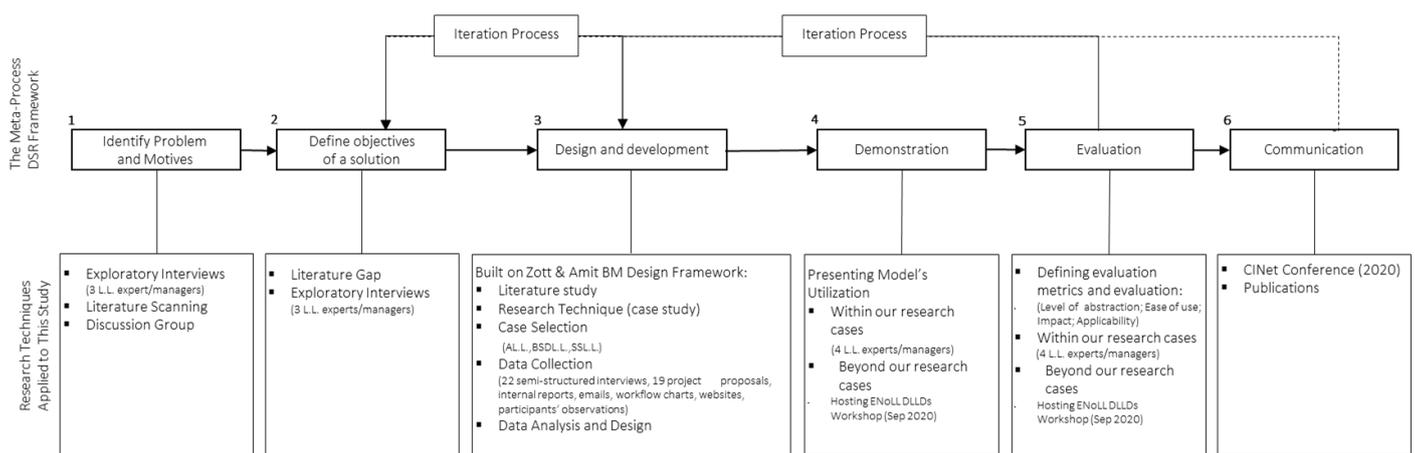


Table 1_ Peffers’ Framework and research techniques applied to this study

This study follows the nominal sequence of the framework (1 to 6). In the following, steps taken, including the literature review, research techniques for data collection, analysis, and design, as well as the evaluation process are explained.

Steps 1 & 2: Identify Problem & Define Objectives of a Solution

1. Exploratory Interviews, Literature Scanning, Discussion Group

In order to identify the managerial problems and define objectives to be achieved, a set of exploratory interviews and discussions with 3 living lab experts/ managers is conducted. The experts who are interviewed have positions and connections within multiple living labs and could provide a broad perspective over the existing managerial problems in living lab. With respect to the objectives, we started scanning the literature to explore the existing solutions and the literature gap. Considering both the literature gap and managerial problems, we defined the research question and objectives of the solution.

2. Literature Review

This study is based on an extensive literature review on living labs combined with business models from an innovation ecosystem perspective. We conducted a search using data bases of WoS and Scopus. The terms ‘living lab’ plus ‘business model’, as well as ‘(public) living lab’ plus ‘(open) innovation ecosystem’ were searched covering title, keywords and abstract. We also employed the snow balling technique to find relevant and highly cited documents. For example, we referred to the recent systematic literature review on living labs, performed by Hossain et al. (2019). They searched for documents in the WoS and Scopus databases, as well as a complimentary search for highly cited articles in Google Scholar. They search for the keyword ‘living lab’ and all its variants. After applying a quality cut-off criterion, they finally selected a list of 114 articles. Their study is categorized based on different facets of the living labs phenomenon, amongst which, open and user innovation paradigms, living lab’s stakeholders, activities, business models and networks, challenges and sustainability are the facets which are relevant to our

study. We extract the list of references implied to these facets and added them to our dataset.

Step 3: Design and Development

We Draw on Zott & Amit's (2010) framework for business model design, and extend their framework to ecosystem level. A similar approach is also taken by Van der Borgh et al., (2012) who argue that the ecosystem can be considered as a reference point of the BM.

Zott & Amit, (2010) conceptualize the BM as an “activity system”, a system of interdependent organizational activities that transcends the focal firm, spans firm boundaries, and includes its partners, customers, etc. This is an appropriate approach for this study which aims to extend the boundaries of the BM from a focal firm into the overall ecosystem.

To adapt this framework, it is required to identify 1) the ecosystem-centric business model architecture, including: what are the activities? who performs them? And how are they linked together? And 2) the dominant source of value creation in the business model (novelty, lock-in, efficiency or complementarities)

1. Research Technique (Case Study)

Not many studies take **ecosystem** as the reference point of the business model. This approach is somehow new and hardly studied in literature, therefore, a qualitative research approach is required. We opt for a multi case study technique which is suitable for poorly understood phenomena. This technique is recognized as an empirical inquiry within a real-life context where multiple sources of evidence are used (Yin, 1984).

Our study includes also some elements of action research (Susman & Evered, 1978), as authors of this study participate themselves in one of the cases and have different levels of interaction with and within the ecosystem.

2. Case Selection

This research is scoped around public (and digital) living lab open innovation ecosystems that adopt a quadruple helix model. We collect empirical data within three public living labs and their open innovation ecosystems; namely Atlas Living Lab (AL.L.), Brainport Smart District Living Lab (BSDL.L.) and StrijpS Living Lab (SSL.L.). All cases are public living labs aiming at digital innovation (following the definition of Satish Nambisan, et al., 2017), initiated and funded by support of public organizations, dedicated in delivering public values and perform as orchestrators (intermediaries) in a constellation of heterogonous stakeholders (quadruple helix model). They are all located in North Brabant/ the Netherlands, a characteristic that allows researchers' participation and interaction with the ecosystems' projects and processes and facilitates the access to solid data. The cases are selected due to their fit to the research scope and their accessibility.

Furthermore, the cases have some differences which can enhance generalizability of the results. AL.L. is an office/education building, located in university campus and initiated by a public knowledge/ research center. BSDL.L. and SSL.L. are residential/working districts. BSDL.L. is initiated by a TU/e professor who negotiated the idea with regional municipalities and SSL.L. is directly initiated by regional municipalities who aimed to solve the societal challenges which were raising in the area. BSDL.L. is an urban district while SSL.L. is an intercity neighborhood. As such, all the cases carry some differences in their partnership models, scale and domain of activities.

To summarize, the cases are selected due to their fit to the research scope and their accessibility. However, they have some differences which can enhance generalizability of the results (see table 2).

Similarities and differences between the 3 selected cases	
Similarities	Differences
<ul style="list-style-type: none"> • Public Living Lab • Aiming at digital innovation • Large number of innovation projects (successful/ unsuccessful) • Located in the Netherlands 	<ul style="list-style-type: none"> • Function • Quality of infrastructure • Users' typology • Scale • Living Lab initiator • Partnership models • Domain of activities

Table 2_Similarities and differences between the 3 cases

3. Data Collection

We conducted 22 semi-structured interviews within the three cases. The aim was to understand **the BM architecture** and **the main source of value creation in BM**. Interviews followed an interview guide (Patton, 1990) and the interviewer collected information from each research subject on the following main themes: 1) interviewee's position (to explore interviewees position in the ecosystem), 2) how does the system work and why? (or if it does not work well, why doesn't it? this includes activities and their sequence (to explore all business functions of the ecosystem and the links between them), stakeholders (to explore who performs each activity), stakeholders objectives (to explore ecosystem's overall objective: value proposition), stakeholders' motives (to explore how the system works),

stakeholder's expectations, challenges, problems and proposed solutions (to explore how the system should work). The interview questions were set based on the position of each interviewee in the ecosystem.

For each case, we selected interviewees at different positions within the innovation ecosystem. The reason is to ensure that different perspectives and expectations are taken into consideration. They include living lab managers, living lab coordinators, project leaders, project owners, research owners, industry representatives, government representatives, living lab facility managers, idea creators, product developers and living lab users.

Each interview was conducted in a 60 to 90 minutes face to face meeting or via skype. They were all recorded, transcribed and coded.

In addition, researcher's access to internal documents (internal reports, 19 project proposals, emails and workflow charts) along with participants' observations within the ecosystem of Atlas living lab assisted the internal validity of this study. Open data available on the websites of all the 3 cases were also collected and added to the dataset.

4. Data Analysis and Design

Drawing on Zott & Amit's framework for business model design, (2010), we analyzed the empirical data collected within the cases by content analysis and the coding methods demonstrated in tables 3 and 4. There are two separate coding process to 1) to identify business model architecture and 2) to identify business model dominant source of value creation.

1 Identify business model architecture	
Content analysis and coding methods	Task
Open coding	Organize data based on the case Identify activities Identify actors
Axial coding	Identify and describe activity-sets Identify and describe actor-groups
Content analysis and reflect on LL network structure introduced by Leminen et al., (2016)	Identify BM structure and therefore, design BM architecture

Table 3_Content analysis and coding methods to Identify business model architecture

2 Identify business model dominant source of value creation	
Content analysis and coding methods	Task
Open coding	Explore sources of value creation
Axial coding-1 (based on BM content, governance, structure)	Categorizing and aggregating the codes
Axial coding-2 (focus on BM governance)	Relate codes to LL coordinators practices
Selective coding amongst the themes: novelty, lock-in, complementarities, efficiency (Zott & Amit, 2010; Amit & Zott, 2001)	Identify BM dominant source of value creation (dominant sources of value creation)

Table 4_Content analysis and coding methods to Identify business model dominant source of value creation

Step 4: Demonstration

In this step, we demonstrate the results of the study, explain the artefact's utilization to LL experts and managers and ask for their feedback. This step provides input for the next step: evaluation.

There are two main phases: demonstrating the results to the research subjects 1) within our research cases 2) beyond our research cases.

1. Within our research cases

In 4 one on one meetings, we presented the results via a PowerPoint presentation (20minutes) to 4 LL experts within our cases: strategic manager of Atlas Living Lab (A.L.L.), director of Brainport Smart District Living Lab (BSDL.L.), a project leader at Brainport Smart District Living Lab (BSDL.L.) and a program manager of Strijps Living Lab (SSL.L.).

2. Beyond our research cases

During the Digital Living Lab Days 2020 (DLLDs), we hosted a workshop¹ in European Network of Living Labs (ENoLL). The workshop was held online via Zoom cloud-based video conferencing service and Miro digital collaboration whiteboard. It included 20 minutes for demonstrating the results and explaining the artefact's utilization, and 60 minutes for feedback.

As far as our knowledge, the workshop had 33 participants from Belgium, Canada, Finland, Japan, Korea, Poland, The Netherlands and UK². Participants (in groups

¹ <https://openlivinglabdays.com/workshops-dlld20/living-lab-business-model/> (Sep 2020)

² Besides what we have reported, there might be more participants from living labs and countries other than the ones mentioned here. Our data is based on the profile of the living labs (participants) who nominated to utilize and evaluate our proposed model in the workshop.

of 4 to 5 persons) utilized the model for projects within various living labs, including: Bristol Living Lab, Green Economy Lab, iMec, KRAKOW Technology Park (KTP), Lanaudiere, OnLab (for cancer survivors), and Smart Kalasatama.

Step 5: Evaluation

This step explains the evaluation and optimization processes of the artefact in two main phases: 1) within our research cases 2) beyond our research cases. The artefact is evaluated based on 4 evaluation indices: level of abstraction, ease of use, impact and applicability.

1. Within our research cases

After the presentation (please see step 4), we asked the research subjects to evaluate (within 40 minutes) whether the artefact correctly represents their LL innovation ecosystem BM or not (validity). We also ask them for recommendations to improve the model's level of abstraction, ease of use, impact, and applicability. Input from this step helped the model to be further optimized. The major changes include segregating **business partners** as a separate actor-group, and refinements in business model **governance**.

2. Beyond our research cases

In total, ENOLL DLLDs workshop (please see step 4) included 60 minutes for reflections on the model by participants. 30 minutes for an interactive session, in which participants (in groups of 4 to 5 persons) reacted to the proposed model from individual experiences and practices in other living labs and 30 minutes for plenary debate in which participants provided anonymous feedback on the

proposed model. In order to trigger participant's reflection on the results, we shared a Miro digital whiteboard for a plenary brainstorming by using sticky notes. The digital whiteboard included headlines such as 'level of abstraction', 'impact', 'ease of use', 'applicability', 'set deployment goals', 'gain new insights', 'gaps in activities, stakeholders, links', 'disagree?' and 'suggestions'.

The input by ENoLL DLLDs participants (please see step 4) mainly confirmed the model at its current state. However, this data provided us insights for areas of future research. Appendix 1 presents all the relevant feedbacks.

Step 6: Communication

Besides the present work, results of the study are presented and published at (proceedings of) Continuous Innovation Network (CINet) Conference³.

In the following, the results of the research are presented. We identify 1) value proposition of living lab innovation ecosystem, then we take an overarching view on all business functions of the ecosystem and identify 2) the business model architecture and 3) the business model dominant source of value creation in BM content, governance and structure

³ Kheiri, P., den Ouden, E., Reymen, I. M. M. J., Cloodt, M.M.A.H. (2020). Living Lab Business Model: Towards A Sustainable Innovation Ecosystem. Proceedings of the 21st CINet Conference. p.352-363. <https://www.continuous-innovation.net/members-area/proceedings/2020.html>. ISBN 978-90-77360-23-1

4 Value Proposition of Living Lab Innovation Ecosystem

The overall objective of the public LL innovation ecosystem and its sustainable business model is to create public value through open innovation processes and innovative solutions. Innovative solutions which are technically feasible, economically viable, environmentally sustainable and centered around the prevailing needs of the LL users. This objective relates to the ecosystem level and is also reflected in the ecosystem's business model value proposition: **high potential investment solutions through meaningful processes.**

Our data confirms the value proposition introduced by Katzy, (2012): “high potential investment solutions”. Solutions which graduate from a LL innovation ecosystem are addressing valuable problems and are scalable. They are novel, their functioning and benefit is assessed by experts and their fit is assessed by end users. Such solutions have higher market acceptance and lower risk of market failure: they are high potential investment solutions.

However, there is an insistency on **meaningfulness** of the innovation processes through which the innovative solutions are created. This relates to the objective of the living lab and its sustainable business model, which is public value creation through innovation processes and innovative solutions. Successful innovation processes and solutions are built on participation and long-term engagement of heterogeneous stakeholders with complimentary sets of resources (e.g. information, knowledge, and skills).

Within Eindhoven (living labs) we work as a quadruple helix approach. And this actually means that the municipality was involved, university, VolkerWessels and of course the inhabitants themselves. And it worked quite well because everybody could do in which he is good. I mean! mmm don't ask a building company to make a decision on a public level and vice versa. So, everybody had just a good role. (Lab Project Manager Smart City Project, S2)

[...] But I hope that Atlas living lab, with researchers, with student teams with companies would be a place where really innovative solutions are being delivered. Specially those solutions where you need competence of different people, researchers and business view of companies, as well as creative view of students or other creative people or start-ups, to come up with other solutions than usual solutions[...] Probably we could exploit this living lab much better, commercially, but[...] (what we want is) that through this building many innovations came to the market that influence on the lives of the people, that is interesting for scientific output, but also interesting for business output [...] (Lab Strategic Manager, A1)

These actors hold distinct, heterogeneous and dynamic expectations in the form of values (e.g. societal value, economic values, ecologic values, individual values). Ecosystem's value proposition needs to be holistic, attractive, and responsive to all these multiple and heterogeneous expectations at any stage of the innovation process: it should offer **meaningful processes** to its stakeholders.

In other words, all the actors should perceive the ecosystem's innovation processes meaningful and attractive enough to join and/or stay engaged in the ecosystem activities. They should accept ecosystem's value proposition (i.e. invitation for participation) at any stage of innovation process.

5 Business Model Architecture

Despite some studies which focus on setting up a LL, this study centers around an effective operation of the LL innovation ecosystem until the value proposition is realized, graduates from the ecosystem and enters the growth phase.

In the following, first, we present the business model activities and actors. This includes activity-sets and characteristics of the associated actor groups who perform each activity. Second, we elaborate more on orchestrating the ecosystem. We analyze the business model governance and explain how the ecosystem's activities and actors are orchestrated and managed in three main levels: **program level** (collaborative portfolio management), **transition level** (identifying meaningful challenges) and **project level** (challenge-based co-creation).

BM Activities and Actors

We could identify five activity-sets which collectively comprise all the business functions of the living lab innovation ecosystem from a high level perspective (the approach proposed by Stigler, (1951)). Table 5 introduces these activity-sets and characteristics of associated groups of actors who perform them. Actors assigned to each activity-set can change their position/ role over time (role temporality) or may have two positions/ roles at the same time (role multiplicity).

Activity-sets	Actor groups ⁴
<p>1 Identifying users' needs/ wants/ likes+ Providing feedback on fit of the solutions</p>	<p>LL users</p>
<p>LL users provide diverse information on user behavior and preferences. Consciously or unconsciously, they help the LL innovation ecosystem in the process of knowledge sharing and identifying users' needs and preferences (in general or in response to a specific solution). They may share ideas or provide feedback around personal/technical/economic fit of the solutions or functioning of the LL itself.</p>	<p>A LL user is anyone who lives in the LL or uses the LL, either temporary or permanently. LL users are representatives of a larger group of their own type in society. They may be active (participate actively in innovation activities), or passive (who are being observed doing their daily activities). They mainly have hedonistic motives for participation instead of economic ones. Value proposition of the ecosystem will be manifested to them in the forms of increased quality of life, increased health and wellbeing and lower environmental footprint while using the LL.</p>
<p>2 Ideating conceptual and practical solutions+ Managing the development project</p>	<p>Creators</p>

⁴ For each of these heterogenous actor groups, we created a 'persona': please see [Appendix D](#)

Creators are responsible to bring the initial proposal into the agreed stage of development. Depending on their information, skills and expertise, and with respect to the LL boundary conditions, they need to mobilize the project partners, and align and coordinate the project team and activities in order to fulfil the task.

A creator can be any entity with a creative proposal which is not already developed elsewhere. They recognize added value of the ecosystem in delivering complementary knowledge, experience, skills, money or credits to enrich and realize their ideas. Creators invest (mainly) their time, to gain (business / technical) experience. They (mainly) anticipate on return on investment when the solution is realized or brought to the market, however the project partners who invest on development of solutions may (partially) pay for their hours.

LL's lead users, students, start-ups, SMEs, young researchers are examples of these actors.

3 Providing the required tangible/intangible resources+ Providing feedback on benefit(s) of the solutions

Strategic/ Project Partners

Strategic/project partners may support LL ecosystem both at strategic and/or project level, depending on their expertise and

A strategic/Project Partner can be representative of governments, knowledge or research centers and firms of any scale. Initiators of the LL,

partnership model. They share various tangible/intangible resources required for maintaining the LL infrastructure and/or development of the solutions in the LL innovation ecosystem.

and providers of its infrastructure belong to this category. They usually own a challenge and aim to participate in LL innovation ecosystem to find solutions for their challenge through a more efficient process.

Partners rely on the anticipated tangible or intangible benefits which will be achieved by the added value to their investments (e.g. increased health and wellbeing of residents, increased knowledge, increased value of the real estate, new applications built on their platforms, increased market diffusion, etc.)

4 Orchestrating the ecosystem

LL coordinators

LL coordinators facilitate innovation processes by intermediating between the constellation of heterogenous partners (They are not risk-taking entities). They also manage the LL environment and infrastructure's security and performance. Orchestrating the ecosystem (as a part of the BM governance)

LL coordinators are usually managers experienced in LL activities or innovation management, with high networking skills and opportunities that can connect industry, academia and governors to each other and to the other actors of the ecosystem. They are usually selected by public organization which establishes the public LL.

happens in 3 levels which will be elaborated in the following section.

**5 Venturing the business+
Commercializing the business**

Business Partners

Business partners invest in viable, relatively low risk and ready-to-the-market businesses. Independent from the other actors in the LL innovation ecosystem, they adapt strategies and activities to scale-up and commercialize the business (e.g. launching the solution to society/market or creating spin-offs).

A business partner is any entity who is willing to pay for the LL value proposition. However, it is very probable that **strategic/project partners** be the first actors who venture/ commercialize the business and become **business partners** at this stage; because they have been involved in the gradual development of the solution and may prefer keeping a larger share to increase the chance of positive return on investment.

Table 5_Business Model Activities and Actors

Orchestrating the Ecosystem

1. Program Level

Program level is dedicated to a recurring **collaborative portfolio management** process. LL coordinators set up and coordinate recurring brainstorming and discussion meetings with LL stakeholders, in order to **collaboratively** create and update long-term/ short-term strategies and plans for the LL as a dynamic and always-learning ecosystem. They may employ various digital/physical methods to enable and boost effectiveness of these events. At this level, all heterogenous stakeholders of LL will share and discuss the opportunities, strengths, barriers, limitations, and challenges from their own perspectives. LL coordinators manage to collect, synthesize, and prioritize this data in order to provide input for the next level.

Talking about quadruple helix[...]there is a complete community[...]all invited[...]we let them to talk. We are not the ones who know everything. We are the ones who detect all innovative things on our program lines and how to organize them. So in such a situation it is better to talk to people who are experts in what they want than to think you know everything yourself and just tell them what you are going to do[...]we talk about “where do we stand”, “which initiatives we are dealing with” and all parties interact[...] (Lab Project leader Innovative Projects, B2)

And here in Atlas, you bring all stakeholders at different way of looking at the world together, so people who want the solution tomorrow, people who want the research, at the same table, also Atlas (managers) and student teams together, to bridge all the hierarchical problems, cultural issues, planning issues, time issues, resources, together. (Lab Project Manager, S1)

2. Transition Level

This level is the link between the program level and the project level. At this level, LL coordinators translate the input provided by stakeholders (at program level) into **meaningful challenges**. We define a meaningful challenge as an open question developed based on the current social, environmental and economic challenges that arise in society or the LL, which is tried to be formed in line with the LL stakeholders' areas of interest, expertise, resources, market and roadmap. It is **open**, to enable creativity and innovation, but **not too open**, in order to fit within the boundary conditions of the LL, also to be in-line with what stakeholders are willing to support. Figure 1 summarizes the practices by living lab coordinators to translate the input from the program level into **meaningful challenges** for the project level.

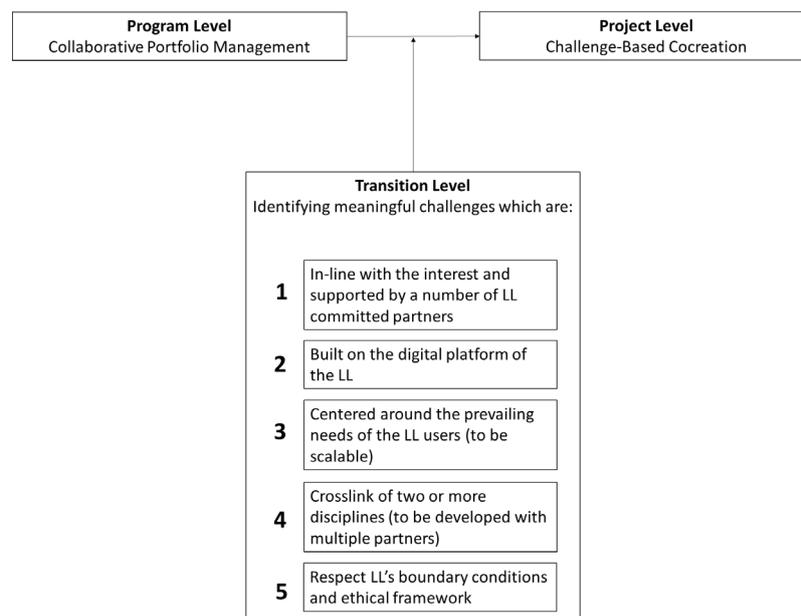


Figure 1_The practices by living lab coordinators at transition level

3. Project Level

At the project level, creative proposals which address the **meaningful challenges** are identified, evaluated, and collaboratively developed as an innovation project. Depending on the proposal, an innovation project may go through certain steps: proposal offering, feasibility study, planning, realization, monitoring and evaluation and project close. At project close, the solution will be evaluated. On condition that the value proposition is realized, the solution will graduate from the ecosystem. These solutions are perceived as attractive offerings to **business partners** and can grow as a viable business. In other respects, the ecosystem will discuss on the continuance of the solution and decide whether the solution can be recycled in the ecosystem as a new proposal and under which conditions.

We label the overall process as **challenge-based cocreation**. Table 6 describes the activities within each step to be performed by collaboration between relevant stakeholders in the ecosystem.

Innovation project steps	Description ⁵
1 Proposal offering	A proposal (research proposal, concept, proof of concept, early stage technology, pilot) is submitted, discussed, assessed, adjusted, and selected (or rejected). Agreement (letter of intent) is set with initiators.

⁵ For further information about activities assigned to each actor group at different levels and steps of innovation management please see [Appendix E](#)

2 Feasibility study	Social (impacts on users), technical and financial feasibility studies are conducted and assessed. Potential project partners and mutual expectations are evaluated. Agreement (letter of cooperation) is set with initiators.
3 Planning	A concrete plan including strategies, partners, responsibilities, timing, etc. is set in collaboration with all involved partners. Agreement (letter of realization) is set with initiators.
4 Realization	Authorizations and authentication for implementing the proposal is managed. Resources based on planning and agreements is provided. Steps and results are communicated with relevant stakeholders for feedback.
5 Monitoring and evaluation	This step takes place in parallel and after the previous step. The progress of the project, performance of projects' partners, LL functioning including the performance, security and maintenance of the LL infrastructure and environment, as well as, data use policy and social impacts of the project is monitored and evaluated. Actual results are assessed based on the expected ones.

6 Project close	End-results, limitations and future developments is shared and evaluated by stakeholders. (Technical/ business) recommendations for continuance of project is provided (to recycle the ideas in the ecosystem).
Graduation	A milestone where the value proposition is realized and solution graduates from the ecosystem.
7 Business growth	Graduated solution is mature enough to derive business growth (e.g. market launch, spin-offs, start-ups, scale-ups).

Table 6_Innovation project steps and description

BM Structure

LL coordinators orchestrate the ecosystem, yet, they don't have a dominated power over other stakeholders and their activities. Every stakeholder in this ecosystem has their own business objectives and operations and can voluntarily and directly choose the suitable partners to collaborate with.

[...] activities are distributed amongst the public/ private partners and living lab can't define or control their business model and operations. (Lab Director/ Project Owner, B1)

[...] no one really has power and authority [...] (Lab Strategic Manager, A1)

If we control the system, we kill creativity. They should decide for themselves [...], but it shouldn't be too loose as well [...] (Lab Project Manager, S1)

These characteristics resemble the configuration visualized by Leminen et al., (2016) as “multiplex-distributed-network” for LLs. They introduce this configuration as a constellation of various actors who don't have a control over each other's BMs, they stand at the same level and equally can decide to partner with any other actor who they find the most appropriate. However, they add that this structure still needs a coordinator who orchestrates the network. They visualize the coordinator of the network as a dashed circle in the center, exclusively as a facilitator without any central control over other stakeholders' operations. Other activities are directly linked together.

Accordingly, with respect to both literature and our empirical data, we adopt a **multiplex-distributed-network** configuration to illustrate LL BM structure. This structure directly links the activity-sets (and actors who perform each activity-set) together, and positions the LL coordinators, exclusively as an orchestrator, in the center. However, business partners are only joining the LL innovation ecosystem

when the ecosystem’s value proposition is realized, and the end-solution is ready to **graduate** from the LL innovation ecosystem. In effect, they launch the ecosystem’s value proposition to society. Figure 2 illustrates the BM architecture of public LL innovation ecosystem⁶. It includes all business activity-sets from a high-level perspective, actor-groups who perform each activity-set and how they are linked together (above) and how the ecosystem is orchestrated (below).

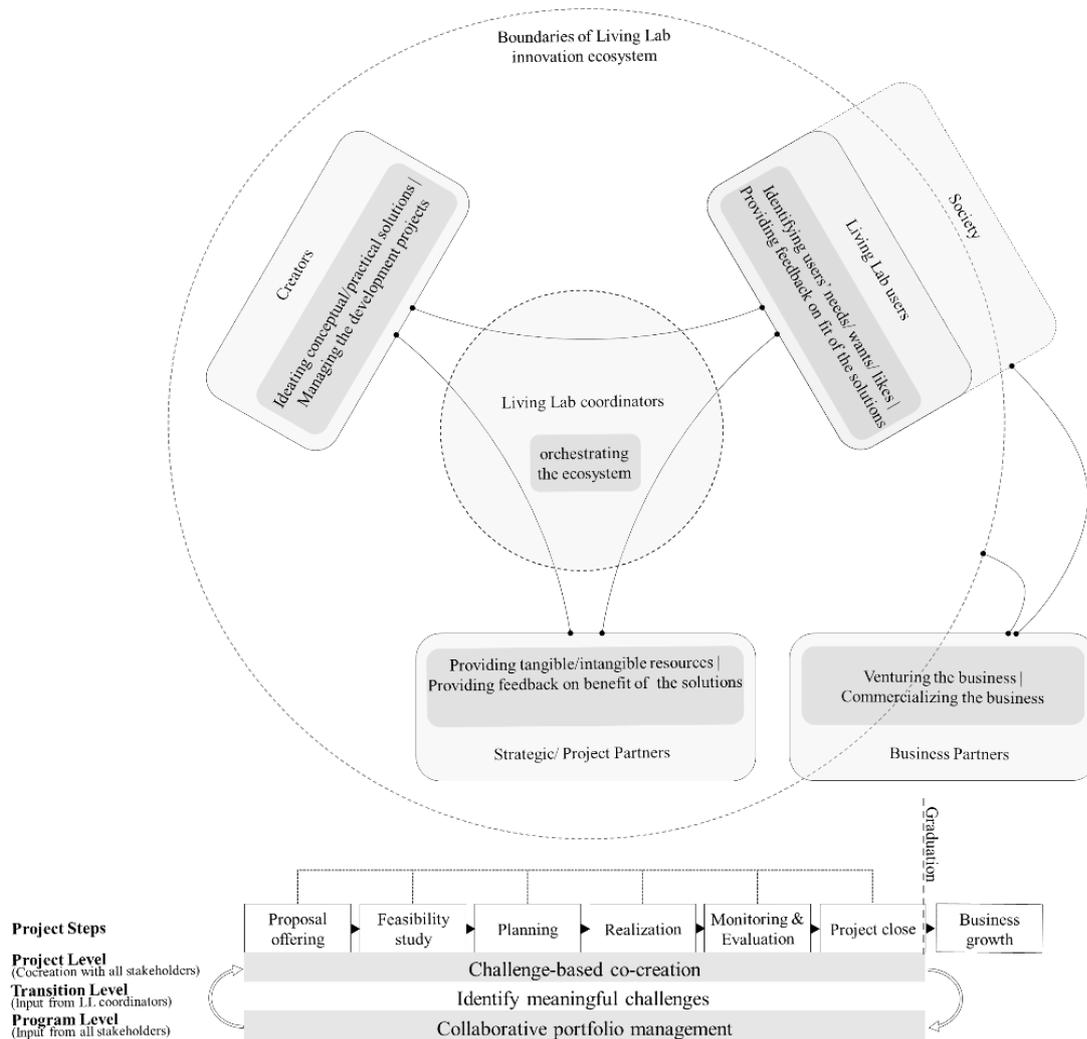


Figure 2_Business Model Architecture

⁶ Further elaboration on how the results are translated to the model is visualized in [Appendix F](#)

6 Business Model Source of Value Creation

Our data recognizes **lock-in** as the dominant source of value creation in BM content and governance and both **lock-in and efficiency** in BM structure.

Source of Value Creation in Business Model Content

By collaborative portfolio management, living lab coordinators enable the participants of the LL innovation ecosystem to customize the content (activities) of the ecosystem. Participants are empowered to give direction to the living lab activities starting from the program level. The only intervention by LL coordinators is to ensure that the content **respects living lab's boundary conditions and ethical framework**.

[...] she completely decides for herself what research she wants to do using Atlas. She writes the proposal, and she gets funding, and she decides on content. Then she is dependent on approval process if she can do it. Content-wise she is powerful, [...] (Lab Strategic Manager, A1)

As such, at the project level, participants are enabled to specify the activities and limits of the responsibilities which they are willing to undertake. For example, to identify one of the challenges, we conducted an interview with Signify (Philips lighting). First, we shared the common goal with them (to develop applications on the platform of Signify which is, also, a part of the LL's digital platform). Then, with respect to the common goal, we asked questions about their interests,

roadmap and priorities, their expectations, required and available resources and limitations, their preferred collaboration model and process, including the timing and their preferred level of engagement.

Thus, living lab participants are empowered to customize the activities of the living lab based on their own business model, preferences, and limitations. However, customization requires participants to invest some time and effort. For example, they are required to participate in interviews or attend the recurring events. The time and effort which is invested by each participant to customize the activities to their own business model increases the switching costs. Higher switching costs discourages the participants to shift to other ecosystems which are not yet customized: therefore, they prefer to stay in the same ecosystem: they are locked in.

Figure 3 demonstrates this practice and its generated mechanism which creates lock-in for all groups of the stakeholders (users, creators, strategic/projects partners and living lab coordinators).

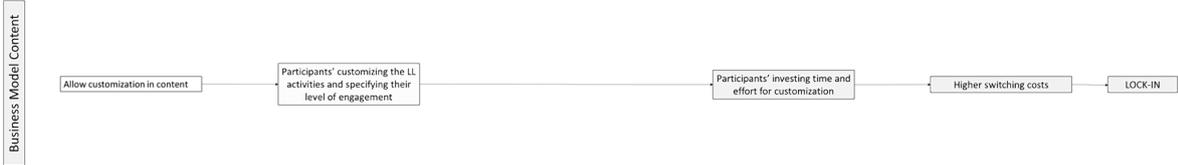


Figure 3_Orchestrating practice in BM content and its generated mechanism

Source of Value Creation in Business Model Governance

This section introduces the 5 orchestrating practices by LL coordinators and their relevant generated mechanisms which ends in lock-in in BM governance.

First practice: as mentioned in the previous section, living lab coordinators manage to collect the input from different stakeholders at program level in order to identify meaningful challenges. They ensure that challenges are **in-line with the interest and supported by a number of living lab's committed partners.**

Each innovation project creates an innovation ecosystem around itself. Innovation ecosystems are dynamic in nature, various actors with different business models and motivations enter and exit the ecosystem during the life cycle of a project. However, an effective coordination requires to balance new relations and existing ones and to develop a certain level of stability in the ecosystem. This is known as dynamic stability (Dhanaraj & Parkhe, 2006; Klerkx & Aarts, 2013)

I don't believe in static ecosystems. Ecosystems by nature are dynamic. In terms of, new people come in and other people dropping out. And that has to do with where are the opportunities for research, where are the opportunities with new business and that's shifting all the time, I think. So, I would think that we should be open to new partners all the time, but at the end we have to organize it [...] (Lab Strategic Manager, A1)

One approach to organize dynamic stability in the ecosystem (both LL innovation ecosystem and innovation projects' ecosystem) is to inspire collaboration with a number of committed and trustworthy partners at each project. This enables the projects to start small, informally and based on trust. New members can be added at later steps and based on the emerging needs.

First approach was setting the organization structure, get the money, set the organization structure and then we start. And the other one was bottom-up, (the better approach is) starting with people which understand the system, but have the sense of dealing with different people, and this organization will grow. They spend less money, less people but more efficient than the other one. Because this is something organic [...] and stable. People fall off, people come in. this is something like more rigid structure and is not really able to adjust to the situation change, the outside world, the stakeholder fall off, money coming or not coming. (Lab Project Manager, S1)

Committed partners are who have developed sustained relationships in the ecosystem. They have been already engaged in ecosystem's activities for a certain period of time. They are familiar with mutual expectations and somehow aligned with the processes. They boost reciprocal, trustworthy and win-win perspectives in the ecosystem. Partnership with committed partners, with such perspectives in mind, facilitates initiation and advancement of innovation projects.

[...] (it is important to) build a sustainable relationship with the partners, so what I mean is that you have companies, municipalities, researchers that you do multiple challenges [...] so not just one challenge for one semester but to engage them for a longer period of time [...] (TU/e Program Manager Business Collaboration, A4)

[...] it takes a lot of time and effort to get aligned. to align university with external companies, takes time to trust. With partner companies if you do mistake, you forgive each other. So, it is always better working with clusters of companies which have certain kind of patience, because it needs time for them to adapt to us, and time for us to adapt to them. But if we have set up this collaboration, we have like a network, a group of companies in this mindset, then it starts to work, and it works for a very long period. This is why companies like BSD [...] they bring companies together, and they establish long term

relationships between companies and government and companies and universities. They are like kind of a foundation. (Lab Project Manager, S1)

Collaboration with such partners creates a margin which enables financial support of the projects. Public funding plays a significant role in continuance of innovation projects in public living labs. Even though public LLs have a high potential of access to public funding, the liquidity (availability of the money) is mostly not aligned with emergence of prevailing needs and innovative proposals which need financial support. Committed partners can fill the time gap until the financial support becomes available. They enable initiation of the projects by trust-based and informal agreements. LL coordinators compensate this investment at the time when the money becomes available. As such, due to the reciprocal relationships between LL coordinators and the committed partners, the latter are given a higher chance to customize the activities of the living lab innovation ecosystem to their own roadmaps and business models. Therefore, they benefit the most from the network externalities.

So, if you wanna do a big project you have to apply for national funding or regional funding, and it take at least 6-12 months [...] and then their interest is gone. But if they work continuously on this system, then they know (about the time lag in the system) [...] It is like fishing, we have our fishing rod, and we put 10 of these rods. Maybe we catch today one fish, tomorrow 3 fish [...] it is like statistics, and when you have a company coming for the first time, they say, oh, I go to the rod, I catch the fish and I go. (Lab Project Manager, S1)

As such, presence of committed partners attracts higher number of **creators** to join the ecosystem and keeps them motivated to stay: Locks them in. Creators invest (mainly) their time, to get the chance of networking and collaboration with other multidisciplinary partners and to gain real-life business / technical experience.

Presence of committed partners raises perceived positive network externalities to the creators and makes the ecosystem more attractive for them to join and stay. A creator in A.L.L. innovation ecosystem, explains:

I would make sure that at least partners are already there before the creators come [...] Most of the time they chose the challenge not for the challenge itself but because they like the company [...] maybe attract some companies [...] could be start-ups, could be larger companies like Signify, who are really committed and interested in it (in the challenge) [...] For them (students/ start-ups) that would mean that they only work on the application here in Atlas but that they can also collaborate with these people from the firms. And that would also refer back to the practical experience. (TU/e Student & Team Solid Member, A12)

To ensure a certain level of stability in the ecosystem, it is necessary to support initiation of the projects with presence of a small number of committed partners, however, a successful innovation ecosystem is dynamic. The stakeholders involved in each innovation project can decide to add new members to the ecosystem. This happens naturally (as A.L.L Project Manager (S1) called it “organic”) and does not require any orchestrating practice.

[...] you don't have to arrange every company. You should only arrange the starting point [...] then they can also contact companies for themselves and say “hey we wanna do this project and this application. Are you willing to have an interview with us?” (TU/e Student & Team Solid Member, A12)

While identifying meaningful challenges, LL coordinators ensure that the challenge is **in-line with the interest and supported by a number of living lab's committed partners**. They do this by setting trust-based and informal agreements which indicates whether the committed partners may act as a **key partner** in the

innovation project or as the **first customer** of the solution. This initial agreement increases stability and viability of the projects and further clarifies the roles and relationships between the actors.

CEO of Sorama B.V. explains that owing to the support of the **key partners** they could realize and improve the project and demonstrate its functioning, both nationally and internationally. However, he indicates that in an ideal case the committed partners should be the first customers (not necessarily the end-customer) of the solutions. In such case, the partner is demanding towards the end-customers' needs and provides critical feedback on benefit and fit of the solutions. This allows start-ups to **scale up** smoothly. He brings the example of their own project: developing sound cameras, sound visualization, localization and classification technology at both SSL.L. and AL.L.. At this project municipality of Eindhoven is the **key partner** but not the **end customer**.

“Municipality or the police has the feeling that it could help them and they like it [...] (but) they might be nurturing us too much, you know! saying that, “well, it is nice to do projects together with local companies and local universities and we are happy” [...] And I think that the role of the government should much more be like, they represent the city, they know what problems are in the city, they want to make the living lab to find solutions that are scalable and can be proven [...] So, they would become more critical on, mmm[...]what value does it bring for municipality (or for the city). Because if they kind of position them as a future end customer, I believe it really triggers both innovations, but it also triggers the innovation that leads to proper scalable business models.” (Sorama CEO, S3)

In conclusion, identifying challenges which are **in-line with the interest and supported by a number of living lab stakeholders** increases **dynamic stability** of the innovation ecosystem and innovation projects. In such ecosystem, participants hold a higher chance for initiation, sustainable advancement and

scaling up an innovation project. Participants join the ecosystem to benefit the positive network externalities. They also recognize that developing sustained relationships and long-term engagements can enhance the reciprocal, trustworthy and win-win perspectives in the ecosystem and increase the success rate and the positive network externalities exponentially. Therefore, they prefer to stay committed and engaged with the ecosystem to benefit the most: they are locked in.

Figure 4 demonstrates this orchestrating practice and its generated mechanisms which leads to lock-in specifically for creators and generally for all involved stakeholders.

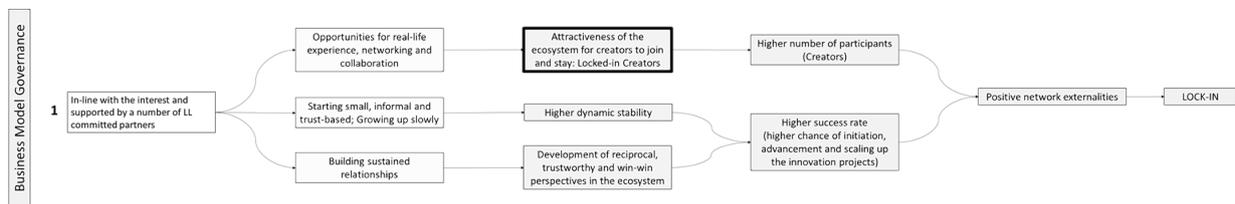


Figure 4_Orchestrating practice and its generated mechanisms in business model governance

Second and third practices: LL coordinators define challenges which can be **built on the digital platform of the living lab** and **centered around the prevailing needs of the living lab users**. These two practices increase participants' dependencies to the LL infrastructure and its users. It also orients and converges the efforts of all the stakeholders towards a shared objective which is centered around the LL and the prevailing needs of its users. The dependencies and shared objective encourage the involved heterogeneous stakeholders (including the creators and users) to join living lab's recurring events and activities and facilitates creation of informal networks and communities. By passing time, these stakeholders can further adopt to each other and create stronger bonds amongst themselves. Forming informal networks with strong bonds increases the switching costs for ecosystem's participants and creates lock-in.

Besides that, building on the digital platform of the LL and implementing the results in the LL environment builds up users' awareness and boost their participation in the cocreation process. This is more effectual, when challenges rise from the real-life problems and needs of the living lab users. This practice raises the sense of belonging and motivation of the users to participate regularly and provide responsible feedback on fit of the solutions. They are interested to join and keep contributing in optimization of the solutions that has impact on the quality of their own lives: they are locked in. As one of the users in A.L.L says:

[...] ask open questions, what do you want? What are your real problems working here? Even, mmm ask what we like to have [...] and make it easy, and fast, and clear(questions) [...] responsible feedback comes if your product is interesting to me, to our colleagues, then we talk about it, we follow it, if it's interesting [...] also if it's some technology out of my knowledge I cannot give feedback [...] let us know the progress, what happened to our feedbacks, was it helpful? Or not? why? it is important, [...] it excites us to follow up, we talk about all what happens around at coffee breaks [...] (Lab User, A15)

User participation and providing responsible and critical feedback by users can increase the success rate of a business by enhancing the chance of market acceptance and lowering the risk of market failure.

However, the meaningful challenges should address the needs which cross the boundaries of a single living lab and be valuable at larger national or international scales.

I wouldn't want to limit it too much to the of the current building that we have now but more to the activities and the process, that happen here, and you can innovate on that and depending on the innovation, you inhabitants can have a market outside that could be bigger than the similar buildings. (Lab Strategic Manager, A1)

This will add to the value of the challenge and its associated innovation solutions. Dealing with the challenges and solutions which are highly valuable in the market (to be a world changer), facilitates the processes of starting up and scaling up a business.

One of our interviewees (also one of the members involved in the project: Chairgonomics) infers that the debility of the solution to be a world changer complicates the process of finding business partners. He claims this as one of the reasons which compelled them to skip the project and leave the innovation ecosystem.

We had to do a lot of work [...] the technology that we were implementing to the chair would not be a world changer, so it wouldn't improve the world that much and also regarding the market it was hard also for us to picture companies really seeing the benefit of the product. (TU/e Student Electrical Engineering, A13)

A member of Team Solid, in response to the question “how can A.L.L be more successful?”, says:

Showcase that Atlas is a living lab, so it is meant to be used in the other offices, other sharing facilities, whatever, but really make sure that Atlas doesn't stand alone. It really, in some presentations, looks like to me that “ow, we wanna design something for Atlas”, no we wanna design something for offices and Atlas is your testing facility, so you don't really want to design something only for Atlas, this is not the purpose of a living lab.
(TU/e Student & Team Solid Member, A12)

As such, S3 indicates the importance of formulating challenges which are internationally valuable, in scaling up the business:

[...] in your own living lab if you are not clearly stating problems that are scalable and that are the same problem that New York and Taipei having , Tokyo having or other cities internationally, then it is only something that is nice to do in your back yard and not internationally. (Sorama CEO, S3)

higher market acceptance, lower risk of market failure and opportunities to smoothly start-up and scale-up the business are positive network externalities that excites the participants to join the ecosystem and stay engaged in the innovation projects and the innovation ecosystem: to be locked in.

Last but not least, building on the digital platform of the living lab is a significant source of motivation for LL coordinators, who shouldn't be ignored after all. The tangible/ intangible values which continuously will be added to the living lab is what makes the ecosystem attractive for LL coordinators to initiate the living lab and stay engaged in its orchestrating activities: they are locked in. As project manager of A.L.L says:

[...] (what is valuable for us is) to find a way to use the result from that kind of projects. Those kinds of projects have an ending, they have different goals, for example they want to add to science, they want to write a paper about it. But it could be a goal for Atlas building and Atlas community to benefit from all these projects and make our own building better and better, so a way to, yea, to grow through these projects in a more structural way, because these projects are, projects, they are incidental, that's what I'm trying to say, the projects are incidental, they build up something, they do the test and then it is gone, mmm the knowledge is of course there but for our building doesn't matter anymore, but a way to make sure all these projects leave something behind to make the building better and better. That would be really nice. (Lab Project Manager, A2)

Or SS.LL project manager explains about the business model of StrijpS and the added value to its real estate:

[...] so! you are interested in our business model. [...] our living lab projects costs a little bit more than what it is generating in terms of the money, but VolkerWessels really makes the money on real estate parts. So, you can imagine that in the beginning StrijpS was well known as one of the worst areas in Eindhoven. It was very cheap to live there, nobody wanted to live there, [...] so we had to make the environment cool, so in the beginning they started with inviting artists over there and they could do whatever they want and at a certain moment it became attractive to certain people, so they started with events, and then the events became bigger and more people started coming [...] Then, at the certain moment they started to build houses as well, so it became more alive, more people came, so it became more famous, and this way they build the story of StrijpS [...] The most sophisticated area of the Netherlands. (Lab Project Manager Smart City Project, S2)

Obviously, presence of a committed orchestrating role in the ecosystem who aligns participant's efforts can enhance the success rate in the living lab, increase positive network externalities for all involved stakeholders and therefore, lock them in.

Figure 5 demonstrates these practices and their generated mechanisms which leads to lock-in specifically for the users and lock-in for all involved stakeholders.

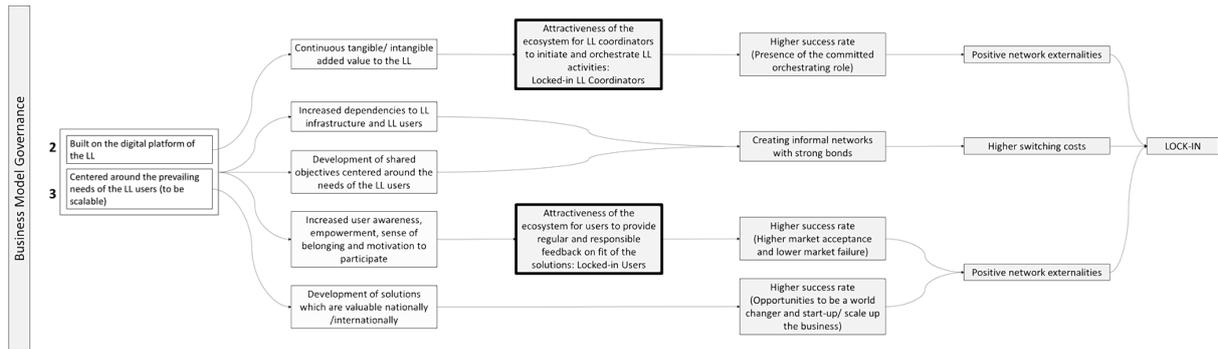


Figure 5_ Orchestrating practices and their generated mechanisms in business model governance

Forth practice: LL coordinators define challenges which are a **crosslink of two or more disciplines and need to be developed by multiple partners**. Coordinators of each LL, depending on the infrastructure and scope of the activities, identify several disciplines (program lines/ work packages/ themes). Each challenge and its associated solution should address 3 or more of the disciplines. Examples can be circularity, participation, society and safety, health and wellbeing, digital technology, mobility, and water. This practice by LL coordinators boost the **novelty** and **meaningfulness** of the solutions associated to each challenge.

Novelty: Stimulating the solutions to combine multiple disciplines and partners opens new windows of opportunity in both solution innovation and business model innovation.

there are a lot of living labs which are specifically pointing on one theme or one topic. And if you would develop an area by developing or by exercising projects on program lines next to each other, then you miss up on any possible advantage of interconnection between program lines. And if you want to be smart, you should as well combine program lines because all the program lines/ themes have connections together as well. So, you need to be able to exercise projects dealing with different program lines in one project. (Lab Project leader Innovative Projects, B2)

[...] so, we had three themes, energy, mobility and ICT [...] it may look like that these projects are not connected, and that's actually not true [...] normally you have only one of these power switches to On and Off the light. But here you have also internet switch in which you can add for example, sensors. So this turns the normal light bulb into the connectivity parts of the city, and this also enables new business models, because normally you have to maintain the lightbulbs, but nowadays VolkerWessels, for example, is renting light bulbs for putting the small cells for the 5G network [...] (Lab Project Manager Smart City Project, S2)

Meaningfulness: the outcome has a higher chance to be meaningful.

Multidisciplinary solutions take multiple perspectives into the consideration and are assessed by professionals at each discipline, from the very early stages of the development.

[...] that is really helpful to have companies, who are working for 50 years checking projects every day, (to control our installations) whether they are confronting to the rules and regulations. And of course, our design is something unique and different, so we need those people with all that experience [...] we always said, "if you don't feel comfortable to build this, then we probably shouldn't do it!" (TU/e Student & Team CASA Manager, B4)

Advancing novel and meaningful solutions can easier attract **business partners** who are willing to pay for meaningful and high potential investment solutions. Accordingly, the solution can easier be commercialized and launched in the market. Furthermore, this approach aims to bring a couple of beneficiary stakeholders from different disciplines to cocreate together at lower risk. Development of innovative solutions may take significant amount of time and resources with no or limited short term financial benefits, as such, the outcome is usually unexpected.

We wanted to create a start up next to Team Solid, but the technology, well, the industry is not ready yet. So we actually predict that the technology will be relevant in 2035. Companies that are collaborating with us are not expecting any short-term financial gain or anything because they also know this. Like they had read our studies and everything, we have communicated it, so they know that when it will be commercialized it will be in 15 years. And then the commercialization will start, so then for 10 years there will be no profit. (TU/e Student & Team Solid Member, A12)

we brought couple of companies together which are able to design and deliver pieces of installation [...] so what we were doing was to go to them and say, see we wanna develop this product and if you be part of our design team with lots of other companies, from each company we just expect a decision maker to be at the table. So each company sort of has ideally bring their director involved to authorize the work, or someone good. And this is fine for them every once in a while [...] (TU/e Student & Team CASA Manager, B4)

Working in multidisciplinary teams provides each stakeholder with the chance to contribute in a mutual development by integrating their own product or service into the innovative solution. In consequence, each stakeholder could scale up their product or business with less investment and lower risk.

If you are a heat pump developer you are not going to invest a couple of hundred thousand euros building a house, [...] what they do is to invest on developing their own heat pump. And we make the whole contact around their product. That is how actually companies are interested to join us [...] e.g. the heat pump that we needed was not made yet. There was not a heat pump in the market with that specification [...] so we made it built, and that is something like a side effect. So one thing was to build the house and also thinking how to inspire all these companies to build what we needed, to innovate. And in terms of heat pump we did it. Because that heat pump company is now known as the first company who has DC heat pumps, but we are the reason that they started doing that. (TU/e Student & Team CASA Manager, B4)

Moreover, multidisciplinary, and multi-partner ecosystems create interdependencies between the partners which prevents the monopoly in the ecosystem.

Consequently, all involved partners can capture a portion of the cocreated value. As one of the students explains:

[...] Firms who are involved have IPRs to copy our ideas [...] it is open source between the partner firms [...] we work with small companies which, alone, they don't have the knowledge available, and their product alone is way far from the final integrated solution [...] I don't think a company can just replicate the results without doing a massive investment themselves [...] makes more sense for them just to do a spin-off. (TU/e Student & Team CASA Manager, B4)

This practice enables multiple stakeholders to relate to an innovative and meaningful project and benefit from the positive network externalities. They will have the chance to start up or scale up their business with shared risk and investment. However, success of each stakeholder depends on the success of the integrated solution. Dependency to the success of the integrated solution and interdependencies between different disciplines encourages the participants to stay committed to the project team and to contribute to the development of the integrated solution: they are locked in.

Figure 6 demonstrates these practices and their generated mechanisms which leads to lock-in for all involved stakeholders.

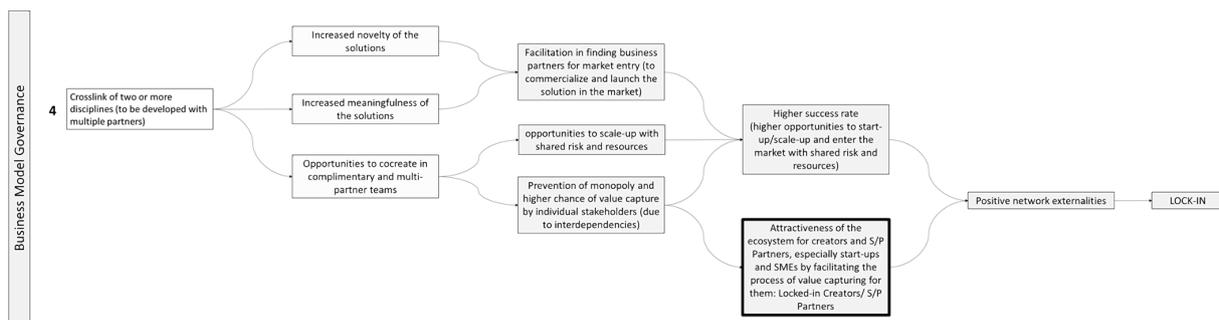


Figure 6_ Orchestrating practice and its generated mechanisms in business model governance

Fifth practice: like any other business, LL innovation ecosystem has a certain vision (a shared vision), and specific objectives. The shared vision and objectives construct certain boundary conditions and an ethical framework for the living lab innovation ecosystem. These elements should be clearly articulated and communicated publicly. As such, LL coordinators should ensure that the challenges are **in-line with the living lab's boundary conditions and ethical framework.**

“To make data available” is important in ecosystems which aim for digital innovations. It is also important to enable implementation and evaluation of the solutions in the real-life context: in the living lab. However, more important is to ensure (data) privacy, security and convenience of the users. Besides the infrastructure which should support this practice, LL coordinators facilitate the process by identifying challenges which are **in-line with the living lab's boundary conditions and ethical framework.**

We don't want (Atlas) to become an experimental maze (Lab Strategic Manager, A1)

Of course, we try to encourage people to share the data, because we want to make their life better by having data and analyzing them. And, what we do not want is that companies like Google to get and commercialize the data of Brainport Smart District. That is what we do not want. (Lab Project leader Innovative Projects, B2)

This intervention also prevents the potential future legal issues which may happen to the stakeholders who used the available data.

Our ethical framework makes it more complicated, that is right, but at the end, it is for the benefit of everyone, it is better for themselves. (Lab Strategic Manager, A1)

This intervention facilitates creation of a more transparent and trustworthy ecosystem in which the shared vision, objectives, boundary conditions and ethical framework is articulated and communicated publicly and respected by the participants.

We set up a data manifest, which is to be found on the website, “the data manifest of BSD”. That is all the rules that we have dealing with data in BSD and I think it is very important for you to read it. Because all initiatives who wants to do any project within BSD have to sign that they agreed with the condition of data manifest. (Lab Project leader Innovative Projects, B2)

Furthermore, only the participants with shared drivers (who can resonate with the ecosystem’s shared vision, objectives, boundary conditions and ethical framework) find the ecosystem enough attractive to join. Participants who have contrasting drivers will be filtered straight away. In consequence, the ecosystem will be a more harmonized community of heterogeneous participants with shared drivers.

Participants, who chose to join, find themselves in a transparent and trustworthy ecosystem with shared drivers, where they can develop stronger bonds with other stakeholders. Establishing strong bonds with other stakeholders increases the switching costs and prevents the participants from defecting to another ecosystems: They are locked in.

On the other hands for some companies it could be that our timeline or their roadmap or whatever does not fit into what we want. You can never develop a system that fits for all possible partners. There will always be partners who have a different vision or whatever. And only if you notice arguments that are very important for you to re-judge whether you are busy in the right way yourself, then you should of course adjust. But Once you are busy with other partners in the right way and they are very eager and willing and parties from all kind of companies and organization and dealing with all kind of program lines (this is

the right approach), if you are busy in the right way, there will always be partners whose roadmap or business model will not fit into. It's a pity but it is what it is. If I make a new type of car, there will be a market but not everybody will buy my car. Because there is different taste, there is different purposes, there are different requirements for people, you can never come up with all the needs of everybody. It is impossible. (Lab Project leader Innovative Projects, B2)

Figure 7 demonstrates this intervention and its generated mechanisms which creates lock-in for all involved stakeholders.

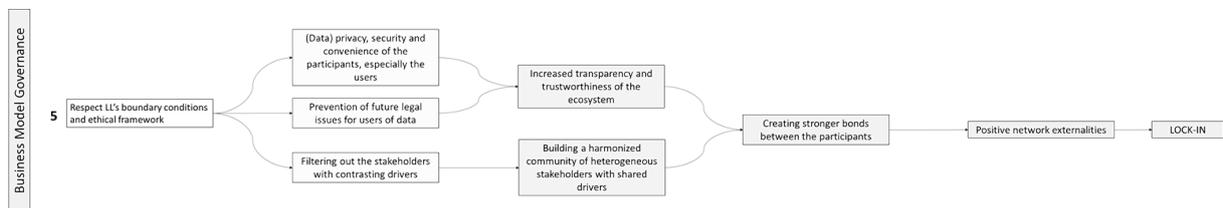


Figure 7_ Orchestrating practice and its generated mechanisms in business model governance

Sources of Value Creation in Business Model structure

The structure of the BM **inspires direct transactions between the stakeholders**. LL coordinators do not have necessarily any intermediary role or central control over the links and transactions between the participants. They, exclusively, enable and facilitate the networking. In this section, we share the experience of team CASA and some results of the interview with their manager.

[...] we were mainly looking for smaller companies, because we could easily talk with them [...] we were calling the companies and say, "Hi, I am student from TU/e, we want to develop something, can I speak with your director" and "sure, no problem" [...] that is the culture in general, there is not much about hierarchy [...] at this stage (realization) we started to look for larger companies, who could invest in our work [...] but the idea is if we need help in something then they (LL coordinators) try to help us with that. (TU/e Student & Team CASA Manager, B4)

There is no need for an intermediary role or a central control over all transactions. Supporting direct transactions decreases the transaction costs of bringing skills and resources together and increases the efficiency of the processes. Therefore, at ecosystem level, **efficiency** can be recognized as a driver of value creations.

Moreover, multiplex distributed network structure provides the participants with the freedom to select and directly collaborate with their preferred partners, whether they are already a member of the ecosystem or not. This will boost the advocacy role of the existing participants to recruit new members for the ecosystem.

[...] we brought couple of companies together which are able to design and deliver pieces of the installation [...] we ensured that we were allowed to work entirely with our partners, so we are allowed to involve our partners without BSD being allowed to decide if they

should join the project or not [...] if we really need them we can chose them as the partner and they can't reject. (TU/e Student & Team CASA Manager, B4)

This characteristic promotes entry of more committed members: the members who have already developed some bonds with the existing participants and are committed to an innovation project. Commitment to a certain project within the ecosystem increases the switching costs and prevents the new members from defecting to other ecosystems and lock them in.

BSD was not known back then, I mean, most of the companies that now we are talking about never heard about BSD by then [...] and now, they are part of the team. We were able to find some companies, and some other were interested themselves to join us. (TU/e Student & Team CASA Manager, B4)

Higher number of participants in an innovation ecosystem, increases positive network externalities for all the involved participants. Network externalities are one of the two main elements of lock-in.

[...] so I would say the positive thing from the living labs is that we have really a broad network and we can kind of cherry pick now who to talk to right away to reach our goal which is scalability and viability. (Sorama CEO, S3)

As demonstrated in figure 8, we could observe both **efficiency** and **lock-in** as the main sources of value creation in LL innovation ecosystem structure: multiplex network structure.

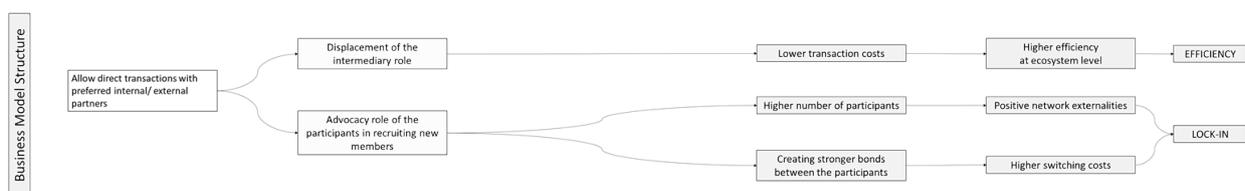


Figure 8_ Orchestrating practice and its generated mechanisms in business model structure

7 Concluding Discussion

In this thesis, we contribute to sustainability and viability of public digital living lab innovation ecosystem by developing an **ecosystem-centric sustainable business model**. We consider ecosystem as the reference unit of analysis in design of the sustainable business model and take all the involved stakeholders and their perspectives into account. This approach is a complement to existing living lab, ecosystem and business model literature where business models are mainly firm-centered (Adner, 2017; Hossain et al., 2019; Oskam et al., 2020; Radziwon & Bogers, 2019; Van der Borgh et al., 2012).

Aiming to design a sustainable business model with the ecosystem as the level of analysis, we build on the definition of sustainable business model by (Geissdoerfer et al., 2018) and definition of ecosystem by Adner, (2017). In order to integrate these two definitions, we employ Zott & Amit's framework for business model design (2010), which is originally for design of firm-centric business models, and extend it to ecosystem level.

To extend the framework, instead of considering the focal firm's value proposition (Zott et al., 2011), the ecosystem's value proposition is considered as the starting point of the business model design. In effect, we integrate the structuralist approach to ecosystem construct (Adner, 2017) with the framework for business model design (Zott & Amit, 2010), and identify the business model architecture (activities, actors, governance model and structure) and dominant source of value creation at ecosystem level.

In the result, we answer the first research question and introduce the ecosystem-centric business model by identifying 3 parameters:

- 1 **Ecosystem-centric value proposition**, in which the overall objective of the ecosystem (i.e. all its stakeholders) is reflected (Äyväre, 2017; Frow et al., 2014). Ecosystem's stakeholders perceive the ecosystem-centric value proposition as an invitation to join the ecosystem and stay engaged in its activities. In the context of living lab innovation ecosystem, we identified **high potential investment solutions through meaningful processes** as ecosystem's value proposition. Compared to the firm-centered value proposition identified by Katzy, (2012), our results are ecosystem-centric and show the importance of the **meaningful processes** in development of high potential investment solutions.
- 2 **Ecosystem-centric business model architecture**, which requires identifying 1) all **activities** for the ecosystem's value proposition to be realized from a high level perspective, 2) all the **actors** who should participate to accomplish the activities, 3) the **governance** model and mechanisms to coordinate the efforts and manage the expectations of all the actors and 4) the **structure** of the business model which shows the links between the activities, and therefore the actors associated with each activity.

Compared to existing studies such as García-Guzmán et al., (2013), who take a business model perspective to identify living lab activities at firm level, we classify all activities of **living lab innovation ecosystem** into five activity-sets (see table 5). These activity-sets can compensate all business functions to materialize the ecosystem's value proposition.

Each activity-set is performed by actors with certain characteristics. Therefore, in identifying the ecosystem's actors, we adopt a top-down approach, starting from the ecosystem's value proposition, identifying activities required to materialize the value proposition, and consequently recognizing required actors who undertake the

activities. This approach to identify ecosystem's actors resulted in five actor groups: living lab coordinators, strategic/ project partners, creators, users and business partners (see table 5). Even though there is some overlap between the actor groups in living lab anatomy recognized by our approach with the existing ones in living lab literature, yet we didn't find any of the existing anatomies corresponding enough to be employed for this study. This includes the classification by Westerlund & Leminen, (2011), who recognize utilizers, enablers, consultants (interpreted as researchers), producers and users, or the classification by Nyström & Leminen, (2011), who identify utilizers, enablers, providers and users (and researchers (Schuurman, D., Lievens, B., Veeckman, C., Marez, L. D., & Ballon, 2016)) in living lab networks. These living lab anatomies did not fit our classification and the comparison between them is beyond the scope of the current study.

After identifying required activities and actors, we introduce **collaborative portfolio management** combined with **challenge-based cocreation** as a governance model to orchestrate the ecosystem: coordinate the efforts and manage the expectations of all the actors in the ecosystem. This model includes solid practices and mechanisms that ensure long term engagement of all the involved actors (Figure 9: Business Model Governance). Stakeholders' long-term engagement is the key to the success and sustainability of the living lab innovation ecosystem (Hossain et al., 2019; Verbeek et al., 2020). In effect, it is only with actors' long term engagement that the ecosystem can deliver the ultimate value proposition for which the business partners are willing to join the ecosystem to invest (Katzy, 2012). Although business partners are mapped out of the boundaries of innovation ecosystem, their participation in the ecosystem's activities at this ending stage of the process is essential (see Figure 2). They support scaling up the businesses/solutions and launch it to society. Therefore, it is only after their effective participation, that the desired public value, as the main promise of a public

living lab, can be captured in the larger scale: a society (Baccarne et al., 2014; Evans et al., 2015; Palo & Tähtinen, 2013).

Recognizing ecosystem's activities, actors and understanding the processes based on which the ecosystem functions helped us to recognize the living lab innovation ecosystem's structure: multiplex network structure (introduced by Leminen et al., (2016)). This configuration can support emergence of radical innovations, since the knowledge will distribute open, free and spontaneously amongst innovation cocreators, who can contribute to proactive joint development activities (Leminen et al., 2016). By identifying ecosystem's structure, we could determine the links between the ecosystem's actor groups, which, based on Nyström, Leminen, Westerlund, & Kortelainen, (2014) is a challenging task. They recognize it challenging because of the characteristics of LL innovation ecosystem, in which actors change their role/position over time (role temporality) or take two roles/positions at the same time (role multiplicity).

3 **Ecosystem-centric business model dominant source of value creation.**

Our findings recognize **lock-in** as the dominant source of value creation at business model content, governance, and structure. Accordingly, we argue that lock-in is the dominant source of value creation in an ecosystem-centric business model. This argument supports the dominant significance of actor's long-term engagement in success, sustainability and viability of ecosystems (Hossain et al., 2019; Verbeek et al., 2020). However, we do not discredit relevance of other sources of value creation (novelty, complementarities, efficiency) at an ecosystem-centered business model. Presence of each value driver can positively influence on any other value driver's effectiveness; in effect, they mutually reinforce one another (Zott & Amit, 2010; Zott et al., 2011). As we also observed **efficiency** in ecosystem's structure, as well as some elements of **novelty** and **complementarities** in ecosystem's governance.

We also answered the second research question by introducing practices and mechanisms which can support coordination of efforts of ecosystem's actors by generating lock-in and ensuring that actors are motivated to be engaged until the ultimate value proposition is created (Figure 9). This is in line with the common notion that ecosystem's actors cannot be directly managed or controlled, instead, they can only be motivated to get engaged in ecosystem's activities and value creation processes (Hossain et al., 2019; Leminen et al., 2012; Ståhlbröst & Bergvall-Kåreborn, 2011).

Moreover, the literature on collaborative settings indicates simultaneity of value creation and value capture processes (Aarikka-Stenroos & Ritala, 2017; Oskam et al., 2020), while value creation occurs at ecosystem level and value capture at actor level (Oskam et al., 2020; Radziwon et al., 2017; Van der Borgh et al., 2012). Our results confirm these concepts by demonstrating the mechanisms which end in value creation **for** each actor group, during the process of value cocreation by themselves. In other words, we demonstrate **how** each actor group perceives their expected value to be captured from the ecosystem, and therefore, finds the ecosystem **attractive** to join and stay (Figure 9: bolded arrows).

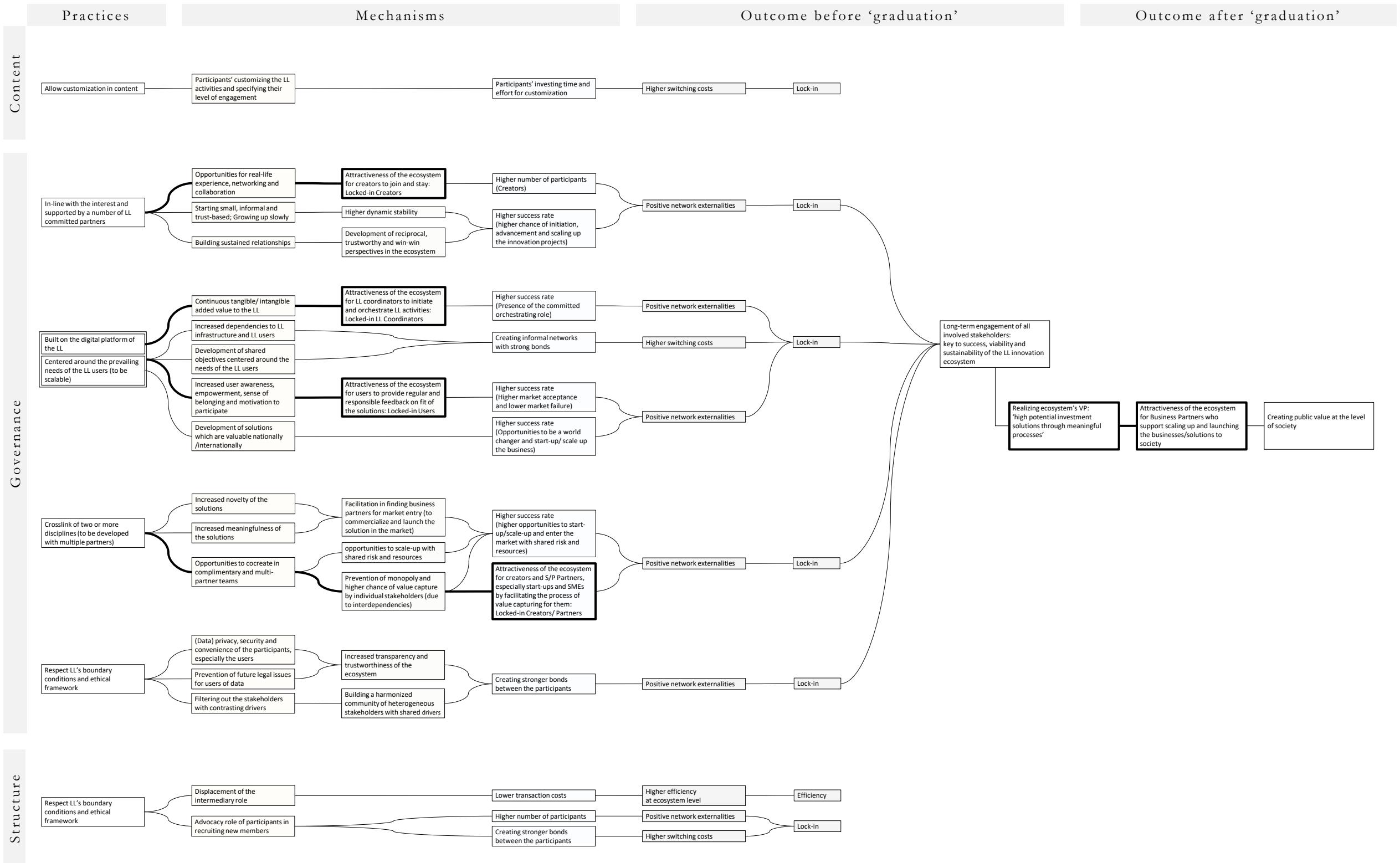


Figure 9_Practices and mechanism which end in processes of value creation at ecosystem level and value capture at actor level

Research Implications, Limitations and Future Directions

This study extends Zott & Amit's frame work for business model design, (2010), from **firm level** to **ecosystem level** and applies it in the context of public digital living lab innovation ecosystem. As one of the first who consider the ecosystem as the level of analysis, we develop an ecosystem-centric sustainable business model for public living lab innovation ecosystems. Living lab practitioners can exploit our results to design, coordinate, assess and optimize their living lab innovation ecosystem by defining deployment goals and practices. Other living lab stakeholders can employ the holistic business model to find their position and links to other actors, in the ecosystem. They can, also, find an overarching perspective on projects' processes and its relevance to themselves.

We contribute to living lab, ecosystem, and innovation management literature by introducing **high potential investment solutions through meaningful processes** as value proposition of public living lab innovation ecosystem. We also recognize **lock-in** as the dominant source of value cocreation in public living lab innovation ecosystem, and a solution to ensure sustainability and viability of innovation ecosystems.

Apart from inherent limitations of qualitative studies, this study is limited in number, scope and geographical (cultural) context of the selected cases, which reduces generalizability of the results. We focused only on public digital living labs in Brainport/ the Netherlands, while contextual elements such as cultural issues are a determinant in this study (e.g. lower organizational hierarchy in this region). Future research can evaluate functionality of the model in other contexts and scopes, for example notably small-scale or large-scale organic living labs (as proposed by living lab experts at ENoLL DLLDs Workshop, 2020).

Furthermore, our investigations have a cross-sectional perspective which allowed us in-depth analysis of the cases, however due to always evolving characteristics of

innovation ecosystems, it is interesting to observe dynamics of the ecosystem during a longer time span (Dattee, Alexy, & Autio, 2018; Leminen et al., 2016), e.g. to study when and how stakeholders' expectations change during the innovation development process, and accordingly, how coordination practices should evolve to be responsive to the emerging expectations.

As such, inclusion of measurable values to the model, which can help living lab stakeholders to quantify and compare their pains and gains, is a valuable contribution which is generally missing in the extant literature (Hossain et al., 2019; also proposed by living lab experts at ENoLL DLLDs Workshop, 2020).

Considering that the current thesis offers a sustainable business model, a comparison between the activities and actor groups recognized here and the ones existing in the literature could reveal interesting results which may also contribute to sustainability of living labs by exploring missing roles and activities. On top of that, in depth analysis of living lab stakeholder's motivations for participating in living lab's innovation activities is still a fragmentary topic in living lab and innovation ecosystem literature.

Our data suggests that scalability of innovation solutions can be enhanced if **business partners** are involved from the early stages of innovation processes, and if they take role as the **first customers**. The practices and mechanisms proposed in this thesis may facilitate management of this process, however, further research is required to focus on the important challenge of scalability (Bakici et al., 2013; Gascó, 2017), and to answer the question 'how the intermediation process can facilitate scalability of innovative solutions?'

This thesis opens up remarkable prospects for the theory that ecosystems can survive without leadership roles or with a shared leadership (Adner, 2017; Oskam et al., 2020). Even though in our cases living lab coordinators take the main lead in orchestrating the ecosystem, we argue that the introduced orchestrating model can

decrease ecosystem's dependencies to a focal orchestrating role. The influence of the model can be enhanced by digitalization and automatization of the processes as much as possible⁷. Future research can delve into the influence of digitalization and automatization of these processes on the dependencies of the ecosystem to the orchestrating role.

Last but not least, we encourage researchers to employ the extended framework for business model design proposed in this study for design of ecosystem-centered sustainable business models and contribute to its development through both qualitative and quantitative methods.

⁷ For this purpose, we designed and developed ATLAS: a support tool in the form of a mobile application (an interactive prototype) for implementing the business model. Please see [Appendix G](#)

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Appendices

A List of Interview Participants

B Interview Protocols

- Interview Protocol No.1
- Interview Protocol No.2
- Interview Protocol No.3
- Interview Protocol No.4
- Interview Protocol No.5

C Scheme of ENoLL DLLDs Workshop 2020

- Scheme of the Digital Board in Miro Used by Participants
- Participants' Feedback

D Personas

E Activities @ Different Levels and Steps of Innovation Management

F From Results to Model

G ATLAS: A Support Tool for Implementing The Business Model

- 1 Platform's Information Architecture
- 2 Interactive prototype

A List of Interview Participants

List of interview participants			
No.	Code	Position (s)	Involved in
1	A1	Lab Strategic Manager	Atlas Living Lab
2	A2	Lab Project Manager (Internal Relations)	Atlas Living Lab
3	A3	Lab Coordinator	Atlas Living Lab
4	A4	TU/e Program Manager (Educations) Business Collaboration	Atlas Living Lab
5	A5	TU/e Head of Management and Maintenance TU/e Technical Advisor and Property Management	Atlas Living Lab
6	A6	Lab IT project manager	Atlas Living Lab
7	A7	TU/e Professor and Research Owner Human Technology Interactions	Atlas Living Lab
8	A8	TU/e Research Policy Advisor	Atlas Living Lab
9	A9	TU/e Project Coordinator (Education)	Atlas Living Lab
10	A10	TU/e Program Director Human Vitality & Technology TU/e Professor and Research Owner, Concept Creator & Developer Data Science	Atlas Living Lab

11	A11	Signify Key Account Manager Signify Commercial Director	Atlas Living Lab
12	A12	TU/e Student & Team Solid Member	Atlas Living Lab
13	A13	TU/e Student Electrical Engineering & Team Chairgonomics Member	Atlas Living Lab
14	A14	Lab User	Atlas Living Lab
15	A15	Lab User	Atlas Living Lab
16	B1	Lab Director & Project Owner	BSD Living Lab
17	B2	Lab Project leader Innovative Projects & Lab Advisory Board Member	BSD Living Lab StrijpS Living Lab
18	B3	TU/e Professor Information Systems in the Built Environment & BSD Board Member	BSD Living Lab
19	B4	TU/e Student & Team CASA Manager	BSD Living Lab
20	S1	Lab Project Manager (External Relations)	StrijpS Living Lab Atlas Living Lab
21	S2	Lab Project Manager Smart City Project	StrijpS Living Lab
22	S3	Sorama CEO	StrijpS Living Lab Atlas Living Lab

Table A.1_ List of interview participants

B Interview Protocols

Five interview protocols are developed for interviewees at different positions in the ecosystem. This information is presented below.

Interview Protocol No.	Interviewee's Code
1	A1, S1
2	A2, A3, A4, A6, A9, B1, B2, B3, S2
3	A7, A8, A10, A12, A13, B4, S3
4	A11
5	A5, A14, A15

Table A.2_Interviewee's code

Interviewees were invited by an e-mail including a short self-introduction, topic, objective of the project and main interview questions.

Interview Protocol No.1

Interviewees: A1, S1

1 Introduction

By this interview I aim to achieve a deep understanding of Atlas Living Lab and its innovation ecosystem from a high-level perspective. The focus is mainly on key stakeholders, their needs, interrelations and expectations. I try to perform this interview with all key-actors involved in innovation ecosystem of Atlas Living Lab, to map stakeholders and their mutual relations. I also need to explore strength and deficiencies in Atlas innovation ecosystem and seek for suggestions from your side. Your insights can help strengthening and stabilizing this ecosystem.

- 1 What is your exact position and what are your responsibilities and activities in relation with Atlas Living Lab?
- 2 Please explain how Atlas Living Lab looks like to you. The main objectives and activities. (Your opinion)

2 Understanding and classification of stakeholders

- 1 Who are the core actors/partners of Atlas? Who are involved in value creation and capturing process? (Actors)
- 2 Is one of them more dominant to control the system or to coordinate all the partners? (Stakeholders structure)
- 3 Which of them is the most important to you/ your organization?
- 4 How often do you meet any of other core partners? Which one do you meet the most?
- 5 Who has the most **power/authority** in running the projects? (Based on their “formal” position)
- 6 Who can **informally influence** the process of work in Atlas? (Facilitate or delay)
- 7 Who will be the most **effected** by activities of Atlas? (Both benefits and drawbacks)

- 8 Who is the most **interested/motivated** in development of “innovation ecosystem” in Atlas? (The key driver)
- 9 Who spends the **most/least time** amongst the ecosystem?
- 10 What does the most important **achievement** for each of the partners, look like? (in your opinion)

3 Innovation ecosystem inter-relations

- 1 I am trying to understand Atlas innovation ecosystem model and its mutual relations; so, as you are one of the actors in “innovation ecosystem” of Atlas, I want to know your own opinion about this collaboration.
- 2 When and how did you/your organization become a partner in this collaboration?
- 3 What was your main objective for collaborating as a partner in Atlas Living Lab? What does “success” mean to you in this context?
- 4 Are you still interested in this collaboration? Are you in a good orientation to achieve your objectives?
 - a. What is missing? The problems? What can be optimized and how?
- 5 How do you see the alignment between the “current partners”? How could it be optimized?
- 6 Do you think forming collaboration with “new partners” is a good idea? How and why?
- 7 What value proposition does Atlas deliver? And who are the end users? (In current situation)
- 8 How the value proposition and end-user segment can be developed? Your suggestions.
- 9 What is your contribution for “value proposition” to be realized? (Money, time, knowledge, human resources, etc.)
- 10 And how do other actors add value to the system?
- 11 Do you think these contributions are well matched and aligned to create and capture value? Or it could be managed better? (new activities, time alignment, new partners, any ideas)
- 12 What “activities” do you perform? (in line with creation and capturing value)
- 13 Which values do you earn by being a part of this ecosystem? And what are the “pains” in return? (In current situation)
- 14 How important is to you, “realization of this value proposition”? Is it one of your priorities?

- 15 Do you see to “be a partner in Atlas living lab”; a short term or long term investment? Why?

4 Projects workflow

- 1 Do you know any projects (development of product/services) that is/was running in Atlas?
- 2 Can you narrate its story? (Each project separately, except if all of them had the same story!)
 - a. Where did the idea come from? Did users of Atlas have any role in creating or developing of the idea?
 - b. Was the innovation approach “Top-Down” or “Bottom-Up”? How? (For each project)
 - c. Who initiated to develop and support the idea to be realized?
 - d. When did you get involved?
 - e. Were all the key-partners involved since the start? Who was involved actively and/or passively?
 - f. How often were you involved? (Meetings/ giving feedbacks/ alignments)
 - g. How was the flow of “activities” based on your observations? Where were bottle necks?
 - h. What happened to the project at the end? Which level of its development is it?
 - i. Where does the money for the projects come from?
 - j. Can you compare the existing situation of workflow and the ideal situation; what is missing? (money, time, knowledge, alignment)
 - k. Do you think an agile alignment between key partners is needed? Why?

5 Final considerations

- 1 At the end, and for conclusion, can you explain if you see any strength or weak points in the process, which is not already mentioned?
- 2 Do you have any additional insights or suggestions about how to improve the system?
- 3 Do you have any suggestions for me; about my approach or people that I need to meet?

Interview Protocol No.2

Interviewees: A2, A3, A4, A6, A9, B1, B2, B3, S2

1 Invitation (before interview)

Invite by e-mail: include a short self-introduction, topic, objective of the project and main interview questions.

2 Introduction

Explain to the participant the reason of the current interview: Briefly introduce the topic and objective of the project and our method.

Explain the set-up of the interview: first, general information, then, mapping the current situation, and last, addressing the current issues and proposing recommendations for optimizing the system.

- 1 Can you tell me about your current work position?
- 2 How are you connected to Atlas/BSD/StripS Living Lab or TU/e innovation projects? What is your position with respect to them?

3 Mapping the Current Situation

Ask about the overall process of applying an innovation project in the case. Ask the participant to name a few (successful/unsuccessful) cases with a brief overview about them. Focus on one or two of these projects.

- 1 Can you tell me who were the applicants in this project and how did they find you?
 - Students/ Researchers/ Startups/ SMEs
 - Larger companies
 - Universities, research and knowledge centers
 - Other public organizations
 - Others
- 2 In your opinion why did they choose your living lab (or your program)? What was their motivation? What advantages were they seeking for?

- 3 Do you think they could achieve what they were willing to? To what extend? Bring some examples.
- 4 (With respect to NO.3) If any dissatisfactions, what were the reasons?
 - Technical
 - Organizational
 - Others
- 5 (With respect to NO.3) what were the reasons for their good experiences? Please explain.
 - Your way of working
 - Your supports
 - Your values
 - Others
- 6 Who do you see as the “users” of your Living Lab?
- 7 How do you involve them in the innovation projects? How do you enable the applicants to develop “user centric” innovation projects (considering the privacy of the users)?

4 Recommendations for Future

With respect to the answers in the previous section (No.4 & No.5), ask for the participant’s recommendations.

- 1 In your opinion, what are the main issues that needs to be addressed to improve the performance of the system in the future?
- 2 How can we address these issues and optimize the system?
- 3 Do you have examples of successful systems and their approach?

Note: the last two questions are asked when the research subject has a relevant role in a living lab. The focus of the questions is slightly adjusted when research subjects are educational coordinators.

Interview Protocol No.3

Interviewees: A7, A8, A10, A12, A13, B4, S3

1 Introduction

Explain to the participant the reason of the current interview: Briefly introduce the topic and objective of the project and our method.

Explain the set-up of the interview: first, general information, then, mapping the current situation, and last, addressing the current issues and proposing recommendations for optimizing the system.

- 1 Can you tell me about your current work position?
- 2 How are you connected to Atlas/BSD/StrijpS Living Lab or TU/e innovation projects? What is your position with respect to them?

2 Mapping the Current Situation

Ask about participant's experience with the case.

- 1 What project/s have you been involved in? (or did want to initiate and couldn't?)
- 2 How did the collaboration initiate? How did you hear and get involved in?
- 3 How did the collaboration go on? An overview of the whole process.
- 4 What were your initial motivations to join? Or your expectations.
- 5 Did you achieve them (No. 4)? What were the advantages and disadvantages of the collaboration for you?
- 6 What challenges, gaps or difficulties did you find in the process?

3 Recommendations for Future

With respect to the answers in the previous section (No.5 & No.6), ask for the participant's recommendations.

- 1 In your opinion, what are the main issues that we need to address in the future?
- 2 How can we address these issues and optimize the system?

Interview Protocol No.4

Interviewee: A11

1 Introduction

- 1 Could you introduce yourself and your position within Signify?
- 2 Quick introduction why we are doing this:
 - a. Continued pipeline of challenges from Signify to innovation Space.
 - b. We want to embed system knowledge of Signify to students of the Tu/e. Using this knowledge, students start building applications on infrastructure of Signify.
 - c. For the common goal of developing applications on the platform of Signify. This increases the value of the platform.

2 What do we have to do to organize this?

- 1 Challenges:
 - a. Does Signify want to position itself between TU/e and customer?
 - b. What kind of projects would you like the students to do?
 - Outside the roadmap?
 - Inside the roadmap?
 - With / without priority?
 - c. How do you see the process of an ongoing collaboration regarding these kinds of projects?
- 2 Knowledge:
 - a. What systems are relevant for the students when they want to build applications for you?
 - b. What knowledge do the students need to start using these systems?
 - c. How can we transfer this knowledge from Signify to students?
 - i.e. Information package for students
- 3 Requirements: Learning about the requirements of your systems.
 - a. Students are the testers of the systems, so you know how to make them sufficient when external developers are going to use them.
 - b. How are we going to use the findings of students in the roadmap of Signify?

Interview Protocol No.5

Interviewees: A5, A14, A15

1 Introduction

Explain to the participant the reason of the current interview: Briefly introduce the topic and objective of the project and our method.

Explain the set-up of the interview: first, general information, then, mapping the current situation, and last, addressing the current issues and proposing recommendations for optimizing the system.

- 1 Can you tell me about your current work position?
- 2 How are you connected to Atlas/BSD/StrijpS Living Lab or TU/e innovation projects? What is your position with respect to them?

2 Mapping the Current Situation

Ask participant about Atlas and try to picture their understanding from the Living Lab.

- 1 What do you know about Atlas, as a Living Lab? Can you define it?
- 2 Do you know about the infrastructure and facilities of this smart building?
- 3 Do you think these facilities can be employed for your benefit (as a user of the building)? If yes, give some examples.
- 4 Do you see any disadvantages or threads for your privacy, safety, or security (as a user of the building)?
- 5 At the moment, several innovative projects are running in Atlas. These projects, mainly, aim to enhance health and wellbeing of Atlas users or their quality of life, or reduce the environmental footprint of the building. Do you know about any of them?
 - If Yes) Do you call those projects user-centered? Explain.
 - If No) Are you interested to know about them? Explain why yes or no.

3 Recommendations for Future

With respect to the answers in the previous section, try to understand participants' expectations and ask for their recommendations.

- 1 What is an efficient and interesting way to inform you about Atlas, its facilities and innovative projects which may interest you? Share any ideas.
- 2 How can we encourage you to participate in the projects, test them and provide feedback on them? Propose the possible ways which might work for you or others.
- 3 What are we doing wrong? Or what we shouldn't do? Do you observe or foresee any issues?

C Scheme of ENoLL DLLDs Workshop 2020

Agenda

- 1 Introduction (10 min)
- 2 Plenary presentation (15 min)
 - A holistic business model for sustainable living lab innovation ecosystems (based on Atlas Living Lab, Brainport Smart District and the iCity Living Lab on Strijp-S)
- 3 Interactive session (25 min)
 - React to the proposed model from own experience and practice in other living labs
- 4 Plenary presentation (5 min)
 - Living lab interventions: How to create and capture value
- 5 Plenary debate (30 min)
 - Topics arising on the whiteboard
 - Feedback on the proposed model

Scheme of The Digital Board in Miro Used by Participants

Dimitri

Consider a project in your living lab:
Use the sticky notes to identify different stakeholders involved in that project and map them on the model below. Keep in mind: a stakeholder may belong to different groups at the same time.
Please write down a short summary about the living lab and the project's objective as well.

Living Lab:
Project name: **Innov. Living Lab Heterogeneity project**

Project summary:
Description of a smart communication format across the city network that has been among researchers in digital divide. The researchers have been able to create their own network in the project that allow people who are beyond the network to participate in the project. In this way, the project can serve as a model for other living lab projects in a non-physical environment as well as a model for the project.

Use the sticky notes to indicate the stakeholders in the project and put them in the right place on the model by dragging & dropping.

Thinking about the same project (above), please evaluate to what extent the following sentences stand true.
Keep only the appropriate colored circle and delete the other two.

In our living lab projects, we ensure that multiple partners, from different disciplines are involved in development of projects, whose knowledge is complementary and needed in the project's development process.	<input checked="" type="radio"/> True <input type="radio"/> Somewhat true <input type="radio"/> Not true	Could you elaborate on that?
We make an explicit effort to understand the interests of all our living lab stakeholders (creators, strategic project partners and users) to ensure we can increase their engagement by adapting to their needs and interests and increase complementarities between the partners.	<input checked="" type="radio"/> True <input type="radio"/> Somewhat true <input type="radio"/> Not true	
Our living lab projects make use of our (continuously evolving) living lab's (digital) platform or physical environment to develop their solutions.	<input type="radio"/> True <input checked="" type="radio"/> Somewhat true <input type="radio"/> Not true	
Our living lab projects involve user participation and are centered around living lab users' needs.	<input checked="" type="radio"/> True <input type="radio"/> Somewhat true <input type="radio"/> Not true	
To ensure safety, security and privacy of the living lab users, we have made the living lab boundary conditions (policy) explicit and created an "ethical framework" that all stakeholders respect.	<input checked="" type="radio"/> True <input type="radio"/> Somewhat true <input type="radio"/> Not true	

In use by Noemie

Consider a project in your living lab:
Use the sticky notes to identify different stakeholders involved in that project and map them on the model below. Keep in mind: a stakeholder may belong to different groups at the same time.
Please write down a short summary about the living lab and the project's objective as well.

Living Lab:
Project name: **Living Lab Laender e**

Project summary:
Services provided in the lab: **Services provided in the lab**

Roles: **Business Partner, Creator, Startup, Industry Worker, Clients**

Use the sticky notes to indicate the stakeholders in the project and put them in the right place on the model by dragging & dropping.

Challenges: to attract researchers, new way of working.

Thinking about the same project (above), please evaluate to what extent the following sentences stand true.
Keep only the appropriate colored circle and delete the other two.

In our living lab projects, we ensure that multiple partners, from different disciplines are involved in development of projects, whose knowledge is complementary and needed in the project's development process.	<input checked="" type="radio"/> True <input type="radio"/> Somewhat true <input type="radio"/> Not true	Could you elaborate on that?
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Our living lab projects make use of our (continuously evolving) living lab's (digital) platform or physical environment to develop their solutions.	<input type="radio"/> True <input checked="" type="radio"/> Somewhat true <input type="radio"/> Not true	
Our living lab projects involve user participation and are centered around living lab users' needs.	<input checked="" type="radio"/> True <input type="radio"/> Somewhat true <input type="radio"/> Not true	
To ensure safety, security and privacy of the living lab users, we have made the living lab boundary conditions (policy) explicit and created an "ethical framework" that all stakeholders respect.	<input checked="" type="radio"/> True <input type="radio"/> Somewhat true <input type="radio"/> Not true	

Figure A.1_Scheme of the board used by workshop participants

Participants' Feedback

Participants' Feedback at ENoLL DLLDs Workshop 2020 using sticky notes in Miro Digital Board

Participants' Feedback

Evaluation Indices

Nice tool to work online together with stakeholders, with help of Miro

Ease of use

We will try to implement the elements of the model into our laboratory system

Applicability

I didn't test my own project yet, but I think it can be very useful

Impact

Applicability

An interesting model. My team will definitely get something out of it. it gave me a different perspective

Impact

Applicability

It was interesting. I have been coordinating a living lab for two years but still a lot of things to learn. Your questions of the model gave me insights (→ refers to the 5 practices)

Impact

Testing it on a variety of living labs, especially the ones that focus on complex problems and not simple products.

Applicability

(future research)

I am not sure if it reflects all the variety of different living labs including large-scale & small-scale organic ones. **Applicability**
(future research)

I would be interested to see how you apply the model with the inclusion of “numbers” (money, efforts spent, etc.) **Applicability**
Level of abstraction
(future research)

It would be great to compare it with the utilizers/ enablers/ providers[...]model → I think that one is more applicable for a LL organization, whereas yours is more on an actor level, applicable for project analysis. **Applicability**

Table A.3_Feedbacks related to ENoLL DLLDs workshop 2020

D Personas

To increase usability of the results, we developed 5 personas that represent the 5 actor groups identified in this study. Each persona is introduced by a card that includes: 1) a picture, 2) the main reason of being identified as a member of the ecosystem, 3) the main added value by actor to the ecosystem, 4) the main expected value from the ecosystem, and 5) the primary motivation that attracts the actor to participate in the ecosystem's activities.

Living Lab users | Society

	Living in (using) the living lab
	Added value: information on user behavior & preferences
	Expected value: better quality of life increased health & wellbeing
	Motive: hedonistic motives

Creators

	Looking for complementary (in)tangible resources
	Added value: creative & novel proposals time & energy to coordinate the project team
	Expected value: gain experience, networking opportunities, visibility & reputation have fun enrich & realize own ideas
	Motive: intrinsic motives ROI after success

Strategic | Project partners

	Own a challenge and looks for solution through more efficient processes
	Added value: share various tangible/intangible resources to maintain the LL infrastructure or for development of solutions in LL
	Expected value: more efficient processes to develop new solutions inline with their (organization's) interest and roadmap
	Motive: anticipated tangible or intangible benefits through added value to investments

Living Lab coordinators

	Are responsible for viability & functioning of LL
	Added value: orchestrate the ecosystem network and connect
	Expected value: information on quality of LL functioning and work progresses
	Motive: Added value to the living lab itself

Business partners

	Investigate the ecosystem seeking for viable investment opportunities
	Added value: payments scale-up and commercialize the businesses
	Expected value: Viable, relatively low risk and ready-to-market products/businesses
	Motive: Access to high potential investment solutions

Figure A.2_Personas

E Activities @ Different Levels and Steps of Business Model

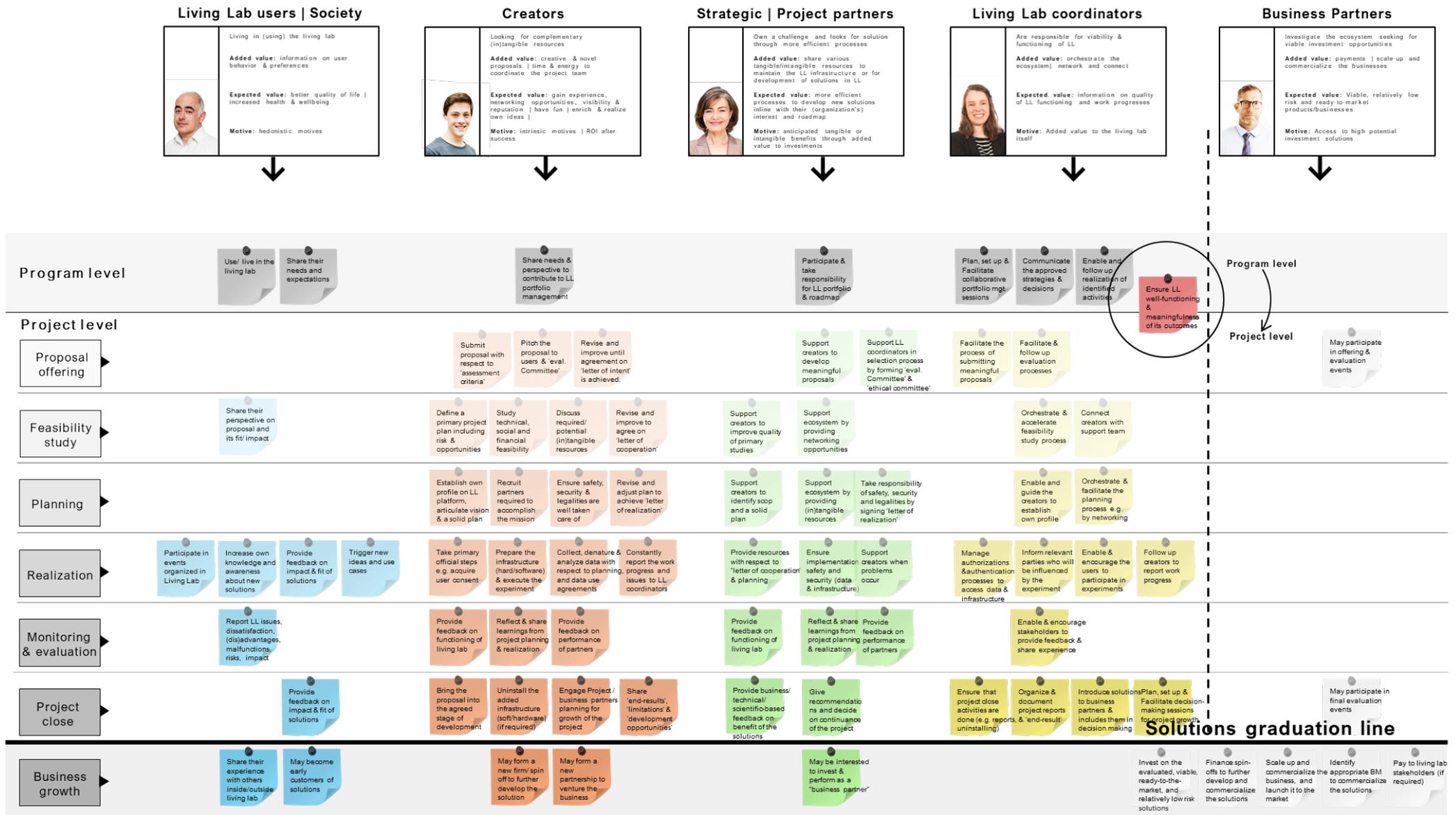


Figure A.3_Activities at different levels and steps of business model

F From Results to Model

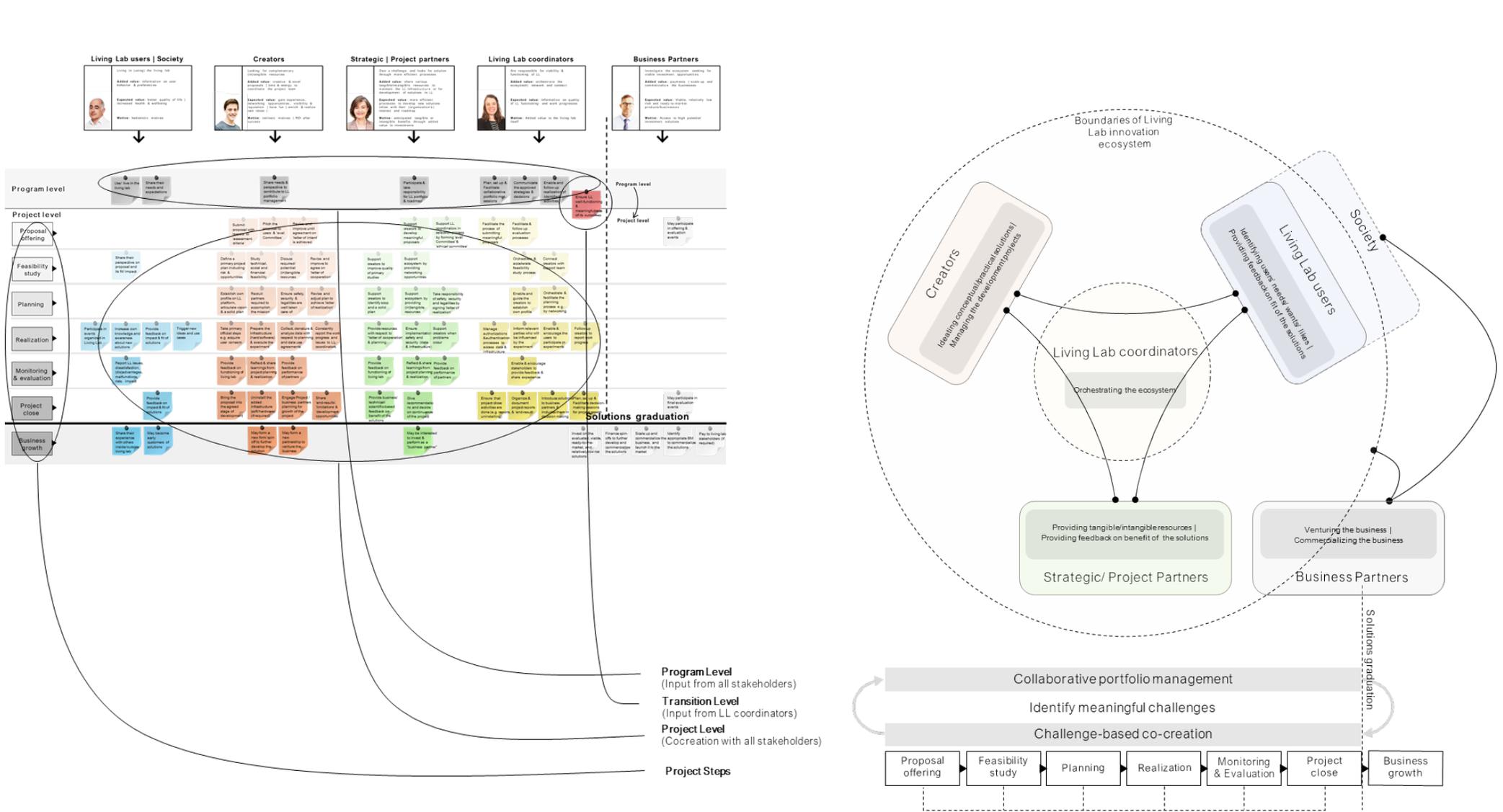


Figure A.4_Summarizing and transforming the labels into the model

G ATLAS: A Support Tool to Implement The Business Model

The proposed support tool is in the form of a digital platform: a responsive website or a mobile application. This appendix includes 1) platform's Information Architecture, and 2) an interactive prototype for a mobile application that is developed based on the Information Architecture.

1 Platform's Information Architecture

We create the Platform's Information Architecture by answering the following questions:

- 1 **Who** do we expect to use the digital platform?
- 2 **Why** do we require them to use the platform? To create which outcome (added value)?
- 3 **What** tasks do they need to perform to create the expected outcome (expected added value)?

Figure A.6 demonstrates the answers to these questions. Figure A.6 also shows how the Information Architecture starts to be formed built on these questions.

Figure A.7 presents the complete version of Information Architecture. This version is the result of breaking the tasks down into smaller tasks.

2 Interactive Prototype

The interactive prototype of the mobile application is accessible by scanning the following QR code.

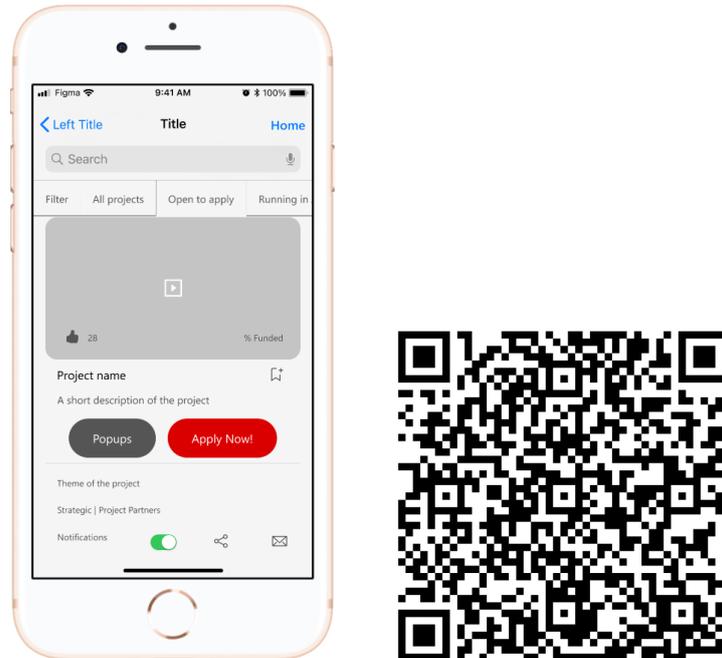


Figure A.5_QR code (right) to access the interactive prototype (left)

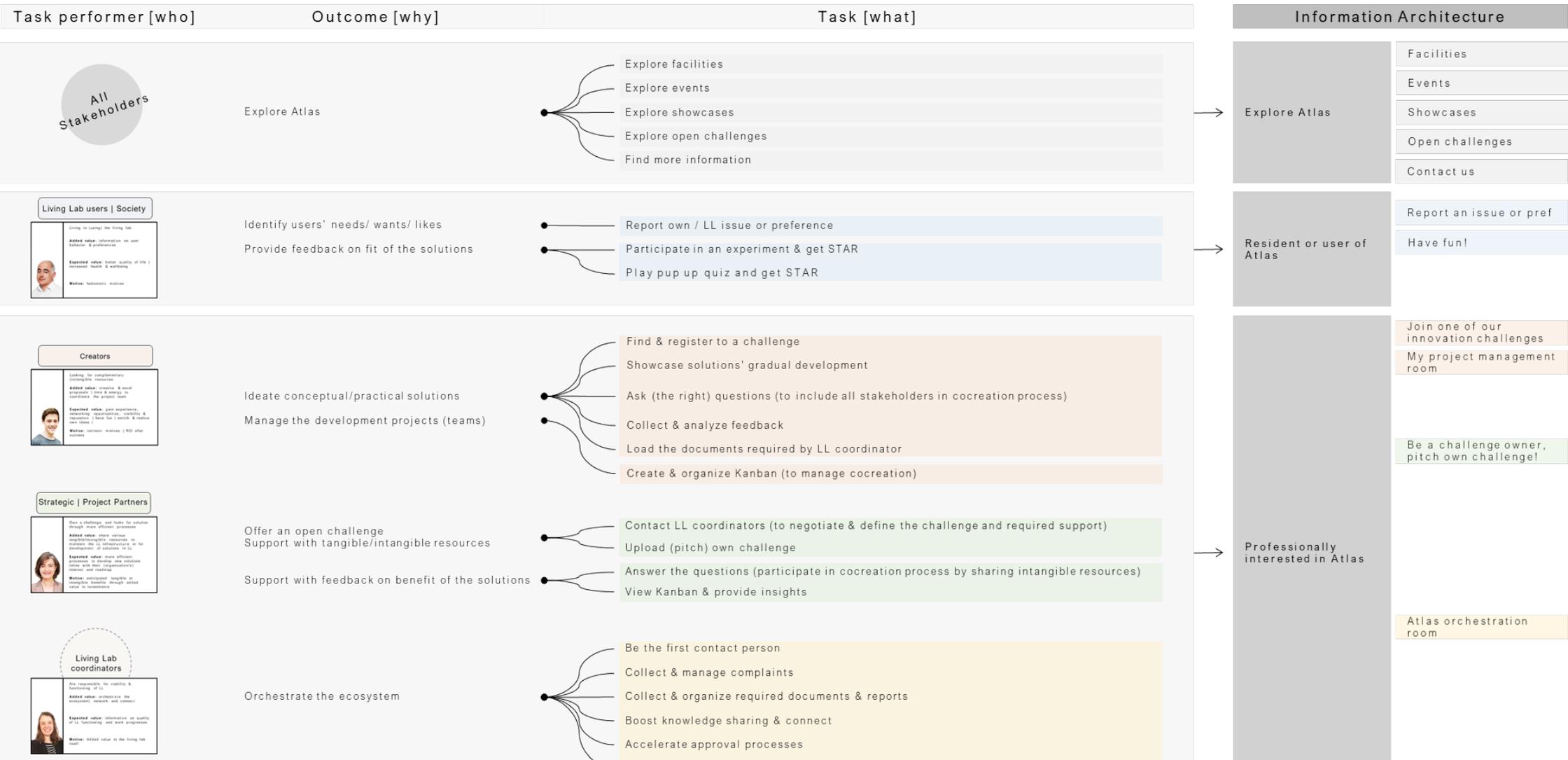


Figure A.6_ The design process of platform's Information Architecture

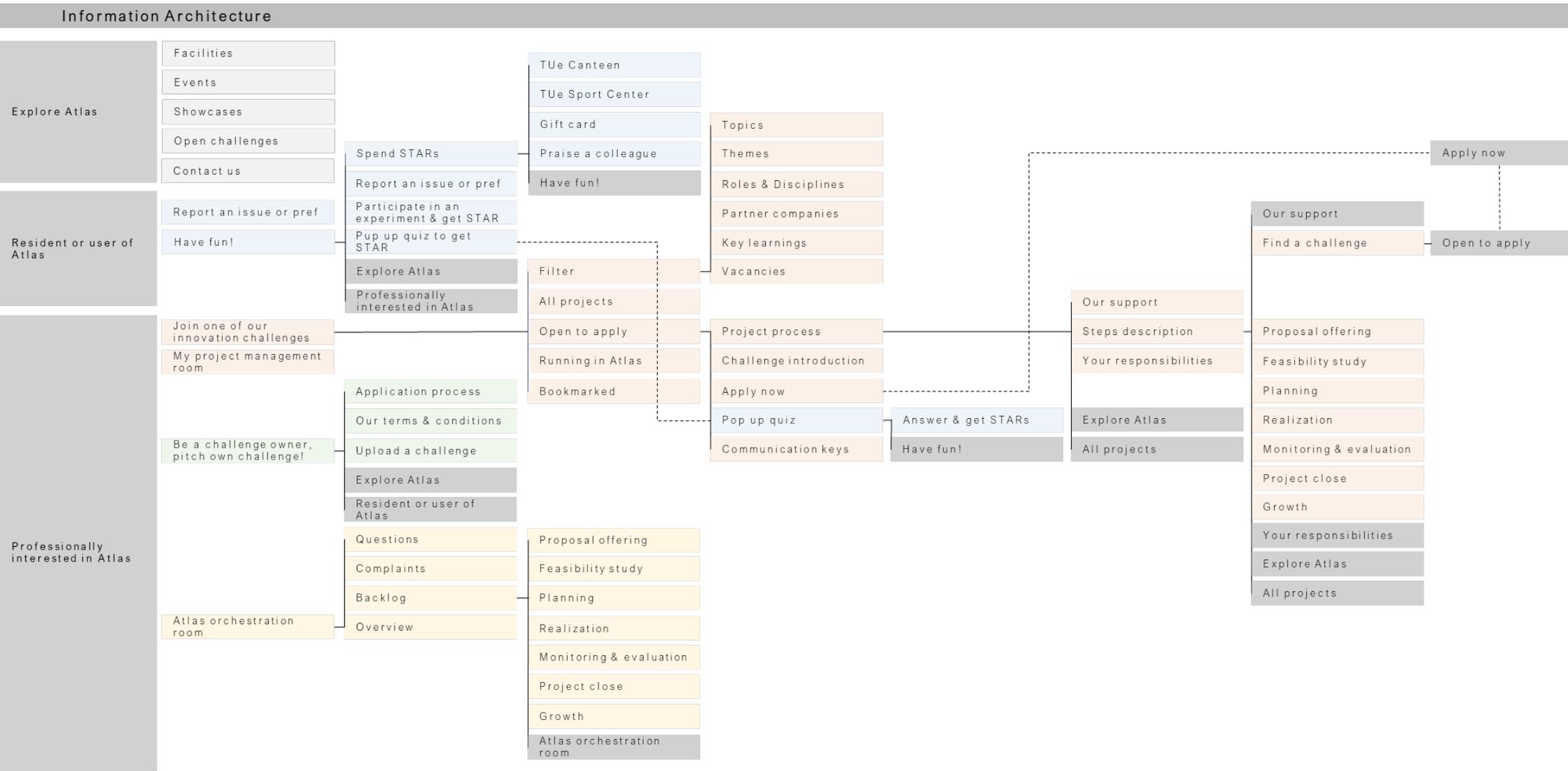


Figure A.7_Digital platform's Information Architecture

