CHAPTER 5

Discussion

In this dissertation I studied how digital innovation processes are organized in ecosystems with heterogeneous actors over time. I zoomed in on three organizational challenges for different stages of ecosystem evolution: creation, growth, and maturity. In this final chapter I summarize the key findings, discuss theoretical contributions, and give suggestions for future research. After that I present the practical implications that follow from my research, and finally I share my reflections on the research methodology.

5.1 Summary of key findings, contributions, and future research

In the preceding three chapters I presented studies that together aim to answer the overall research question of this thesis, formulated as follows: *How do organizations address the challenges of managing digital innovation in evolving ecosystems consisting of heterogeneous actors?* I broke down this question into three key organizational challenges associated with managing digital innovation during specific stages of ecosystem evolution. In Chapter 2 we looked at coordination during the *creation* of an innovation ecosystem, and analyzed how involved ecosystem members were able to overcome 'temporal complexities' that are the result of the differences among actors. Chapter 3 focused on the process of *growing* an ecosystem, and reveals different ways in which a platform owner manages connections with various complementors. In Chapter 4 we addressed the importance of maintenance work for *mature* ecosystems to ensure overall quality of the digital platform and associated complementary services. Below, I reflect on the key findings, theoretical contributions, and suggestions for future research for each distinctive stage of ecosystem evolution (see also Table 5-1 for an overview).

5.1.1 Creating an ecosystem

Key findings. In Chapter 2 we set out to understand the coordination challenge in nascent innovation ecosystems. Coordination is necessary to align activities by interdependent ecosystem members in order to effectively create and share value. We build on a qualitative, longitudinal field study of a smart city project and analyzed data covering the very first beginnings of the creation of this ecosystem. We focused on the variety of actors involved and their collaborative activities over time. The local municipality was a key stakeholder, who was struggling with a problematic entertainment area in the city center and saw opportunities for creating a better

Table 5-1 Overview of key findings per chapter

	Organizational challenge	Key Findings
Chapter 2: Creating an ecosystem	*Coordination:* To establish a successful ecosystem, heterogeneous organizations need to be aligned. However, nascent ecosystems are highly ambiguous and uncertain, which makes coordination of actors and activities a key challenge.	Misalignment among ecosystem members can be avoided through *temporal coordination*. This, however, does not always involve achieving synchrony, instead the data revealed three alternative strategies to circumvent temporal complexities: 1) leveraging moments of temporal concurrence, 2) creating temporal suspension of misaligned actors, and 3) bringing the future to the present.
Chapter 3: Growing an ecosystem	*Managing complementors:* during ecosystem growth, a growing number of third-party complementors develop products and services that get integrated (connected) with the core platform. Besides the technical connections, the platform owner needs to manage the organizational relations with a diverse group of complementors.	Third-party complementors create connections between digital products, beyond the control of the platform owner, resulting in an 'ecology of platforms'. These connections vary in complexity: from dedicated complements, to complements that bridge multiple platforms, and ultimately complements that embed the focal platform in larger ecosystems. Consequently, platform owners rely on different modes of collaboration with their complementors: from arm's length contracts to intensive partnerships.
Chapter 4: Maintaining a mature ecosystem	*Maintenance to ensure quality:* while in early stages of platform ecosystem achieving sufficient quantity of complements is key, in later stages the quality of these complements becomes a pressing issue to keep up performance of the whole platform system.	Quality is not fixed, but changes when the platform ecosystem evolves over time. We show that complementors need to regularly update their products to maintain 1) integrity and 2) functionality of the system. As a result, platform owners depend on complementors' engagement. Users play an important role in stimulating necessary updating practices by complementors.

atmosphere through the usage of new digital technologies. They invited others to contribute ideas and offered a 'space' for exploration with prototypes. Over time, the initiative attracted numerous new ecosystem members interested in providing technological solutions (such as big data analytics) to target at the area's problems. These technology companies varied from start-ups to international incumbents, and used the project as a 'testbed', that is, a pilot to prove technologies in early phase to ultimately turn these into commercial solutions for other cities. Research institutes and university researchers (as well as students) participate to independently test and study the effectiveness of these technologies. The aforementioned actors entered at different points in time, and all had their own incentives to join the LivingLab ecosystem.

Despite these differences and highly dynamic nature of the innovation ecosystem, our data analysis revealed that alignment among members was achieved through *temporal coordination*. That is, the organizational differences inform each organization's temporal frame and time pacing (including timelines, rhythms and orientation to the past, present and future) leading to potential temporal misalignments (i.e., "temporal complexities"). We found three strategies for how ecosystem members were able to effectively circumvent temporal complexities. First, we learn that coordination among a variety of actors takes place during particular moments of synchrony, i.e., when different internal pacers align nicely, instead of adjusting to one dominant external pacer. Ecosystem members can leverage such moments of temporal concurrence to accelerate progress. Second, our findings show that it can also be beneficial to temporary suspend actors with a different time frame to avoid conflicts. Third, the LivingLab case illustrates how disconnecting from the 'now', and enacting the future as if it is already a reality allows to bridge temporal differences among ecosystem participants.

Contributions and future research. This study's main contributions to the ecosystem literature are threefold. First, we contribute by taking a temporal perspective on coordination in innovation ecosystems. According to Adner (2017),

an ecosystem is "the alignment structure of the multilateral set of partners that need to interact in order for a focal value proposition to materialize" (p.40). We follow this definition, and studied in particular the time dimension of alignment among ecosystem members. Prior research has pointed out that each organization has its own temporal rhythm, pace, orientation and time horizon (e.g., Orlikowski & Yates, 2002), and that when multiple organizations come together to innovate, their differences may result in misalignment of collaborative efforts (Garud et al., 2013). Furthermore, prior (time-)research suggests organizations need become in-sync (e.g., Pérez-Nordtvedt et al., 2008; Davis, 2014). In line with this, our study shows that in *moments of synchronization* the collaborative efforts take place. However, it also shows that being out-of-sync may be as effective. Adapting own temporal structures to one dominant pacer or another actor's rhythm may involve force-fitting. Future research could further investigate the conditions under which being in- or out-of-sync is most preferred.

Second, while most ecosystem research suggests that coordination revolves around a value proposition or/and a dominant focal firm or platform owner as the prime orchestrator, we show that ecosystems can also be organized without such central coordination devices. In our study, the municipality (who could be considered as the hub) acted more like a 'facilitator' of the innovation ecosystem and did not interfere so much in collaborative efforts taking place between members. We did not observe that one actor took the lead, instead we saw that the ecosystem emerged organically and members developed technologies in 'sub-groups' (Davis, 2016). Only after such sub-projects were started (and sometimes also completed), integration was made when actors saw opportunities for further complementarities. This also worked generatively (Yoo et al., 2012): finished projects inspired others (from inside and outside the ecosystem) to develop new solutions that build on exciting LivingLab technologies. The fact that the particular innovation ecosystem that we studied could survive without a formal organizational structure could be due to its exploratory nature; the risks for each participant were relatively low as most projects were in a

pilot stage and technological failures still resulted in important learning's for further development. Furthermore, the lack of a clear value proposition may have also played a role in creating a more informal organization because roles and objectives remained mainly undefined. More (empirical) research is needed to understand whether such an alternative, more democratic way of organizing ecosystems is also effective in other situations.

Third, we contribute by empirically investigating an innovation ecosystem from birth to early stages of creation; a stage of ecosystem-evolution that has so far been under addressed in the growing body of research on ecosystem coordination and management (Autio & Thomas, 2013). A notable exception is Dattée, Alexy and Autio (2018), who make explicit that during ecosystem creation it is hard for complementors to commit resources as the ecosystem has not been formed yet (a chicken-and-egg problem). We extend their work by showing that an image of the future allows for coordination when a clearly defined value proposition is still missing. Typically, the focal firm defines a value proposition, however, the LivingLab example shows that each member can contribute to the future image of what a smart city should look and feel like. Future research is needed to better understand if and how such co-created futures can eventually evolve into a value proposition with accompanied business model that resonates with exciting and future ecosystem members.

5.1.2 Growing an ecosystem

Key findings. In Chapter 3 we investigate how platform owners manage a growing ecosystem of heterogeneous complementors. Complementors develop products and services (i.e., the complements) that work with the platform core components (e.g., an iPhone without third-party apps has little use value) and thereby increase the overall value of the system. To achieve ecosystem growth, platform owners may open up (part of their) standardized interfaces (e.g., APIs) so that outsiders are able to easily develop complements that work smoothly with the platform core components. Besides the technical integration, platform owners need to manage the relations with their

complementors.

We carried out an in-depth study of the Philips Hue to understand how Philips Lighting organized its ecosystem of complementors. Innovations by complementors have contributed significantly to the success of the Hue smart light bulbs by offering almost endless options for usage through third-party applications, launched on different platforms (most importantly Apple's iOS and Android). For example, Hue Disco is a third-party app that allows users to sync their Hue lights with music – a functionality that the official Philips app does not offer.

A further analysis of these complements developed by third parties revealed different types of integrations between the Hue system and the complements. First, third-party developers have created relatively simple apps that add to the Hue platform only to offer e.g., more advanced control of the light bulbs beyond the basic features of the official Philips Hue app. Second, we found that app developers, in their desire to create new applications, combine the Hue interface with a variety of external APIs, and thereby connect to multiple platforms. Third, more complex connections exist when complementors embed the Hue system in other smart home platforms, thereby making in-direct connections with other available smart devices. Depending on the level of complexity of the connections, we found different modes of collaboration (of varying intensity) between Philips Lighting and their complementors.

Contributions and future research. A major contribution of the findings as discussed in Chapter 3 is showing that complementors play an important role in growing ecosystems by creating connections *between* platforms. That is, independent complementors combine standardized open interfaces (such as open APIs) from different platforms, and through their third-party complements build bridges between those platforms. The Hue case illustrates how third-party app developers typically rely on multiple platform resources to develop new use cases, thereby creating integrations that were not foreseen by the platform owner Philips Lighting. Some recent studies on digital innovation have noted the possibilities of combining different digital interfaces (e.g., Um et al., (2015) study the structure of the Wordpress platform

by analyzing combinations of internal and external APIs in plug-ins). However, the focus was primarily on the technical integration and not so much on how and by whom these are established. We extend this work on recombinations in digital innovation (e.g., Henfridsson et al., 2018, Flath et al., 2017) by showing that third parties act as important facilitators or creators of such recombination.

In addition, we elaborate on the implications of 'complementors acting as connectors' for how platform owners manage their ecosystems. To illustrate, while Philips Lighting does not officially support Windows, a third-party developer created an app allowing Windows smartphone users to also use the system, opening up a new potential user base for Philips. At the same time, it also means Philips Lighting became reliant on third parties for the overall user experience of their system. Furthermore, complementors can create undesirable integrations, such as with competing products (competitor light bulbs as in the Philips Hue case). Thus, the fact that complementors do not only complement to the platform but also build bridges between them, and that this happens beyond the control of the platform owner, has consequences that can turn out both positive and negative.

To address these implications, we show that different modes of collaboration with complementors are necessary to appropriately manage complex connections around digital platforms. In doing so we bring together (digital) platform ecosystem literature and the open innovation literature. On the one hand, research on digital platforms suggests arm's length collaborations are appropriate to manage interactions between the platform owner and complementors (typically third-party developers) (e.g., Ghazawneh & Henfridsson, 2013). On the other hand, open innovation suggests more intensive bi-lateral relations where actors collaborate to develop new products and services that integrate well together. Our study of the Philips Hue ecosystem shows that both approaches co-exist and suit different purposes. In particular, we find that the type of connection determines what mode of collaboration with a complementor suffices. Our insights are in line with Huber et al., (2017), who developed a process-model on how platform managers deal with the tension between co-created value and

governance costs. They make explicit that standardized, arm's length contracts have low governance costs but the co-created value may be limited, while partnerships are more costly but result in higher co-created value. This is similar in the Philips Hue case where the partnership managers assess interesting complementors on their potential, e.g., does the use case of connecting two platforms generate sufficient new user base to be worth additional time and energy? For example, when Philips Lighting partnered with Amazon to become embedded in the Echo voice controlled smart home platform it was worth the extra development effort on Philips' side because in this way they could piggyback on Amazon's success. Moreover, we extend the work by Huber et al., (2017) by considering the different levels of integration as a condition for shifting a to particular mode of collaboration.

Lastly, another key contribution that results from our findings is that we make explicit that platform ecosystems should not be seen as isolated objects, but instead exists in an 'ecology of platforms'. To date, platform research has primarily studied the focal platform with its complementors (for example, Eaton et al., (2015) look at Apple and the community of third-party iOS app developers). Because we took a broader perspective in our study of the Philips Hue, we learn that complementors (perhaps even more so than platform owners themselves) create connections between platforms. If we only had considered the relations between Philips Lighting and the third-party app developers, we would not have discovered this important role that complementors play. Inter-connectivity between platforms becomes especially relevant to consider when studying ecosystem dynamics in the 'digital age', as digital interfaces and standardization increasingly allows for such connections. Therefore, we suggest future research should also include the interconnections *between and across* platforms ecosystems. In particular, more research is needed how platform owners can manage such connections that are beyond their reach.

5.1.3 Maintaining a mature ecosystem

Key findings. Chapter 4 focused on the challenge of maintaining a mature ecosystem. Maintenance of components is necessary for long-term survival and depends on the collective actions by the different ecosystem members. Specifically, complementors need to engage with their product and service when the platform core components evolve over time, in order to ensure a smooth integration and avoid obsolete functionality. When such maintenance work by complementors does not take place, the overall system may lose its value, and platform owners may struggle to keep a leadership position.

To understand how complement quality can be ensured over time, we relied on our field study of the Philips Hue ecosystem. We studied the evolution of the platform core components and third-party apps available for Hue. Our analysis of app data (including release notes) from the iOS and Android stores, complemented with interviews with a sample of third-party app developers, revealed different types of updates; 'bug fixing' and 'ensuring compatibility' are necessary to maintain integrity, and 'enhancing user experience' and 'adding functionality' are needed to avoid becoming obsolete feature-wise.

Furthermore, it is important to note that the decision to carry out updates is solely with the complementor (i.e., platform owners cannot 'force' complementors to update). We found that such decisions are informed by a complex interplay between the complementor, end-users, and platform owner. In particular, our study of the Philips Hue ecosystem revealed that users interact frequently with the third-party app developers, to discuss suggestions for features and/or report issues, and thereby stimulate continuous innovation.

Contributions and future research. Our study of the Philips Hue platform and its third-party apps contributes to the platform ecosystem literature by focusing specifically on the quality dimension of complements. While in early stages of ecosystem evolution platform owners are concerned with attracting a large enough *quantity* of complementors, in later stages platform owners increasingly also need to

make sure the output of these complementors are of sufficient *quality*. The emphasis on generating sufficient quantity of complements is a result of the critical importance of generating network effects, which determine success of failure for multi-sided platforms. At the same time, platform owners should not disregard the quality of the complements produced; after all, the performance of the system as a whole depends on the combination of the core platform components and complementary products. While most prior research looks a complement quantity, our research contributes by studying complement quality, which so far has received little attention. A notable recent exception is by Cennamo, Ozalp and Kretschmer (2018) who look at complement quality performance trade-offs when complementors multi-home their products (in this case video games) on different platforms.

In addition, we contribute by addressing that complement quality is not fixed but subject to time, and may increase or decrease as the platform ecosystem evolves. For example, when interfaces change complementors need to act accordingly and adjust their products to ensure a smooth integration (e.g., otherwise apps may 'break' and become dysfunctional). Thus, we make explicit that maintenance work (in the form of updating) is necessary to ensure quality *over time*. While in Chapter 3 we address the importance of maintenance for the overall performance of the system from a platform owner's interest, it obviously also has implications for complementors who are in turn dependent on platform owners actions. Performance glitches can be detrimental in particular because "it becomes increasingly hard for complementors to benefit from their innovations as platforms evolve" (Rietveld et al., 2018, p. 28), as a result of declining demand and increased marketing costs. Future research could further investigate the complementor's perspective to platform evolution, for example to better understand complementors' strategies to survive in an ever-evolving and highly dynamic context. In addition, we need better insight in how platform owners can help their complementors can thrive their businesses over time (which is in turn in their own interest too).

As a result, our study adds that platform owners should also consider how they

keep complementors engaged over time. Prior research, in response to the challenge of achieving sufficient complement quantity, has uncovered different tactics platform owners employ to attract complementors to their platform, e.g., through sponsoring the supply side by lowering the barriers for entry and/or through targeted developer marketing (Evans et al., 2006). However, in the Philips Hue case we observed that after some time third-party developers lost interest in the Philips Hue platform and eventually became inactive or left. Our analysis shows that a platforms' end-users play an important role in stimulating developers to keep on working on their app after release (e.g., through downloads and providing feedback). An interesting avenue for future research would be to further unpack the temporal dynamics of third-party developer motivations, i.e., what attracts complementors initially to develop for a particular platform and what motivates developers to stay with a platform in the long term (or: why developers leave after some time). For instance, in the context of open source software communities, Shah (2006) found that developer' motivations to contribute shift over time from need-driven to hobby (fun and enjoyment), and that governance structures (open versus gated) affect these motivations. In a similar vein, future research could investigate what mechanisms platform owners can use to actively incentivize complementors at different points in time (early versus late) in order to keep them engaged.

5.2 Practical implications

The core message of this thesis is that the shift from developing purely physical products to connected, smart products is not purely a technical transition, but also has organizational implications. Traditional product and service providers transform from engineering into IT driven organizations, as software development becomes a key activity in new product development. Besides such internal transformations, organizations engaging with digital innovation need to more than ever before orient

themselves *externally*: the different components that compromise smart products (e.g., hardware, software, network protocols, and applications) are developed by an ecosystem of heterogeneous and distributed firms. To complicate matters, the relations with other actors are not like traditional partnerships but have a more distant and uncontrollable nature.

Next to theoretical contributions, the insights from this dissertation research also yield practical lessons for managers concerned with digital innovation in a web of heterogeneous partners. These practical lessons are in particular informed by the numerous conversations with key informants and practitioners that took place during my research. During such enlightening conversations I was regularly asked for my advice on how I thought the practices that I observed could be improved. This meant that I had to step out of my role as 'objective observer', which sometimes made me feel uncomfortable but at the same time pushed me think beyond literature and allowed me to further analyze the insights that my studies have generated. Below I will briefly touch upon two themes that in particular stood out from these interactions.

Acknowledge temporal differences. Time is a fuzzy concept that is hard to grasp, yet always present in (organizational) life. Activities are planned on a timeline; projects and budgets have a start and end date; products are launched around important events; the financial quarterly cycles affect strategic decision-making, etc. But time can also be more subjective: progression can feel slow for one actor whilst rapid for another – this depends on own temporal experiences.

When collaborating with multiple stakeholders in an innovation ecosystem it is helpful to understand each organization's temporal frame. Organizations can vary on many dimensions that influence e.g., time horizon and organizational rhythms. For instance, in the LivingLab ecosystems both start-ups and large international tech companies were involved. The start-ups have a short-term strategy as their resources are only sufficient for near future survival. Larger organizations have long-term strategies for achieving growth and entering new markets. At the same time, organizational changes such as a merger or split can suddenly lead to a strategic shift

and budget changes, which influences how and where resources are spent. In the Philips Hue case, paradoxically, individual developers could adjust their apps much faster than Philips (with a large team), when users ask for new functionality. Such dynamics may lead to conflict when they are misaligned. It may result in delays where one actor needs to wait on another, and even may lead to the end of a collaborative effort.

Interestingly, though this all might sound rather obvious, time is so implicitly integrated in daily practices that we are often not aware of its importance. Simply paying attention to temporal differences may create a better understanding of why and how other stakeholders act the way they do. In turn, managers can respond accordingly to synchronize *or* asynchronize activities in such a way that conflicts can be avoided. The realization that temporality is embedded in how actors think and act is applicable in basically any organizational context and therefore an extremely powerful way to assess one's own structure and that of collaborators.

Do not underestimate the importance of autonomous complementors. We may tend to think about complementors as actors who simply *complement* the focal firm by offering additional user value through products and service that integrate with the core technology. Such complementors typically act autonomous and therefore it may be assumed that organizations have little influence over what they do, and the other way around. Instead I would urge managers to more carefully consider their pool of complementors, since these actors may actually have much more impact than one might expect at first. Even when the revenues of complement sales go directly to the complementors, and one wonders what (monetary) value they add to the platform, it is worth investing in a dedicated third-party programme.

The Philips Hue case illustrates this point best. Users typically start using the Hue light bulbs with the official Philips app. This app allows for basic set-up and control of the lights. However, users all over the world have unique wishes and desires to what they would like to do with smart lights. The third-party app developers address these user needs with dedicated, niche apps. Thus, autonomous complementors do

a great deal to Philips and the overall system by providing additional functionalities. Some users may even become reliant on these third-party apps for their usage of the system. As a result, the third-party developer is suddenly the prime interface between the Hue bulbs and the user, by-passing Philips. This has far-reaching consequences: user feedback stays with the app developer (and never reaches Philips) and the user experience is no longer in the hands of Philips but out of their control. Furthermore, as noted before, third-party developers have integrated the Hue with other (competing) platforms. Once connected, it may be technically possible to undo such integrations, but in practice it may be more difficult to disintegrate as users (again) become dependent on such integrations for their usage of the lights.

Thus, in the case of Philips Hue, an important part of the user experience becomes dependent on the efforts by third-party developers. In particular, from a user point of view it is hard to evaluate who is responsible for performance break-downs; the developer or Philips? I learnt that users maintain a good relationship with the third-party developer of their preferred app, because developers are typically actively responding to user questions and requests, something a large corporate like Philips may not be able to do in similar way. Thus, users may develop more sympathy for the third-party app developer than Philips, even when de app developer is the one to 'blame' (e.g., when unsupported APIs are used).

This example illustrates the complexity of sharing the responsibility for the user experience with autonomous third parties. Complementors' actions may have far-reaching implications and therefore, for platform owners, it is important to evaluate how to approach the community of developers. Next to providing technical support, I recommend paying attention to the 'people side'. To illustrate, when I contacted third-party app developers for participation in an interview, I primarily got positive reactions. Developers appreciated the interest I had in their work, and one even noted how much he enjoyed talking to a "human being". It may be difficult to contact each developer personally when the community consists of hundreds or thousands of members, but organizations can create online spaces or organize dedicated developer events where

developers can engage with in-house developers.

To summarize; the role of complementors should thus not be underestimated. Platform owners should take their community of third-party developers seriously and devote appropriate resources to build good relationships with their complementors. This, in turn, will create means to guide and stimulate complementor behavior.

5.3 Methodological reflection

The type of in-depth field research approach that I maintained in this dissertation (and in the KIN Research Group specifically) can also be labeled as *'embedded research'*, meaning that the researcher is embedded in (part of) the organization during data collection. By doing so, we, as researchers, can get as close as possible to what 'really' happens in organizations. Adopting this approach in my dissertation research has generated unique insights that would be hard to gain through more distant research approaches (such as interviews only). Furthermore, being in constant, direct interaction with the practitioners in the field allowed me to communicate frequently about my emerging findings, which helped to make sense of my data (Bartunek & Rynes, 2014).

My experiences during this PhD journey have also lead to a number of learnings such as how to get deep level access to a research setting, how to study ecosystems, and on how to study time. I have discussed these insights regularly with colleagues and other PhDs, and would like to use the subsequent sections to share them here.

5.3.1 On organizing access

First and foremost, doing in-depth field research within an organization begins with the process of negotiating access to a research site. After all, without access one cannot collect in-depth data, produce insightful results and publish in top journals. Methodological sections in academic articles generally do not include a reflection

on this process, but instead start from the moment of actual data collection[5]. Also, methodological books and courses rarely address this aspect of the research process. The result is that it "disregards the uncertainties and complexities of the field and oversimplifies the research experience" (Cunliffe & Alcadipani, 2016, p. 2).

It should be noted that recently, a couple of academics have explicitly attempted to open up this black box of getting access. Peticca-Harris, DeGama and Elias (2016) build on the "uncomfortable, ambivalent and awkward encounters" experienced throughout their PhD projects, and develop a process model of gaining access which emphasizes on the need to remain flexible and constantly re-strategize your approach. Similarly, Cunliffe and Alcadipani (2016) note that gaining *and* maintaining access is an ongoing process, in which the researcher is confronted with political and ethical dilemmas, and needs to make (sometimes difficult) decisions on how to deal with these. These insights resemble my experiences: getting access is not a straightforward and linear process, but requires careful consideration and adaptation. In particular, it can be a time-consuming process in which you have to go back and forth with your key informants, and therefore being patient is of critical importance. In short, there is not *one* strategy to gaining access (to illustrate: for both my field studies we followed different trajectories). Nevertheless, I feel there are some 'tips and tricks' that can be helpful in any journey, which I will share next.

First, one needs to approach firms to see if they are interested in letting an outside researcher in to study their internal processes. We used personal contacts for getting introduced. Then we had to find the right person in the organization, typically a senior manager, who is close enough to the daily practice you are interested in studying, yet high enough in the management hierarchy to give permission. After an initial introduction by our personal contact we talked to different people in the organization first, in order to find this key person.

A subsequent, challenging task for the research team is to 'convince' practitioners

5 A nice, recent exception is the Academy of Management Discoveries Journal, which gives authors the opportunity to reflect beyond the method section, through an online supplementary audio voice recording. For example, in "the Author's Voice" Hatch, Schultz and Skov (2015) discuss their challenges with access and building trust, and Leonardi & Bailey (2017) explain how they were able to access by leveraging prior interactions with the company in another research context.

about the importance and relevance of academic research in general and specifically on what they can get out of the proposed research project. Time is a scarce resource in organizations, and letting someone in demands some investment from the organization's side, therefore, there needs to be some assurance that engaging in the research project is time well spent. As a PhD researcher with little experience, I benefited from involving senior researchers (my supervisors) in these conversations, in particular to build on their knowledge of the subject and insights from prior research. In addition, their seniority also helped to show that we took this project seriously and enabled sharing other prior successful experiences in performing this type of research.

Next, it is time to develop an engaging research proposal for the envisioned project. While having a theoretically interesting question in mind, it is, in this phase, important to find out what related problems or issues the organizations are facing. This may sound obvious, but when starting a PhD (or any academic research project), one typically first spends considerable time and energy in reading relevant theory, to understand where "gaps" are. These gaps are then addressed in a research proposal that forms the starting point for the research project, and this then may lead to a 'tunnel-vision'. In my experiences, it took some time before I could really let go what I had been reading in the weeks and months prior. But once I was able to do so, I learnt that I was better able to see what the organization in mind was struggling with, and in turn developed a proposal that better resonated with their experiences. In addition: a useful advice that I received and which proved to be extremely helpful was to develop attractive PowerPoint slides instead of a long text document, since this is the format typically used for communication within companies.

Once agreement about the research project is reached and the actual fieldwork begins, negotiating access continues to be a key activity. I experienced that a couple of weeks or even months of presence were necessary to build a relationship with the people in the organization in order to get really involved and allowed me to follow their projects through e.g., invitations for sessions and meetings. In this 'start-up period' I was present at the office, even if I did not have any particular events to

attend or appointments scheduled. I was lucky that at my research site there were open offices and flex workspaces, allowing me to easily take a seat and desk to work. Thus, no particular data collection was taking place; instead this time was needed *to become embedded*. I found the numerous coffee talks and lunch walks extremely helpful to become increasingly aware of ongoing dynamics and the when/where/who of interactions that were relevant for my research interest. As a field researcher I had to remain confident that eventually I would find the right 'spot' where the action is taking place, and then being allowed to capture this. I found this stressful at times, but the only way to cope with it is to accept that this is a time-investment that will pay off in the end. Again, one has to be flexible, and may be required to follow up on different 'leads'. But once this stage is reached and you are on top of what is happening, field research is an invaluable and exciting endeavor.

5.3.2 On studying ecosystems

The focal phenomena that I investigated in this dissertation are (innovation) ecosystems. Ecosystems have been an emerging topic in the academic discourse, and different methods have been used to study them empirically. For example, Adner and Kapoor (2015) analyze secondary data from the semi-conductor industry, and Boudreau and Jeppesen (2016) build on a large dataset on online game platforms. Quantitative analysis seems to be appropriate when studying large numbers of complementors, e.g., to learn about platform strategy and competition. At the same time, several studies rely on rich qualitative data to yield valuable insights into the micro dynamics of ecosystem management. For example, Wareham et al. (2014) developed grounded theory based on a single, in-depth case study of an ERP software provider.

In this thesis I took the latter approach and adopted an inductive process research approach in two field studies on different ecosystems. Applying this approach was not without methodological challenges. First, it is hard to define the boundaries the ecosystem. That is, what 'is' the ecosystem, and what is beyond scope? Autio and Thomas (2013, p. 208) explain: *"The defining underling element of innovation*

ecosystems is not a given product, but a rather, a coherent set of inter-related technologies and associated organizational competencies that glue a variety of participants together to co-produce a set of offerings for different user groups and uses. [...] think about ecosystems as an evolving community that specializes in the development, discovery, delivery, and deployment of evolving applications that exploit a shared set of complementary technologies and skills." While this was helpful, in practice however, it can be difficult to decide what to include in the unit of analysis.

To illustrate, during the analysis of the LivingLab case I struggled to define and represent the innovation ecosystem, and have been shifting the boundaries over time. I started with taking the development of the smart lights as central technology around which different organizations needed to collaborate and coordinate efforts. However, as continued my analysis, I had to broaden my scope to also include other (emerging) technologies that were developed and tested at the LivingLab, and take this overaching initiative as the focus point around which the ecosystem formed. The interdependencies between the diversity of participants, and technological integration of different solutions, made the need for coordination more complex and important. Furthermore, because the LivingLab ecosystem was still in an early stage and thus continuously evolving, it made sense to subsequently also redefine the boundaries over time.

To deal with this challenge, it was helpful to be open and relaxed about this definition during data collection, e.g., I spoke with as many people as possible, even if they at first seem to be only at the periphery of the ecosystem and had a minor role. During analysis I was able to reflect back on who belonged to the ecosystem and at what moment in time. Thus, it may be difficult to decide up front what 'the ecosystem' is, but through retrospective reflection this eventually becomes clear.

A second methodological challenge was to capture the different perspectives of the various ecosystem members. Ideally one would rely on ethnographic methods to collect data from within each organization involved. However, it is simply impossible

to become fully embedded when studying multiple organizations. Working with multiple researchers could solve this problem (Berthod, Grothe-Hammer and Sydow, 2017), however, in a PhD project you are typically just by yourself. Therefore, I also had to heavily rely on interview data. In the LivingLab case I spoke with many ecosystem members to learn about their experiences.

Related, ecosystem dynamics are difficult to observe. Preferably, observations of the interactions between ecosystem members would yield most insightful data, because then you can really 'be there'. However, I experienced that these interactions typically happen unplanned and by coincidence. To deal with this I relied on *open, unspecified observations*, i.e. "phases that do not rely on following any specific object or person" (Berthod, Grothe-Hammer and Sydow, 2017, p. 308). My field research approach allowed me to do this at the organization that I was granted access to. As noted before, I was regularly present at the office, and sometimes I was 'lucky' to be there when encounters between ecosystem members would take place. Other occasions for unspecified observations were events like conferences or talks, where one or several ecosystem members would gather and present themselves. I remember vividly how I was casually having a conversation at a drink after a presentation session, when three stakeholders were to have an ad hoc discussion on how to divide tasks for a next approaching milestone. This turned out to be one of the most informative moments throughout my data collection phase, which would not have been possible if I would have only observed at formal and pre-planned meetings.

Another research design consideration is to appropriately define the right time scale for data collection. As process researchers, we preferably study our phenomena of interest real time and in situ, over a longer period of time, to gain a deep understanding of the underlying dynamics in play. This requires aligning the duration of our study with our phenomena's "existence interval", that is "the length of time needed for one instance of the process, pattern, phenomenon, or event to occur or unfold" (Zaheer, Albert, and Zaheer, 1999, p. 730). Several years may pass by for an ecosystem to emerge or mature (which is, to complicate matters, hard to predict

beforehand), and thus requires long-term engagement with the field. However, this may be hard to achieve for researchers because of "institutional reasons" (Ancona et al., 2010, p. 647), such as contract durations and the 'tenure clock'. A three-year PhD project sounds like a long time frame, and at least sufficient for conducting high quality longitudinal research, however, I experienced first-hand that throughout the research journey valuable time may get 'lost'. For example, as mentioned above, the process of getting (and maintaining) access was time-consuming. Furthermore, the actual data collection can be delayed, for example when the project that is observed is (temporary) put on hold, thereby making it difficult to use the time for data collection effectively.

In short, these obstacles and time constraints may ultimately force academics to do more short-term research (Ancona et al., 2001). Still, I think with proper preparation a three or four year PhD project (or post-doc) is actually a perfect opportunity for doing such intensive research and data collection. Furthermore, in my case, doing two field studies also lowered the risk of relying heavily one research setting for good data. Thus, despite methodological challenges to study ecosystem evolution through in-depth inductive methods, there are certainly ways to overcome them. And, as Adner (2017, p. 56) puts it: *"Beyond new theoretical questions, ecosystems also raise new empirical opportunities. [...] These investment requirements, however, are balanced by a great opportunity to develop new ideas and productively revisit established wisdom."*

5.3.3 On studying time and digital innovation

Lastly, I will reflect on my experiences with regards to studying 'time'. In particular in Chapter 2, where I performed a field study on temporal coordination in innovation ecosystems, the data collection and analysis focused on understanding the role of different time dimensions that affect collaborative efforts among ecosystem members. But, as Ancona et al. (2001) already pointed out: studying time is a challenging endeavor.

First, time is a multi-faceted, complex concept, which makes it extremely fascinating but at the same time hard to capture. As philosophers have wondered for centuries: what is time really? Time is about pace, rhythms, speed, timing, but also about the past, present, and future. In addition, time can be highly subjective: how time is experienced and interpreted is personal and context dependent. Time is often implicit in what we do and how we organize things, thus it may seem like time is everywhere but nowhere at the same time. When, in the beginning of my PhD journey, I explained to (senior) academics that I was studying 'the role of time in collaborative innovation processes', they were all enthusiastic and encouraging because time is a fascinating concept yet understudied in our field of research. At the same time, I also heard some caution when they wished me 'good luck'. After I had read up on the time-research literature I was ambitious to eventually start collecting data. However, I soon experienced that it was not straightforward to inquire about temporal dimensions in my interviews: how to formulate truly open questions about such an implicit concept? I felt I had to be really careful in my framing in order not to steer the conversation into a direction as a result of my own theoretical presumptions. I ended up with more generic questions, and was very attentive to references to time in my interviewee's answers. I vividly remember how excited I was when interviewees mentioned, for example, (differences in) time frames or orientations in their descriptions (while they were actually not aware of it themselves).

Regardless of these methodological challenges, a temporal lens or process research approach suits in particular studying the phenomena of digital innovation. From an architectural point of view, digital innovations consist of multiple "modular layers" (Yoo et al., 2010) (e.g., the 'service layer' includes the applications that users can use on top of the smartphones which are part of the 'device layer'). Taking this well-accepted model as starting point may lead to a more cross-sectional approach, however, it is critical to consider that each layer has its own life cycle. For example, the foundation is formed by the *long-lived* core elements (i.e., the platform, digital infrastructure, standards, interfaces), while variety comes from applications that

are typically *short-lived* (Baldwin & Woodard, 2009; Bygstad, 2016). Furthermore, digital innovations consist of both physical and digital components, which have distinct development trajectories. Software allows for design flexibility, in that adjustments can be made at later stages (through updates), while physical products cannot be changed once put on the market. For tangible products, production is an important part of the life cycle, while for software "the distinction between design and production is largely meaningless" (Henfridsson, Mathiassen & Svahn, 2014, p. 30). As a result, "the components of such [digitized] products cannot be understood as a unified entity that follows the same clockspeed regardless of their properties" (Henfridsson, Mathiassen & Svahn, 2014, p. 40).

Moreover, the combination of modules with different properties and varying rhythms result in a 'paradox of innovation pace'*: "On the one hand, digital technology seems to accelerate the pace of innovation, as the reprogrammable and generative nature of its affordances makes it easy for firms to introduce new products and services. The increased pace in all digital domains has resulted in a situation in which innovation needs to be continuous, relentless, and fast. On the other hand, firms must spend more time to carefully design, build, and deploy platforms and engage in architecting and designing-related standards"* (Yoo et al., 2012, p. 1406-1407).

Also, digital innovations have been analyzed as being generative, which means that such innovations are themselves the source of further developments (Yoo et al., 2012). For example smartphone users can add apps and create ever-new connections with other complementary hardware and software. This exemplifies how digital innovations are not self-contained but shaped in unfolding relations to what came before and what comes after. The very innovation of a smartphone triggers new developments but its own meaning is also shaped by those new developments.

Thus, as these previous examples illustrate, it is important to take the role of time seriously if we want to further unpack the dynamics involved in organizing for digital innovation. Building on ethnographic methods, including observations, in combination with secondary data, offers promising opportunities for future studies.