Inter-Organizational Ecosystems in Software Development

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zur Erlangung der Würde eines Doctor rerum oeconomicarum der Wirtschafts- und Sozialwissenschaftlichen Fakultät der Universität Bern

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List of Abbreviations

AVE	Average Variance Extracted
CEO	Chief Executive Officer
CH	Confoederatio Helvetica (Switzerland)
CR	Composite Reliability
ESSEC	École Supérieure des Sciences Économiques et Commerciales
IS	Information Systems
IT	Information Technology
LogCH	A Major Logistics Firm
NZ	New Zealand
OLS	Ordinary Least Squares
PO	Product Owner
Q&A	Question-and-Answer
REMO	Reorientation Mobile Computing
US	United States of America
VIF	Variance Inflation Factors

1. Introduction

Companies are increasingly exposed to disruptive technologies and unexpected competitors that pose potential threats to their business success. To avert such threats, pressed companies increasingly create and transform goods together with other organizational actors in so-called inter-organizational ecosystems (Adner, 2006, 2017; Jacobides, Cennamo, & Gawer, 2018; Lumineau & Oliveira, 2018). These inter-organizational ecosystems describe groups of interacting organizational actors that are mutually dependent on each other's activities (Jacobides et al., 2018). The growing prevalence of inter-organizational ecosystems builds on information systems (IS), which allow a distribution of innovation agency across multiple organizational actors by means of digital technology (Nambisan, Lyytinen, Majchrzak, & Song, 2017) for co-creating value (Sarker, Sarker, Sahaym, & Bjørn-Andersen, 2012). These advantages are of particular importance in software development and have contributed much to the popularity of platform ecosystems (i.e., Tiwana, Konsynski, & Bush, 2010) and innovation ecosystems (i.e., Adner & Kapoor, 2010). The three studies of this dissertation (see Table 1) focus on platform ecosystems (i.e., studies 1 and 2) and innovation ecosystems (i.e., study 3).

1.1. Platform Ecosystems

Platform ecosystems describe one-to-many structures between one platform owner that provides a platform with a range of development and marketing resources (Gawer, 2009; Ghazawneh & Henfridsson, 2013; Tiwana et al., 2010), and many complementors that draw on these resources to extend the platform with own complements, often aimed at niche markets (Boudreau, 2012; Tiwana et al., 2010). Prominent examples of platform ecosystems are the software systems on contemporary smartphones that allow users to combine mobile operating systems (i.e., the platforms), such as iOS by Apple or Android by Google (i.e., the platform owners), with millions of different applications (i.e., the complements) from several thousand application developers (i.e., the complementors) (AppBrain, 2019; Liao, 2018). Although this unique one-to-many structure allows to create added value for the users, it also leads to a situation of asymmetric dependence between the platform owner and the complementors, where the platform owner depends on an ecosystem as a whole and the complementors on a specific platform owner (Kude, Dibbern, & Heinzl, 2012). This asymmetric dependence presents two major challenges for platform ecosystems. First, the asymmetric dependence vests platform owners with power over their ecosystems, which suggests a certain impuissance of the complementors toward the platform owner. Although this power imbalance could pose a major threat to platform ecosystems and their successful survival, still little is known about how power

manifests in platform ecosystems, how and why power changes over time, and how such power dynamics feed into the continued thriving of platform owner–complementor partnerships. The first study of this dissertation addresses these questions by means of a longitudinal multiple-case study with six platform owner – complementor dyads (Yin, 2009). The resulting process model suggests that power in platform ecosystems evolves through a reciprocal process, shaped by both the powerful platform owners and the complementors. More specifically, platform owners can only play to their—in principle—powerful position if their complementors decide to subjectify themselves. As to whether or not complementors subjectify themselves, builds on an evaluation process in which they weigh the potential disadvantages against the benefits. Interestingly, complementors can take measures to mold the power of their platform owner in their favor, while platform owners can lure complementors into subjectification by episodically switching between different faces of power. Eventually, the process model suggests that platform partnerships only thrive if platform owners and complementors are mutually responsive to each other in the reciprocal process of power enactment and subjectification.

Second, the asymmetric dependence confronts platform owners with the challenge of designing efficient and effective rules for governing their platform ecosystems (Tiwana et al., 2010; Wareham, Fox, & Giner, 2014), without causing platform desertion (Tiwana, 2015). In other words, platform owners need to design and practice the rules of their platform ecosystems in ways that allow them to increase complementor dedication, i.e., the extent to which complementors are devoted and faithful to a particular platform, and continuously willing to invest in the partnership with the platform owner. Complementor dedication is a highly desirable governance objective that comes with the promise of an ongoing generation of add-on value to the platform (Benlian, Hilkert, & Hess, 2015; Boudreau & Haigu, 2009; Sarker et al., 2012; Tiwana, 2013). Yet, little is known about how the interplay between designing rules and practicing them influences complementor dedication to a platform. The second study of this dissertation aims at answering this question by means of survey data from 181 complementors, each collaborating with a platform owner. The results of the second study show that rule adequacy independently strengthens complementor dedication. Thus, the more adequate complementors perceive the design of the rules, the more likely they dedicate themselves. However, this relationship is strongest if rule practices are simultaneously benevolent and flexible in contrast to being either benevolent or flexible. Thus, the more benevolent and simultaneously flexible complementors perceive the rule practice by a platform owner, the stronger the relationship between the perceived rule adequacy and complementor dedication becomes.

1.2. Innovation Ecosystems

Innovation ecosystems describe multilateral sets of organizational actors that need to cooperate in order for coherent and customer-oriented digital innovation to materialize (Adner, 2006, 2017; Adner & Kapoor, 2010). Relations between organizational actors build on a highly flexible orchestration that allows a coopetitive (i.e., simultaneously cooperative and competitive) generation and modification of digital innovation (Furr & Shipilov, 2018). Although innovation ecosystems have become increasingly important, still little is known about their emergence or has only been analyzed from the perspectives of dominant actors who purposely attempt to create them (e.g., Dattée, Alexy, & Autio, 2018), which does not do justice to the complexity of innovation ecosystems (Lumineau & Oliveira, 2018). First, organizational actors in innovation ecosystems not always pursue the same goals and motives. While some organizational actors undoubtedly seek to orchestrate the innovation ecosystems (Dattée et al., 2018; Paquin & Howard-Grenville, 2013), others pursue common (i.e., cooperate) and individual (i.e., compete) goals at the same or various times (Hannah & Eisenhardt, 2018). Second, innovation agency in innovation ecosystems is distributed among all organizational actors. However, little is known about the distribution and redistribution of innovation agency to organizational actors with different goals, motives and abilities (Nambisan et al., 2017). Third, innovation ecosystems aim at materializing coherent and customer-oriented innovations through ongoing cooperation of all involved organizational actors (Adner, 2006, 2017; Adner & Kapoor, 2010), which blurs the line between the innovation process and its outcome (Nambisan et al., 2017). Understanding how central organizational actors create innovation ecosystems and how and why such innovation ecosystems progress in their emergence over time and through the interplay of all involved organizational actors that pursue both common and own goals is paramount. The third study of this dissertation addresses these questions by means of a longitudinal single-case study on an emerging innovation ecosystem (Yin, 2009). Our results indicate that an innovation ecosystem progresses to emerge in three different phases, from the creation, to the adaptation (i.e., refinement and stabilization), and finally toward the exploitation of the basic structure and procedures. More particularly, central organizational actors can create the basic structure and procedures of an innovation ecosystem. However, for an innovation ecosystem to progress in its emergence, central organizational actors need to stabilize the basic structure, while all other organizational actors need to help refine the basic procedures. The better adapted the structure and the processes, the better organizational actors can exploit them to materialize coherent and customer-oriented digital innovation.

Table 1: Overview of the Studies

	Study 1:	**Study 2:**	**Study 3:**
Title	Power Dynamics in Software Platform Ecosystems	Complementor Dedication to Software Platforms: Rule Adequacy and the Moderating Role of Flexible and Benevolent Practices	Emerging Innovation Ecosystems: The Critical Role of Distributed Innovation Agency
Research Question	How does power manifest in platform ecosystems, how and why does power change over time, and how do such power dynamics feed into the continued thriving of platform owner–complementor partnerships?	How does the interplay between designing rules and how these rules are practiced influence complementor dedication to a platform?	How do central organizational actors create innovation ecosystems and how and why such innovation ecosystems progress in their emergence over time and through the interplay of all involved organizational actors that pursue both common and own goals?
Method	Qualitative Theory-building	Quantitative Theory-testing	Qualitative Theory-building
Data Sources	- 24 Semi-structured Interviews - Extensive Secondary Data	- 181 Complete Surveys	- 34 Semi-structured Interviews - Observational Data - Extensive Secondary Data
Major Results	- Power in platform ecosystems evolves through a reciprocal process shaped by both the powerful platform owner and the seemingly powerless complementors. - Platform partnerships only thrive if platform owners and complementors are mutually responsive to each other.	- To strengthen complementor dedication, governance design should not exclusively strive for standardization but remain sensitive to complementor needs. - To maximize complementor dedication, rules need to be practiced situationally in both a flexible and a benevolent way.	- Innovation ecosystems progresses to emerge in three phases, from the creation, over the adaptation (i.e., refinement and stabilization), toward the exploitation of the basic structure and procedures. - The better the structure and procedures, the more progressed the emergent innovation ecosystem.
Previous Versions & Publication Status	- European Conference on IS (ECIS) 2014 - Doctoral Consortium of the Swiss Chapter of the Association for IS (CHAIS DC) 2014 - Currently under review (VHB A)	- Organizations and Society in IS Workshop (OASIS) 2014 - Currently under review (VHB A)	- International Conference on IS (ICIS) 2015 (VHB A) - CHAIS DC 2016 - Global Sourcing Workshop (GSW) 2015, 2017, and 2018 - To be submitted (VHB A+)

2. Power Dynamics in Software Platform Ecosystems

Abstract [1]

Even though power dynamics are increasingly critical to the functioning of modern organizations, IS research has been mostly silent on this vital issue. Platform ecosystems are an empirical context uniquely suited to deepen our understanding of this matter because they promise novel insights into the multi-level and reciprocal nature of power. Therefore, this paper asks how power manifests in platform ecosystems, how and why it changes over time, and how such power dynamics feed into the continued thriving of platform owner – complementor partnerships. To answer these questions, we conducted a theory-building, longitudinal multiple-case study of six platform partnerships. Our findings show that power in platform ecosystems evolves through a reciprocal process shaped by both the powerful platform owner and the seemingly powerless complementors: The platform owner can only play to its dominant position if the complementors decide to subjectify themselves. This decision builds on an evaluation process in which complementors weigh the downsides against the benefits of subjectification. Moreover, platform owners can lure complementors into subjectification by episodically switching between different faces of power, while complementors can take measures to mold the platform owner's power in their favor. Finally, we found those platform partnerships only thrived if the platform owner and the complementors were mutually responsive to each other in the reciprocal process of power enactment and subjectification. We synthesize these findings into a process model, which has significant implications for the literature on power in and governance of platform ecosystems, as well as broader research on power.

Keywords: Power dynamics, software platform ecosystem, episodic power, systemic power, power mitigation, coercion, manipulation, domination, subjectification

[1] The research project has been conducted in collaboration with Thomas Huber and Jens Dibbern. Thomas Hurni was the main contributor.

2.1. Introduction

Software platform ecosystems are a contemporary organizational arrangement to create digital innovation across organizational boundaries (Gawer, 2009). Although platform ecosystems are a relatively recent phenomenon, they are on the verge of becoming the dominant form through which software is developed and distributed (McKinsey & Company, 2018). Almost all major software companies—including Apple, IBM, Microsoft, Oracle, and SAP—have transformed into platform owners that cultivate ecosystems with myriads of complementors (Tiwana et al., 2010). Two types of actors populate such platform ecosystems. One is the platform owner that provides a range of resources including the platform, development environments, and marketing tools and governs the surrounding ecosystem (Gawer, 2009; Ghazawneh & Henfridsson, 2013; Tiwana et al., 2010). The other refers to the complementors that draw on these resources to extend the platform with complementary solutions, often aimed at niche markets (Boudreau, 2012; Tiwana et al., 2010). The mobile operating systems, Android and iOS, are cases in point. The platform owners—i.e., Google and Apple—both partner with thousands of complementors that offer millions of complementary applications for their platforms (AppBrain, 2019; Liao, 2018). The micro-level driver underlying the success of such platform ecosystems are large numbers of thriving partnerships between platform owners and complementors, i.e., partnerships that continuously co-create value (Sarker et al., 2012).

The unique one-to-many structure of a platform ecosystem leads to a situation of asymmetric dependence between the platform owner and its complementors, i.e., the platform owner depends on the ecosystem as a whole rather than on individual complementors, while the complementors depend on the specific platform owner (Kude et al., 2012). This asymmetric dependence vests the platform owner with power over its complementors and its ecosystem. A peculiarity of this power is its multi-level and reciprocal character. It is multi-level because platform owners have power on the ecosystem level but also enact power on the dyadic level. It is reciprocal because the platform owner and the complementors are not members of the same hierarchy (Tiwana et al., 2010), and as independent companies, complementors are to some extent free to accept or reject the power of the platform owner (Tiwana, 2015). For example, complementors can reject the power of a platform owner by lowering their commitment to a platform, e.g., by refraining from making valuable platform-specific investments (Huber, Kude, & Dibbern, 2017). This behavior, however, is neither in the interest of the platform owners nor in the interest of the complementors, as it puts the continued thriving of the partnership on the line (Huber et al., 2017; Sarker et al., 2012). Hence, the managerial challenge in platform ecosystems is to use power in a way that is acceptable for complementors, such that the

partnerships continue to thrive. Prior research on power in platform ecosystems, however, has not paid explicit attention to the multi-level and reciprocal intricacies of power in this novel but important empirical context (Hurni & Huber, 2014; Valença & Alves, 2017; Valença, Alves, & Jansen, 2018). Therefore, we ask the following research question: *How does power manifest in platform ecosystems, how and why does power change over time, and how do such power dynamics feed into the continued thriving of platform owner–complementor partnerships.*

Given the novelty and importance of this research question, we conducted a longitudinal multiple-case study of six platform owner–complementor partnerships from three different ecosystems (Yin, 2009). This research design ensured that we were able to capture differences in power enactment over time and on different levels (i.e., dyadic and ecosystem level). Our data analysis was guided by the integrative power conceptualization of Fleming and Spicer (2007, 2014), which is designed to capture multi-level and reciprocal processes of power. We synthesized the findings of our analysis into a process model of power in platform ecosystems. This process model suggests power in platform ecosystems evolves through a reciprocal process shaped by both the powerful platform owner and the complementors: The platform owner can only play to its—in principle—powerful position if the complementors decide to subjectify themselves. This decision builds on an evaluation process in which complementors weigh the potential downsides against the benefits of subjectification. Platform owners can lure complementors into subjectification by episodically switching between different faces of power, while complementors themselves can take measures to mold the platform owner's power in their favor. Finally, we found that platform partnerships only thrived if the platform owners and the complementors were mutually responsive to each other in the reciprocal process of power enactment and subjectification.

The structure of our paper is as follows. First, we provide a brief literature review on the concept of power and its use in IS research. Then, we introduce the reader to the intricacies of power in the context of platform ecosystems before we develop the conceptual foundations of this study. Afterward, we discuss our method, present our findings, and inductively develop our process model. The final section discusses the contributions, implications, and limitations of our research.

2.2. Background

2.2.1. The Concept of Power

Power is seen as integral "to organizations as oxygen is to breathing" (Clegg, Courpasson, & Phillips, 2006, p. 3). It is often described as resting upon a conflict of interest around a matter

that is deemed important (Bachrach & Baratz, 1963) and it is widely considered as a multifaceted concept which manifests in various ways and forms (Jasperson et al., 2002; Lawrence, Malhotra, & Morris, 2012; Simeonova, Karanasios, Galliers, Kelly, & Mishra, 2018). Given the significance of power, it is hardly surprising that it has attracted much attention in the wider social sciences (Fleming & Spicer, 2014). As an inherently complex concept, this has resulted in a plethora of views on what constitutes power (Bierstedt, 1950; Clegg, 1989; Jasperson et al., 2002). For example, one view focuses on where power exists (Fleming & Spicer, 2014). According to this view, power exists in relationships between two or more actors, which is epitomized by the description of Weber (1978, p. 53), according to which power is "the probability that one actor within a social relationship will be in a position to carry out his own will despite resistance". This view highlights the two-sidedness of power, i.e., it is not only considered important how powerful actors exercise their power but also how less powerful actors react on this exercise of power (Clegg et al., 2006; Fleming & Spicer, 2014). Another view focuses on the sources that make certain actors more powerful than others. According to this view, power builds on distinct sources, such as expertise or legitimacy that constitute different bases of power (French Jr & Raven, 1959).

In an attempt to integrate the prevailing fragmented, overlapping and one-sided views, Fleming and Spicer (2007, 2014) set out to develop a more comprehensive power conceptualization, resulting in their four "faces" of power (2014, p. 240). This conceptualization rests on the well-established distinction between episodic and systemic power (Clegg, 1989; Lawrence et al., 2012; Simeonova et al., 2018). Episodic faces of power generally rely upon identifiable acts that shape the behaviors of the less powerful actors through either *coercion* or *manipulation* (Fleming & Spicer, 2007, 2014). Different from episodic faces, systemic faces of power mobilize institutional, ideological, and discursive resources to influence through *domination* and *subjectification* (Fleming & Spicer, 2007, 2014).

2.2.2. Power in IS Research

More than 30 years ago, the seminal work of Markus (Markus, 1983) has already highlighted the importance of power dynamics in the development, implementation, and use of IS. A few studies followed the example of Markus and explored power processes and dynamics in IS contexts (Koch, Leidner, & Gonzalez, 2013; McBride, 2013; Simeonova et al., 2018; Willcocks & Lioliou, 2011). For example, prior research has explored how new technologies change power relations (Allen, Brown, Karanasios, & Norman, 2013; Jasperson et al., 2002), how power affects communication and collaboration processes (Sapsed & Salter, 2004) and the role of power in the emergence of workarounds (Malaurent & Avison, 2016).

Notwithstanding the significant contributions of this work, power has mostly remained an undertheorized concept, and power dynamics have received relatively limited attention (Koch et al., 2013). However, in modern societies characterized by novel forms of organizing that are enabled by increasing digitization, and online inter-connectedness, power, and power dynamics become increasingly evident (Baptista, Wilson, Galliers, & Bynghall, 2017; Faraj, Krogh, Monteiro, & Lakhani, 2016; Simeonova et al., 2018).

2.2.3. Power in the Context of Platform Ecosystems

A vital novel form of organizing made possible by digitization and online inter-connectedness are platform ecosystems (Ghazawneh & Henfridsson, 2013; Tiwana et al., 2010). Such platform ecosystems are characterized by unique power asymmetries that are rooted in asymmetric resource dependencies between the platform owner and its complementors (Kude et al., 2012). On the one hand, the platform owner makes ecosystem investments with the goal to create and maintain ecosystem resources that are valuable for many, if not all, complementors within its ecosystem (Boudreau & Haigu, 2009; Ghazawneh & Henfridsson, 2013; Kude et al., 2012; Wareham et al., 2014). Such ecosystem resources entail the software platform, development suites, code repositories, and marketing tools (Ghazawneh & Henfridsson, 2013; Kude et al., 2012; Wareham et al., 2014). On the other hand, complementors make platform-specific investments by creating and maintaining resources that are significantly more valuable in a particular partnership with a platform owner than outside of it (Dyer & Singh, 1998). For example, complementors acquire platform-specific technological knowledge, make platform-specific certifications, and build up networks of interpersonal relationships with the staff of the platform owners (Kude et al., 2012; Wareham et al., 2014). Given these asymmetric resource investments, platform owners hardly depend on individual complementors but rather on the ecosystem as a whole, while complementors highly depend on the focal platform owner (Kude et al., 2012). This asymmetric dependence vests the platform owner with power over the complementors and with the power to shape the ecosystem as a whole (Boudreau & Haigu, 2009; Hurni & Huber, 2014; Kude et al., 2012)

Despite the importance of power in platform ecosystems, few IS publications have explicitly addressed this important topic. While prior research has highlighted the importance of power in ecosystems formed among equals (i.e., SMEs) (e.g., Valença & Alves, 2017; Valença et al., 2018), barely any study has explicitly explored power dynamics in ecosystems between large international platform heavyweights, such as Apple, Microsoft, IBM or SAP, and small to medium-sized complementors that provide complementary application and services. One rare exception is the work of Hurni and Huber (2014), which has investigated how power and trust

interact over time in such platform-centric ecosystems. This paper suggests that studies in the context of platform ecosystems promise unique insights into two important, but under-researched aspects of power. First, power in platform ecosystems is likely to be uniquely multi-level, as platform owners are powerful on both the ecosystem- and the dyadic level. On an ecosystem level, platform owners have the legitimacy to stipulate standards, rules, and regulations that ensure all complementors act in their interest to some extent (Boudreau & Haigu, 2009; Huber et al., 2017; Hurni & Huber, 2014; Wareham et al., 2014). On a dyadic level, platform owners can bend such standards, rules, and regulations to answer specific complementor needs (Huber et al., 2017; Hurni & Huber, 2014). Thus, platform ecosystems provide a promising context to explore how different types of power operate on different levels and mutually shape each other over time.

Second, power in platform ecosystems is likely to be a uniquely reciprocal process that differs considerably from power processes in traditional hierarchies (such as an IS department). In traditional hierarchies, people occupying higher levels have the legitimacy to influence the behavior of their subordinates through direction, control, and command (Fleming & Spicer, 2014). In platform ecosystems, however, the platform owner and the complementors are not members of the same hierarchy (Tiwana et al., 2010). Quite the opposite, complementors are legally independent companies that are free to abandon a platform whenever they feel like it (Tiwana, 2015). Platform owners, therefore, are only powerful to the extent that complementors accept their power. If complementors reject it, they may lower their commitment to the platform or even abandon it altogether, which is not in the interest of platform owners. For example, complementors may refrain from acquiring and building-up platform-specific resources, including certificates, technical expertise, and sophisticated features, if they feel that the platform owner abuses its power. Thus, platform ecosystems provide a promising context to explore reciprocal processes of power enactment and power acceptance.

2.2.4. Conceptual Development

To explore the multi-level and reciprocal power dynamics in platform ecosystems, we build on the power conceptualization by Fleming and Spicer (2007, 2014) introduced above. This conceptualization builds on the idea that power operates on different levels that reciprocally influence each other. Table 2 provides formal definitions of the four faces of power underlying this conceptualization. The next paragraphs develop a contextual understanding of the four faces of power in platform ecosystems.

Table 2: Core Concepts

Power Face	Definition	Example Indicators
Domination	The hegemonic framework that makes the power of an actor appear inevitable and natural (Fleming & Spicer, 2014; Lukes, 2005).	• A platform owner has construed binding ecosystem-wide strategies, standards, rules, and regulations. • A platform owner has chosen a technology to which complementors must conform.
Coercion	The direct power exercise through which one actor gets another actor to do something it would not have done otherwise (Dahl, 1957; Fleming & Spicer, 2014).	• A platform owner changes its strategy and urges a complementor to follow suit. • A platform owner provides a new software platform and urges a complementor to provide its complement on this new platform.
Manipulation	The active wielding of the hegemonic framework to ensure that actions occur within one's interests (Bachrach & Baratz, 1963; Fleming & Spicer, 2014).	• A platform owner uses the rules of the partner program to reward a complementor for dedicating itself to the platform. • A platform owner enforces incentive schemes of the partner program to lure a complementor into developing specific features, applications, or add-ons.
Subjectification	The ideological determination of the very self of an actor, including their emotions and identity (Fleming & Spicer, 2014; Foucault, 1977).	• A complementor joins a platform ecosystem and conforms to its complementor role. • A complementor aims to please a platform owner and dedicates itself to the partnership.

Domination describes the hegemonic framework that makes the power of an actor appear "natural and unchangeable" (Lukes, 2005, p. 24). In the context of platform ecosystems, domination operates on the ecosystem level and builds on the ability of a platform owner to provide a software platform that is central to the product or service offerings of existing and prospective complementors. This centrality provides the platform owner with the legitimacy to determine strategies, standards, rules, regulations, or technologies that apply to the entire ecosystem and that appear natural and unchangeable to individual complementors. For example, a platform owner usually prescribes that each complementor has to acquire distinct certifications, such as technical certificates, and complementors usually perceive such certification as a natural and inevitable component of the platform partnership.

Coercion describes the direct mobilization of power, through which one actor gets another actor to do something it would not have otherwise done. In other words, one actor simply tells another actor what to do or else (Fleming & Spicer, 2007, 2014), i.e., "A has power over B to the extent that he can get B to do something that B would not otherwise do" (Dahl, 1957, p. 202). In the context of platform ecosystems, coercion operates on the partnership level in the sense that a platform owner coerces one specific or only a few—but not all—complementors. For example, a platform owner could enforce tighter rules for one or a few complementors and expel them from the ecosystem in case of a refusal to conform.

Manipulation describes attempts of using the existing hegemonic institutional framework to ensure actions occur within desired boundaries (Fleming & Spicer, 2014). As such, manipulation primarily operates on the partnership level. For example, a platform owner may wield incentive schemes defined in the partner program o purposefully reward or help an individual complementor.

Subjectification describes attempts to shape the sense of self, experiences, and emotions (Fleming & Spicer, 2014). While such shaping of the sense of self may well take place on a macro level (e.g., ecosystem level), the notion of subjectification also highlights that in order for domination to actualize (i.e., brought to bear), a less powerful actor needs to conform to the pre-shaped self-perceptions. Thus, without the conformance of the seemingly less powerful actor, the power of the seemingly powerful actor becomes not actualized (Fleming & Spicer, 2014), which directly ties to the idea that power is a reciprocal process driven by both powerful and powerless actors. In the context of platform ecosystems, platform owners often devise specific predetermined roles for the complementors of their ecosystem (Wareham et al., 2014) and platform owners may or may not subjectify themselves by conforming to these predetermined roles.

These contextualized definitions of the four faces of power insinuate that power processes in platform ecosystems are reciprocal in that domination, coercion, and manipulation are power moves enacted by the platform owner but that these moves can only manifest if complementors subjectify themselves. However, as far as subjectification helps to manifest the platform owner's power, power asymmetries are likely to solidify, which may hinder partnerships from thriving (De Brabander & Thiers, 1984). This potential threat raises the question of how the power moves of the platform owner and the subjectification moves of the complementors can help rather than hinder the partnership from thriving. Therefore, our study builds on this contextualized understanding of the four faces of power to investigate how power is enacted and changes over time and the role of such power dynamics in platform ecosystems for the continued thriving of the partnership.

2.3. Method

To understand how power manifests in platform ecosystems, how and why power changes over time, and how such power dynamics feed into the continued thriving of platform owner–complementor partnerships, we conducted a longitudinal multiple-case study (Yin, 2009).

Table 3: Studied Cases and Case Level Interviews

Platform Owners	Complementors	Description	t	Interviewees
PO-A	***CA-1***	Medium-sized company (Headcount: < 250); Partnership since 2001; Core products: Complementary customer relationship-, case-, and anything relationship management solution for PO-A's middleware platform	t1	• Partner manager A1 • Complementor chief technology officer (CTO)
			t2	• Partner manager A1 • Complementor CTO
	CA-2	Small company (Headcount: < 50); Partnership since 1998; Core product: Complementary enterprise document creation tool for PO-A's business productivity platform	t1	• Partner manager A2 • Complementor chief marketing officer (CMO)
			t2	• Partner manager A1 • Complementor CMO
PO-B	***CB-1***	Medium-sized company; Partnership since 1999; Core product: Complementary energy trading and accounting tool for PO-B's database management platform	t1	• Partner manager B1 • Complementor CTO
			t2	• Partner manager B1 • Complementor CTO
	CB-2	Medium-sized company; Partnership since 1996 – an erstwhile subsidiary of PO-B; Core product: Heavily customized solution for public companies and governments that complement a variety of PO-B's platforms on multiple layers	t1	• Partner manager B2 • Complementor partnership representative
			t2	• Partner manager B2 • Complementor partnership representative
PO-C	***CC-1***	Small company; Partnership since 2007; Core product: Complementary, hard- and software based point of sales solution for PO-C's enterprise resource planning platform	t1	• Partner manager C1* • Complementor CTO
			t2	• Partner manager C1* • Complementor CTO
	CC-2	Medium-sized company; Partnership since 2004; Core product: Complementary field service management solution for PO-C's enterprise resource planning platform	t1	• Partner manager C1* • Complementor chief executive officer (CEO)
			t2	• Partner manager C1* • Complementor CEO

* CC-1 and CC-2 were managed by the same partner manager with whom we conducted the interview about CC-1 and CC-2 on the same day

We selected seven partnerships from four different ecosystems. We excluded one of these seven partnerships from our final sample due to the reluctance of the respective platform owner to participate in the second round of interviews. The platform owners of the three remaining ecosystems – referred to as PO-A, PO-B, and PO-C – are among the largest software firms in the world and they offer a variety of enterprise software platforms ranging from business applications to databases and middleware. Each of the three platform owners maintains an ecosystem with several thousand complementors, divided into three to four different partner levels. We approached the heads of these partner programs to ensure commitment for a longitudinal study. Based on this commitment, we began purposefully sampling two partnerships from each ecosystem. All partnerships had to be at least five years old to ensure that the study timeframe would be sufficient for power dynamics to emerge. Besides, we made

sure that the partnerships were likely to or already had ascended from lower to higher partner levels, which increased the probability of observing variations in and changes of power enactment. Table 3 provides an overview of the six platform owner–complementor partnerships.

2.3.1. Data Collection and Analysis

To triangulate our data (Eisenhardt, 1989; Yin, 2009), we collected two types of qualitative data. Our first data sources are semi-structured interviews conducted on both the ecosystem- and the dyadic level. For the ecosystem level, we interviewed three ecosystem managers responsible for managing the entire network of complementors. For the dyadic level, we conducted interviews with the partner managers of both sides of each partnership (i.e., platform owners and complementors) in two separate rounds (i.e., round 1 in 2013 and round 2 in 2015), resulting in another 24 interviews. The interviews lasted 1 hour and 15 minutes on average, with a range from 40 minutes to 2 hours. Each interview was recorded and transcribed and conducted following the recommendations of Myers and Newman (2007). We conducted all interviews in the interviewees' native language (i.e., German or Swiss German) and on site, except for two interviews conducted via Skype. Our second data source is archival data, including ecosystem-wide documents (i.e., the standardized partner contracts, partner program guidelines, and ecosystem codes of conduct) and partnership level documents (i.e., company websites, newspaper articles, and project documentation).

Our continuous data analysis began after the first informal conversations in April 2013. These allowed us to react on novel insights early on and to adapt our semi-structured interview guideline for subsequent interviews. For our data analysis we used NVivo 11, and we followed an iterative bipartite coding approach as suggested by Charmaz (2006). First, we coded each piece of data line-by-line and in much detail, by using the four faces of power as starting points of process codes (Charmaz, 2006; Miles, Huberman, & Saldaña, 2013). This procedure allowed us to curb the human tendency of making conceptual leaps and following existing theories rather than to inductively develop codes from ground up (Charmaz, 2006). However, in order to ensure the significance of these process codes in the specific context of our study, we developed a set of highly contextualized second-order descriptive subcodes (Miles et al., 2013). This bipartite coding approach enabled us to reconstruct how power manifested in each of the six analyzed partnerships and how it changed over time and to map these dynamics into theoretical concepts that categorize our data incisively and entirely (Charmaz, 2006).

To grasp whether a platform partnership thrived or withered, we followed the notion of co-created value, which manifests in the form of discernible instances, such as joint projects, additional features, or flow of software royalties. This notion is particularly well suited for our study because it traces variations and changes in performances of platform partnerships in the enterprise software industry (Huber et al., 2017; Sarker et al., 2012). Accordingly, we coded a partnership as thriving if such instances of co-created value manifested and as withering if such instances became less frequent.

Our next analysis step focused on exploring relationships between our core concepts via axial coding. The goal was to identify general patterns across the six partnerships, i.e., power dynamics that were similar concerning the faces of power. We systematically compared the dynamics within and across cases using replication logic, memo writing, and tables (Miles et al., 2013). This procedure resulted in three recurring power cycles in each of which different faces of power interact with each other in a self-reinforcing way. We finalized our analysis by theoretically coding our data. This final step allowed us to identify the general mechanisms underlying the identified recurring cycles (Charmaz, 2006). By synthesizing and abstracting these findings, we constructed our final process model of power in platform ecosystems that explains how power manifests in platform ecosystems, how and why power changes over time, and how the resulting power dynamics feed into the continued thriving of the individual partnerships.

2.4. Results

The analyzed platform partnerships differed as to whether and how they thrived over time. Some partnerships thrived continuously (i.e., CA-1 and PO-A, or CC-1 and PO-C). For example, in the partnership between CA-1 and PO-A, CA-1 continuously improved its software complement and frequently attracted new customers. Other partnerships only thrived in the beginning but began withering after some time (i.e., CA-1 and PO-A, CB-1 and PO-B, CB-2 and PO-B; CC-2 and PO-C). For example, while the partnership between CA-2 and PO-A evolved favorably in the beginning, it took turns after some time as the strategies of the two partners drove apart and joint revenue decreased. The appendix provides a detailed summary of evidence for such dynamics concerning the continued thriving of the partnerships.

Across our cases, these dynamics in outcomes were systematically associated with how the different faces of power interacted over time. These dynamic interactions build the foundation for three intertwining cycles. Next, we introduce these three cycles before we show how they intertwine using rich illustrations of two representative cases (a summary of evidence for the

other four cases is provided in Appendices A and B). Eventually, we synthesize our findings in a process model of power in platform ecosystems.

2.4.1. The Central Domination – Subjectification Cycle

The domination power of platform owners builds on their ability to provide a software platform that is central to the product or service offerings of their complementors. Across all cases, this vests platform owners with the legitimacy to determine strategies, standards, rules, regulations, or technologies that appeared natural and unchangeable to both present and prospective complementors. In particular, it legitimizes platform owners to determine distinct complementor roles with varying duties and responsibilities. However, in order for domination to actualize in specific partnerships, complementors need to subjectify themselves to one of these predetermined roles. Whether or not complementors do so is the result of an evaluation process on their part. During this process, complementors put the eligibility to complement a software platform and all the associated benefits in a balance to evaluate whether the upsides can offset the downsides of subjectifying themselves to a predetermined complementor role with all the associated duties. If the upsides offset the downsides, a complementor subjectifies itself and the domination actualizes. Conversely, if the upsides do not offset the downsides, the domination of a respective platform owner does not actualize.

This reciprocal trading of subjectification in return for predetermined benefits is cyclical: It begins when a complementor decides to enter an ecosystem and thereby accepts the duties and responsibilities defined in the partner program. The domination-subjectification cycle repeats as complementors ascend to higher partner levels. While these higher partner levels come with more and more demanding duties, platform owners also present the promise of more and more valuable benefits. Again, complementors engage in an evaluation process in which they put the upsides of higher partner levels in the balance to evaluate whether or not they offset the downsides. As with their initial decision to join an ecosystem, complementors subjectified themselves to these increasingly demanding duties, if the associated upsides were able to offset the downsides. In the analyzed partnerships, every complementor voluntarily ascended to the highest partner level. Thus, each complementor increasingly subjectified itself over time, such that the platform owners' domination increasingly actualized. This increasing actualization was in the very interest of the three platform owners, as the ascensions in partner levels implied an increasing dedication of the six complementors to their platforms—which was essential for the continued thriving of the six partnerships.

By repeatedly cycling through the domination-subjectification cycle, all six partnerships initially exhibited a steady movement toward an increasing subjectification on the part of the complementors, which increasingly actualized the domination of the platform owners. However, this steady movement in the domination-subjectification cycle was perturbed in all partnerships. Two additional power cycles were the source of these perturbations in the domination-subjectification cycle. The following sections present these two cycles and describe the conditions that activated them.

2.4.2. The Perturbing Domination-Coercion Cycle

The domination-coercion cycle is activated in situations in which platform owners feel that a change in technology, standards, rules, regulations, and even the strategy itself is pertinent to maintain the competitiveness of the ecosystem. Such situations occurred across our cases and whenever they occurred, platform owners episodically resorted to their coercive power to ensure that complementors follow suit with the new direction. Generally, the rules of all three ecosystems explicitly reserved the respective platform owner the right to unilaterally change existing or impose new strategies, technologies, standards, rules, and regulations. In this sense, the dominance of the platform owner legitimizes coercion. Across the six analyzed partnerships, we observed a variety of different ways through which platform owners exercised coercion. For example, each of the three platform owners unilaterally altered its strategy by focusing on cloud platforms and thereby affected complementors by this shift to adopt a new technological architecture—something the complementors would not have done otherwise. Another example of coercion occurred in the partnership between PO-A and CA-2, where PO-A decided to discontinue one of its platforms and thereby coerced CA-2 to depreciate all its investments in the surrendered platform. Likewise, PO-C altered its platform portfolio by adding another platform and coerced CC-2 to provide its complement on this new platform. In other instances, platform owners exercised coercion by unilaterally adopting the written standards, rules, and regulations of their ecosystem. For example, both PO-B and PO-C unilaterally issued tighter standards, rules, and regulations and made complementors conform to them.

As platform owners imposed changed strategies and technologies, as well as standards, rules, and regulations on their complementors, they altered the foundation of their domination. Because such alterations directly affected the potential up- and downsides of being complementor, this led to a perturbation of the domination-subjectification cycle in the sense that complementors re-evaluated the partnership from scratch. For example, CA-1 increased its subjectification after PO-A had introduced an additional differentiation of complementors on the highest partner level. However, coercion can also be counterproductive. For example, CA-

2 and CB-2 reconsidered and ultimately lowered their subjectification after their platform owners had forced them to follow suit with their strategic turns, which turned out to be disadvantageous for CA-2 and CB-2. Likewise, CC-1 and CC-2 stopped their steady movement toward more subjectification and began to scrutinize the domination of PO-C, once PO-C had unilaterally decided to tighten the standards, rules, and regulations. Importantly, as the complementors reduced their subjectification and started to scrutinize the domination of the platform owners, this led to undesirable outcomes: Complementors started to reduce their dedication to the platform, which hindered the partnership from thriving.

2.4.3. The Perturbing Subjectification – Manipulation Cycle

The subjectification-manipulation cycle is activated in situations in which partner programs reach their limits. In all analyzed partnerships, such situations occurred after the complementors had reached the highest partner level. In these situations, the steady movement toward more subjectification through complementors and more domination through platform owners is in danger of stopping. To ensure the continued thriving of their dyad, platform owners exercised their power more actively, i.e., through manipulation. Different from domination, which as a systemic form of power works more as a background force, manipulation involves a more active power exercise in which the platform owner wields the existing hegemonic framework to lure a specific complementor into more subjectification. For example, PO-A (as well as PO-C) manipulated the conditions to the benefit of CA-2 (CC-2) by co-financing the development of an additional complement, which eventually led to more subjectification by CA-2 (CC-2). Thus, analogous to the central domination – subjectification cycle, complementors again engage in an evaluation process in which they weigh the upsides against the downsides and only continue to subjectify themselves if they feel that the upsides outweigh the downsides. Thus, if manipulation is disadvantageous for a complementor or reduces the benefits of previous manipulations, it is likely that this complementor subjectifies itself less.

Platform owners do not make manipulations carelessly; in fact, they carefully evaluate whether or not a subjectification merits a manipulation. However, complementors can tip this evaluation in their favor by voluntarily subjectifying themselves beyond the expectations of their role. Such voluntary subjectification signaled the continued dedication of a complementor to the platform owner and acted like an advance payment for anticipated extra-benefits. Across all cases, the platform owners always rewarded such anticipatory obedience by manipulating the rules in favor of the complementor. Such manipulations entailed the provision of benefits that went beyond the ones accessible to complementors on the highest partner levels. Among other

things, these additional benefits included detailed insights into the development of the platforms or direct contacts to specialists, which ensured the continued thriving of the partnership.

2.5. Illustrative Case Narratives

Using rich case narratives, we next illustrate how different recursive and intertwined power dynamics lead to different trajectories of thriving and withering. The first narrative illustrates a partnership that continued to thrive throughout the observation period. The second narrative illustrates a partnership that initially thrived but eventually withered. Figure 1 and Figure 2 illustrate the developments of the relationships over time. The other cases are illustrated in the appendix.

2.5.1. CA-1 – The Climber that Excelled as Complementor

Since 1998, CA-1 focuses on enterprise document creation add-ons for the productivity platform of PO-A: *"PO-A always focuses on the masses when it comes to its products. Their productivity platform, for example, is great for a single user, but not for corporate purposes. That is where we come into play." (CA-1 RW T1).*

Initially, CA-1 had to decide whether to become a formal partner of PO-A or not. Such a partnership required conformance with the duties stipulated in the standard partner contract: *"In the end, there is just the partner contract that all complementors must sign." (CA-1 RW T1)*. However, the partnership also entailed access to exclusive commercial and technical resources. CA-1 found that these benefits would outweigh the downsides of a partnership and started to subjectify itself to the domination of PO-A. Eventually, joining the ecosystem significantly increased the sales of CA-1's add-on.

After a few years, CA-1 felt that to continue satisfying its customers, it would have to deepen the relationship with PO-A. In 2010, CA-1 decided to ascend to the highest partner level:

> *"[I am with CA-1] for 2.5 years, and it was my first activity to bring the partnership to a higher level, more specifically to the highest level." (CA-1 RW T1).*

While this ascent came with the promise of more rights and benefits, such as access to additional marketing and sales resources and stronger technical support, it also implied an additional set of duties to which CA-1 had to subjectify itself.

> *"We now need to pay the partner fee, and we must acquire certifications. Besides, we also need to have a certain number of satisfied customers, and we must certify our products." (CA-1 RW T1).*

Again, CA-1 weighed the benefits against the downsides and decided to subjectify itself to the rules of the highest partner level. After the ascent to the highest partner level, the partnership continued to thrive as CA-1 continuously attracted new customers while improving the software and services offered to existing customers. For example, CA-1 attracted new customers within the federal (in contrast to local) government.

Even though the partnership was already thriving, CA-1 had the ambition to stand out from the masses of complementors and began subjectifying itself even beyond the expectations of their role as a partner of the highest level. For example, even though the partner program did not prohibit a diversification to other platforms, CA-1 committed itself exclusively to PO-A:

> *"We are a 100% partner of PO-A. In the end, PO-A is still a market leader in that specific area, and we do not want to scatter our resources on other platforms." (CA-1 RW T1).*

This commitment was noted by PO-A who began recognizing CA-1 as one of the most critical complementors in Switzerland.

> *"In the specific area of our productivity platform, they [CA-1] certainly are among the most important partners. On the one hand, they indirectly promote our sales with their complement. On the other hand, it is their enormous dedication to the partnership and PO-A." (PO-A AR T1).*

This recognition of CA-1's exceptional dedication became particularly important in situations in which the parties were confronted with joint business opportunities that could only be leveraged with some flexibility. It made PO-A more willing to grant such flexibility by manipulating the partner program in favor of CA-1. For example, while the formal partner program stipulates standard information channels between the platform owner and all complementors, CA-1 received a preferred supply of information such as earlier and deeper insights into the development division of PO-A:

> *"We get in touch with the developers at the headquarters of PO-A at a very early stage. Today, they directly inform us about the developments of their productivity platform, which is why we even have a more comprehensive understanding of this platform than the average Swiss employee of PO-A." (CA-1 RW T1).*

Another instance of manipulation occurred when PO-A gave CA-1 the opportunity to present its products and services to potential customers on national and international stages. Besides, PO-A ensured that CA-1 received multiple partner program awards for its add-on, which led to

additional visibility that was key for the continued thriving of the partnership. For example, it enabled CA-1 to acquire its largest international customer in history (to that date):

> *"I believe it [the commitment and the partner level] is essential because it makes us more visible to PO-A on a European level. Not least because of that we were able to acquire one of our largest customers in the Netherlands, who became aware of our solution thanks to a PO-A forum." (CA-1 RW T1).*

Such reciprocal processes of over-subjectification on the part of CA-1 in return for favorable manipulations through PO-A steadily unfolded over several years:

> *"The closer we collaborate with PO-A, and the more we commit ourselves to PO-A, the more we are trusted. It is the same for us; it strengthens our trust when we see the way PO-A gives us a treat." (CA-1 RW T1).*

In light of this mutual give and take, the partnership continued to thrive in the subsequent years. However, this steady movement was at the risk of being disturbed when PO-A decided to introduce a further differentiation among complementors on the highest level, which directly affected CA-1. Since the standardized partner contract stipulated PO-A's right to change the partner program unilaterally, including the adjustment of the partners' levels, there was nothing complementors could do to object this move. The new differentiation came with a more demanding and structured process for managing international projects:

> *"The idea is to define the target markets together with the complementors – thus the countries they want to conquer. Then, for example, we get into contact with our team in Germany to recommend this complementor, such that they push this complementor in Germany." (PO-A OF T2).*

However, PO-A also made sure that the new partner level came with the promise of valuable benefits. For example, the more demanding process also reduced the obstructive competition between the national subsidiaries of PO-A:

> *Well, [before] the Germans were not interested since it was just a Swiss company and not one of their partners. However, they have foreseen this issue, and as of July 1, they [PO-A] have employees, I would say, with a European focus." (CA-1 RW T2).*

Since this obstructive competition had troubled CA-1 for years, CA-1 gladly subjectified itself to the altered domination of PO-A so that the partnership was able to continue on its thriving trajectory.

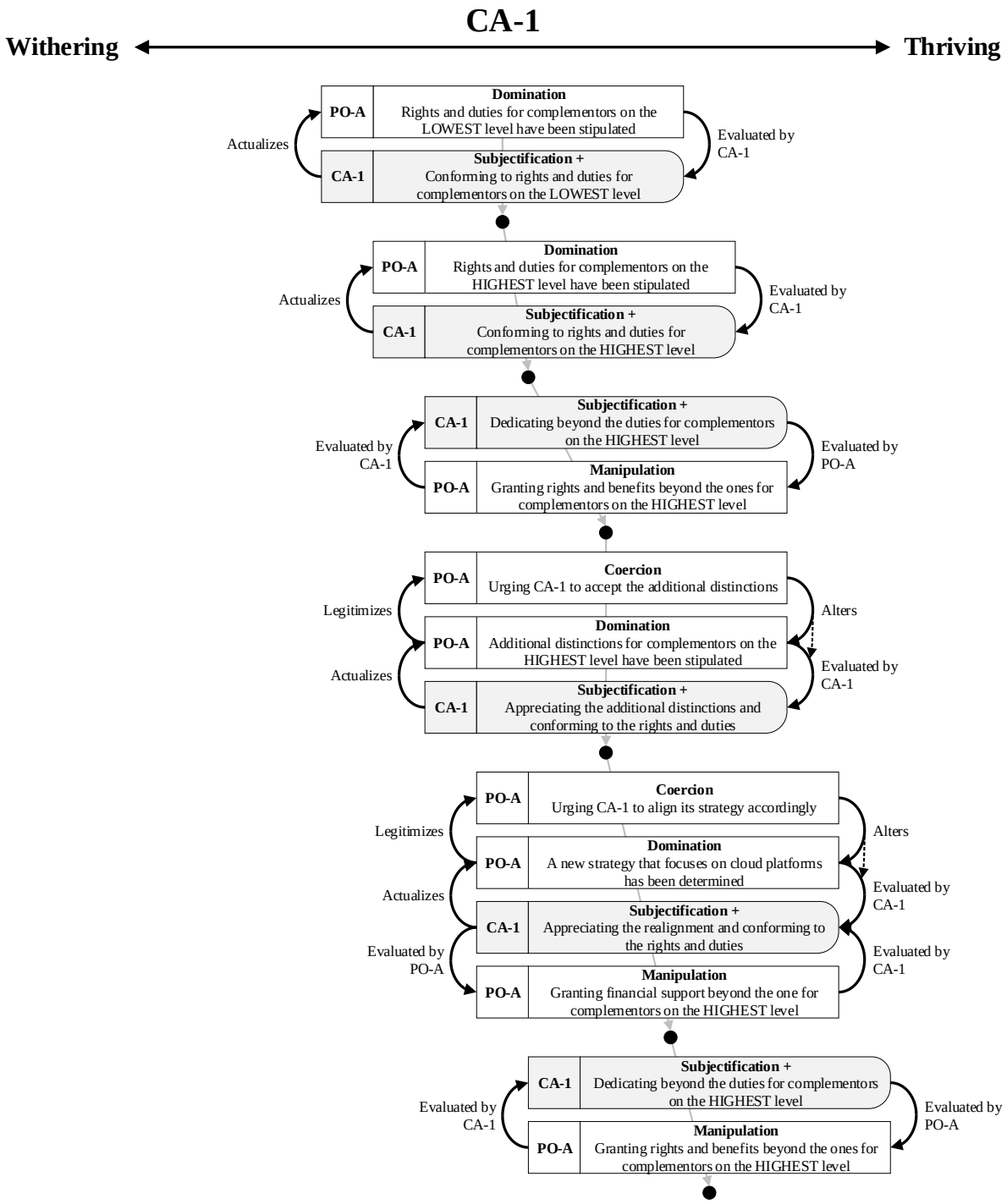

Figure 1: Case Drawing CA-1

Shortly after that, PO-A once again put the steady movement toward increasing domination and subjectification to the test. During this time, PO-A realized that it had to change its traditional delivery models and start offering its software as a cloud-based service. In doing so, PO-A made use of its right to refocus its entire strategy unilaterally and coerced its complementors to follow suit:

"At the moment, an obvious switch is happening – the switch toward the cloud, which concerns not only us but also the entire industry. Especially PO-A, our most important partner, makes us feel that quite plainly. Currently, many things are happening on the way to the cloud, and that is where we are challenged." (CA-1 RW T2).

This strategic shift directly played into the hands of CA-1, which conceived of this shift as an opportunity to make global product offerings:

"I believe that the whole market will change. In the future, apps will replace the applications that we know today. […] One will inevitably become international – except for the ones that isolate themselves, but we do not want that, right?" (CA-1 RW T2).

Against this background, CA-1 voluntarily subjectified itself to the altered domination of PO-A and even beyond that by being one of the first complementors that made its solutions ready for the cloud:

"[CA-1] is highly dedicated and perfectly conforms to our strategy, which is focusing on the cloud. There it [CA-1] invests a lot, and in December it is going to launch two critical apps that will complement our cloud-based productivity platform." (PO-A OF T2).

Again, this recognition of CA-1's extreme commitment became important whenever leveraging a business opportunity required some flexibility that went beyond the rules of the standardized partner program. In these situations, this recognition seemed to make PO-A more willing to use the partner program in inventive ways that favored CA-1.

"There we were heavily supported by PO-A, as we already had the first apps running on the cloud-based productivity platform. PO-A took these apps and presented them during their developers' conference as a paradigm for how they expect to work in the future." (CA-1 RW T2).

PO-A reciprocally responded to CA-1's ongoing subjectification by episodically manipulating the rules of the partner program in favor of CA-1. This manipulation peaked in the admission to an exclusive advisory council of leading partners. Thus, PO-A manipulated the conditions once again in favor of CA-1, who used this opportunity to satisfy new customer needs in innovative ways:

"We are now part of an [international] advisory board of leading partners that advise PO-A. That is what we like to do, and this increased our impact. We always try to bring in the opinions of our customers and to present them to PO-A. Currently, we can do this very

intensively, as our CEO advises PO-A in the area of cloud applications for their cloud-based productivity platform. In other words, to highlight the customer needs." (CA-1 RW T2).

2.5.2. CA-2 – The Flagship Complementor that Sank to Insignificance

Founded in 1998, CA-2 develops, distributes, and implements a customer relationship-, case-, and anything relationship management solution for small to medium-sized enterprises and the public administration.

From 1998 to 2001, CA-2 was relying on PO-A technology as a foundation for its solution – without being a formal partner of PO-A. Only in 2001, CA-2 planned to port its solution *"to one of PO-A's middleware platforms"* and entertained the idea of becoming a formal partner. While becoming a formal partner on the lowest level required conformance with the duties stipulated in the standard partner contract: *"The rules are there and are accepted." (CA-2 BK T1),* it also entailed access to exclusive, valuable resources that would make the integration with the middleware platform easier. CA-2 found that the exclusive access to these resources would outweigh the downsides of becoming a partner and started to subjectify itself to the domination of PO-A by joining its ecosystem. Becoming a formal member of the ecosystem paid off for the partnership because the formal partner status served as a quality seal, which led to significant sales increases for CA-2's relationships management solution.

In the subsequent years, the partnership grew increasingly deeper as CA-2 voluntarily ascended to the highest partner level. This ascent gave CA-2 access to more and more valuable resources in return for accepting the additional duties of the highest partner level. Due to the increasing subjectification of CA-2 to PO-A's domination, the partnership continued to thrive. For example, the ascent to the highest partner level implied the assignment of a dedicated partner manager, which allowed CA-2 to access more information that helped to improve its solution significantly.

Interestingly, CA-2 did not stop at ascending to the highest partner level but began subjectifying itself beyond the expectations of PO-A. For example, CA-2 abandoned a competing platform in favor of focusing all its resources on PO-A's platforms:

"Because of our dedication, we became sort of a PO-A 'joint'. In other words, we use its products as good and as often as possible." (CA-2 BK T1).

Noting the extraordinary commitment of CA-2, PO-A began manipulating the rules of the partner program in CA-2's favor. This manipulation included giving CA-2 preferred access to valuable resources, such as high-quality technical support and exclusive information:

> *"When I was visiting their headquarters, they even granted me a glimpse into their future productivity platform, and showed me their release plan." (CA-2 BK T1).*

Throughout several years, such reciprocal processes of over-subjectification on the part of CA-2 in return for favorable manipulations through PO-A routinely unfolded whenever the standardized partner program constrained CA-2's ability to leverage a specific co-creation opportunity. For example, CA-2 continued to subjectify itself beyond its duties by early-adopting new platforms and technologies such as the "*new frontend platform"* that was *"heavily pushed"* by PO-A *(CA-2 BK T2).* In return, PO-A wielded the partner program to grant CA-2 extra support:

> *"We supported each other – that is how it was. [PO-A] even helped us dispelling our customer's concerns when we tried to introduce the new frontend platform." (CA-2 BK T2).*

Initially, adopting the new frontend platform let the partnership thrive: CA-2 attracted some new customers and thereby contributed to the growth of the ecosystem around the new platform. However, in an unexpected strategic turn initiated by gloomy market prospects, PO-A halted the development of the new platform and announced that it would cease its support soon: *"One year later, there was the change, with the division head declaring the death of the new frontend platform." (CA-2 BK T2).* This coerced CA-2 to depreciate all its investments into the new platform and to recall the solution:

> *"At that time, we already had about twelve to fourteen instances of our solution running on the new frontend platform. Those instances we now have to recall." (CA-2 BK T2).*

CA-2 had no other "*alternative*" *(CA-2 BK T2)* than to follow suit. However, this episode gravely damaged the partnership. In light of the serious financial damage, CA-2 started to question the domination of PO-A, reduced its subjectification, and became more cautious regarding its partnership with PO-A:

> *"It was one of the most distinctive events, and it is because of this event that we no longer trust their strategy." (CA-2 BK T2).*

In 2013, cloud-based delivery models were on the verge of becoming the new standard in the enterprise software industry, and PO-A decided to follow this new trend: PO-A decided to start

moving toward its cloud-based middleware platform. For the new cloud platform to gain market traction, PO-A had to ensure that a broad set of complements was available at the launch date of the platform. To achieve this, PO-A urged selected complementors to complement the new platform. However, to ensure that these complementors conformed accordingly, PO-A began to manipulate the partner program in their favor. One of these complementors was CA-2, whose development costs were co-funded by PO-A:

> *"Currently, we are developing apps for the new middleware platform, and PO-A supports us by taking over some of our development costs. (CA-2 BK T1).*

Despite their initial reservations about cloud-based delivery models, the additional support from the platform owner convinced CA-2 that continued subjectification was beneficial. However, as the years went by and PO-A began to put its entire strategic focus on the cloud, CA-2 started to question this decision. Even though CA-2 had been particularly fast in embracing "*the cloud*", its core customer group—the public sector—turned out to be particularly slow in adopting this new delivery model: *"The cloud tends to be adopted a bit slower in the public sector than in other sectors" (PO-A OF T2).* Thus, the cloud-centric strategy at PO-A was more and more conflicting with CA-2's strategic focus on the public sector. During this time, PO-A noted that CA-2 was "*not quite as dynamic" (PO-A OF T2)* anymore, while CA-2 felt that they were "*no longer at the heart of [PO-A's] strategic investment focus" (CA-2 BK T2).* Even though CA-2 was still on the highest partner level and still received all the standard benefits of that level, PO-A did not consider CA-2 as a priority partner anymore and consequently stopped to provide CA-2 with preferential treatment. CA-2 was seriously concerned: *"Currently, we tend to feel that our partnership on the highest level is going south." (CA-2 BK T2).*

Trapped in a situation where the needs of its customer base conflicted with PO-A's new strategy, CA-2 began to re-evaluate the partnership from scratch and questioned whether the benefits of the highest partner level still outweighed the associated duties:

> *"We asked ourselves what exactly the benefits of our partner level are. Just this week, we discussed if it is still necessary […] no, it is not. In the end, other labels are much more valuable." (CA-2 BK T2).*

Eventually, CA-2 decided that now was the time to lower its subjectification. Therefore, CA-2 made provision for descending the partner level and offering their solutions to other platforms. This provision made the partnership with PO-A withering: Rather than offering platform-

exclusive solutions tailored to the specific needs of its specific customer base, CA-2 started to act as a platform-agnostic software services company open to many competing platforms.

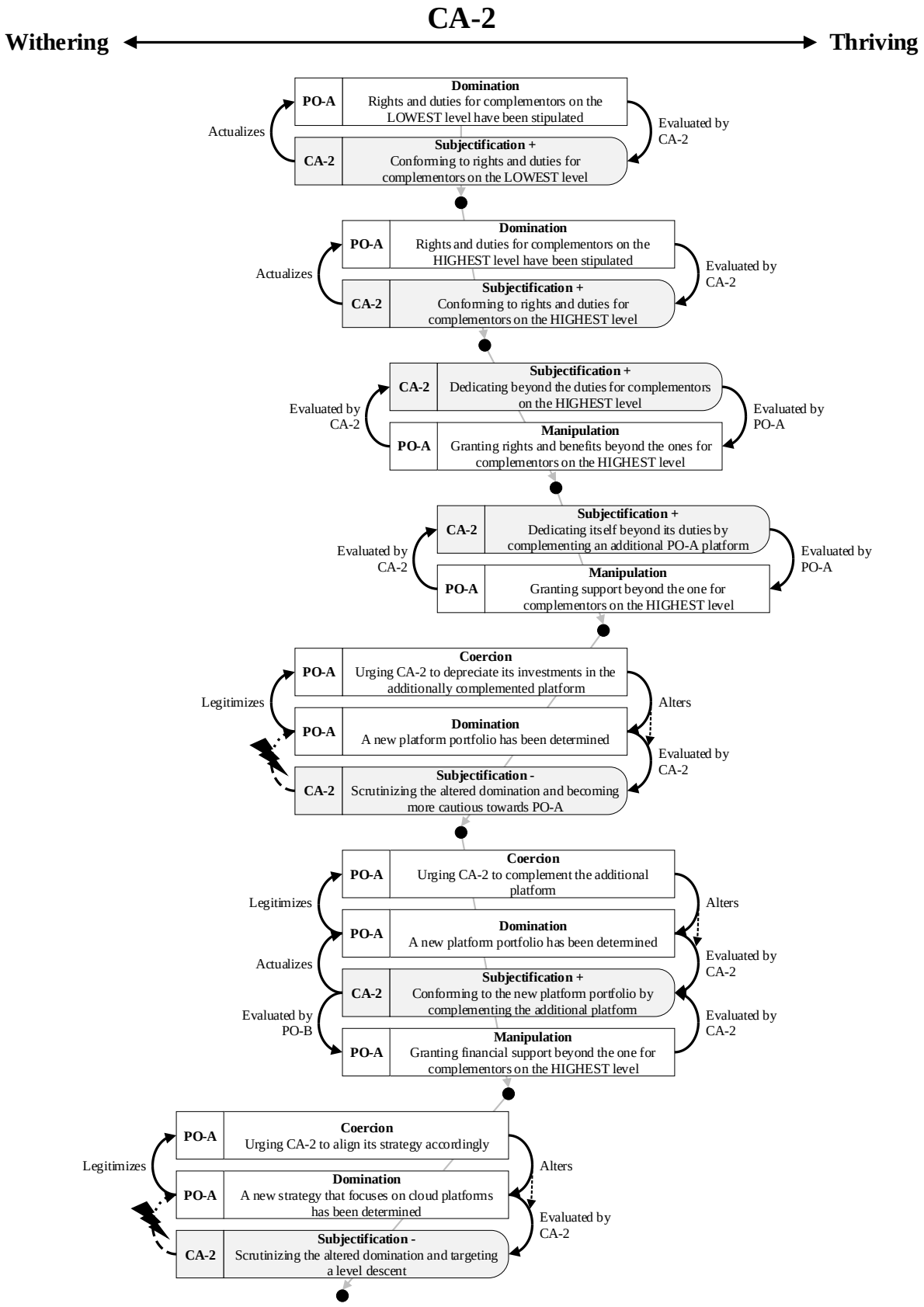

Figure 2: Case Drawing CA-2

2.6. Process Model

Figure 3 shows the resulting process model of power in platform ecosystems. The model explains power dynamics by unveiling how different faces of power that operate on different levels interact with and mutually shape each other in three intertwined cycles. Specifically, power in platform ecosystems evolves through a reciprocal process shaped by both the powerful platform owner and the seemingly powerless complementors: The platform owner can only play to its powerful position if the complementors decide to subjectify themselves. This decision builds on an evaluation process in which complementors weigh the downsides against the benefits of subjectification. Moreover, the model explains how different power dynamics lead to the continued thriving or withering of a partnership. The central domination-subjectification cycle explains the occurrence of constant movements in which partnerships thrive continuously as complementors increasingly subjectify to the platform owners' domination in return for predetermined benefits.

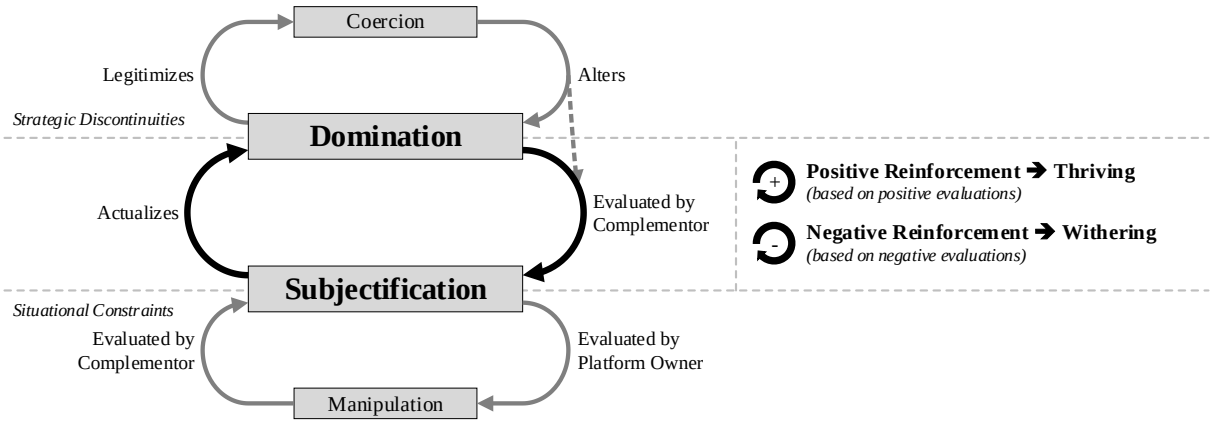

Figure 3: Process Model of Power in Platform Ecosystems

This steady movement toward an increasingly thriving partnership can be perturbed by two additional power cycles. First, the domination-coercion cycle is activated in situations in which platform owners feel that the old way of doing things constrains them in achieving their strategic goals (strategic discontinuities). In such situations, platform owners can resort to coercive power. Such exercise of coercive power becomes the subject of an evaluation on the part of the complementors. Moreover, coercion can alter the foundations of domination and thereby cause an additional re-evaluation on the part of the complementors. If complementors find that, under the changed conditions, the upsides do not outweigh the downsides anymore; they begin scrutinizing the platform owners' domination and therefore put the continued thriving of the partnership at risk. However, if the platform owner exercises its coercive power

in a way that is more sensitive to the complementors needs, the upsides can still outweigh the downsides, and the path toward an increasingly thriving partnership can continue.

Second, the subjectification-manipulation cycle is activated in situations in which the existing partner program reaches its adaptive limits in adhering to the situational needs of a specific co-creation opportunity (situational constraints). In such a situation, platform owners episodically need to take a more active role if they want to ensure the continued thriving of the partnership. Specifically, platform owners can lure complementors into increasing subjectification by situationally manipulating the existing rules and resources of the ecosystem in favor of one complementor. Moreover, complementors can mold the exercise of power in their favor, if they voluntarily subjectify themselves beyond the expectations of their role.

The dynamics depicted and explained through our process model suggest that for platform partnerships to thrive, platform owners and complementors need to be mutually responsive to each other in the reciprocal process of power enactment and subjectification.

2.7. Discussion

The goal of this study was to answer the questions of (1) how power manifests in platform ecosystems, (2) how and why it changes over time, and (3) how such power dynamics feed into the continued thriving of individual partnerships. To achieve this goal, our study was the first to adopt the integrative power conceptualization by Fleming and Spicer (2007, 2014). This novel conceptualization has proven to be uniquely suited to uncover previously hidden multi-level and reciprocal power dynamics. In response to our first research question, our findings show that power manifests in platform ecosystems as different faces (i.e., domination, subjectification, manipulation, coercion) that operate on different levels (i.e., ecosystem and dyadic level). In response to our second research question, we found three intertwining and self-reinforcing cycles to drive power dynamics. The domination-subjectification cycle is the modus operandi of power enactment in platform ecosystems, whereas the domination-coercion and the manipulation-subjectification cycles only occur episodically and in the presence of distinct conditions (i.e., strategic discontinuities and situational constraints, respectively). In response to our third research question, we find those constant movements of increasing domination and reciprocal subjectification lead to the continued thriving of the partnership. The two other power cycles can perturb such steady movements, but they can also be wielded to balance-out such perturbations. The key is that the platform owner and complementors are mutually responsive to each other in the reciprocal process of power enactment and subjectification. Together, these

findings theoretically contribute to the literature on power in platform ecosystems, governance of platform ecosystems, and the broader research on power.

2.7.1. Theoretical Contributions

Prior research on power in platform ecosystems has already established that this new way of organizing is characterized by unique asymmetries of power rooted in asymmetric resource dependencies (Ghazawneh & Henfridsson, 2013; Hurni & Huber, 2014; Kude et al., 2012). Our findings confirm that platform owners do indeed act from a position of power and we unveil that this gives them the potential to enact power on multiple levels, i.e., they can shape the ecosystem as a whole (e.g., through domination) but also individual partner partnerships (e.g., through manipulation). However, in contrast to prior research in the context of platform ecosystems, our study explicitly acknowledges the complementors' perspective—a perspective which prior research has paid "limited attention to" (McIntyre & Srinivasan, 2017, p. 150). This perspective allowed us to shed light on how platform owners can fully leverage the potential of their—in principle—powerful position to ensure that partnerships thrive continuously. We show that this requires platform owners to conceive of power as a reciprocal process that can only unfold undisturbed and for the good of the partnership if complementors decide to subjectify themselves after their careful evaluation. Thus, our findings extend prior research in that they strongly highlight the fundamental importance of the complementors for understanding how and why power dynamics play out in platform ecosystems. While the structural conditions of platform ecosystems do indeed one-sidedly vest the platform owner with power, the how and why of power exercise and power dynamics, as well as the consequences for the continued thriving of the partnership are equally driven by both platform owner *and* complementors in a reciprocal process of power enactment and subjectification.

Our results also have significant implications for research on platform governance. This research has framed governance as a problem of standardizing rules (Baldwin & Clark, 2000; Boudreau, 2010, 2012; Gulati, Puranam, & Tushman, 2012; Parker & van Alstyne, 2005). Our study broadens this perspective by acknowledging for the first time that governance should not only strive for standardization but also be sensitive to issues of power imbalances. While standardization seems to serve as an essential technical pre-condition of thriving partnerships, our findings suggest that platform governance should also seek to create the social power conditions that underlie thriving partnerships. This requires platform owners to refrain from power abuses in order to maintain the continued subjectification on the part of the complementors.

Moreover, prior research on platform governance has investigated desirable outcomes of governance by analyzing the effects of governance on dependent variables such as the sheer number of complements (McIntyre & Srinivasan, 2017), or whether complementors join (Economides & Katsamakas, 2006; Huang, Ceccagnoli, Forman, & Wu, 2013; Kude et al., 2012) or abandon a platform (Tiwana, 2015). However, this research has black-boxed other, more qualitative aspects of partnerships that have been surmised to be an essential driver of ecosystem success (McIntyre & Srinivasan, 2017). By studying how dynamics in power affect the continued thriving of partnerships, our study directly addresses this gap. We show that power dynamics—that are often closely related to governance decisions—are an essential driver of whether partnerships thrive or merely survive.

As a final contribution, our study has important implications for broader research on power. Our study is one of the first to explicitly build on the integrative and comprehensive power conceptualization recently advanced by Fleming and Spicer (2014). This conceptualization conceives of the different types of power (i.e., episodic and systemic) as different dimensions of the same broad construct rather than as competing contestations on how power functions. By adopting this conceptualization, our study was able to unravel the complex, reciprocal, and multi-level interactions through which different types of power mutually shape each other over time. Most importantly, our findings strongly point to the importance of the seemingly powerless for understanding power dynamics. We unveil that complementors are only seemingly powerless because they take an integral and active role in reciprocal power processes, which extends broader power research that has often invoked arguments from resource dependency theory to explain why one actor will dominate another actor (Kude et al., 2012). We show that even in the face of extreme asymmetries in resource dependency, the strong actor does not dominate the relationship. Quite the opposite, without the acceptance through complementors, the power of the platform owner cannot fully actualize. Moreover, complementors can mold the platform owner's power enactment in their favor by over-subjectifying themselves in the fashion of an advance payment. Thus, our findings add the reciprocal interactions between different types of power as an additional explanation for how and why power manifests and changes over time.

2.7.2. Managerial Implications

Our findings provide some meaningful guidance for practitioners on how to use power in a way that allows platform partnerships to thrive continuously. First, the reciprocal and multi-level power dynamics identified in this study have important implications for how managers from platform owners should use their power. Specifically, platform owners need to be very cautious

when changing strategies, standards, rules, regulations, or technologies, because such changes often entail changes in the foundations of their domination, which causes re-evaluations on the part of the complementors. Therefore, when changing strategies, standards, rules, regulations, or technologies, platform owners have to carefully factor in the needs of their complementors. More specifically, platform owners need to make sure that upsides for complementors continue to outweigh the downsides even after such changes.

Second, platform owners need to be aware that the predefined complementor roles (i.e., partner levels) can reach their limits. In this case, platform owners that want these partnerships to keep on thriving, need to take a more active role. This more active role entails situational switching toward manipulation. However, since manipulation is only in favor of a selected complementor, it may involve much effort. Platform owners should therefore carefully evaluate whether this effort is worthwhile. On the one hand, taking this effort may lead to complementor subjectification beyond the limits of the partner program. On the other hand, it stands in conflict with the principle of equality, which is an essential value in most platform ecosystems.

2.7.3. Future Research

Future research can extend our findings in at least two promising directions. First, our findings have shown that manipulations can restore the willingness of individual complementors to subjectify themselves. However, we still know little about what platform owners can do on an ecosystem level to restore this willingness. Thus, what happens if the abuse of power of a platform owner frightens off many or even all complementors that populate its ecosystem? Should this platform owner give every single frightened complementor the high level of individual attention or are there yet undiscovered measures—such as specific ways of using domination—that platform owners can take to escape such a seemingly deadlocked situation? If yes, what are the characteristics of such a careful way of using power and how does such power enactment feed into the cycles that our study unveiled? Second, our study has shown that platform partnerships frequently and regularly reach the limits of standardized partner programs and that maintaining the continued thriving of a partnership in this situation, requires platform owners to situationally manipulate the setting in favor of individual complementors. From a platform owner perspective, the continued thriving of a partnership is, however, only one crucial performance dimension. Another relevant dimension is the costs of governing a partnership (Tiwana, 2015) and engaging in costly dyadic level power interventions may undermine the goal of standardized, low-cost ecosystem governance. Hence, future research should explore how the power dynamics unveiled through this study do not only affect the continued thriving of a partnership but also the costs for governing it.

3. Complementor Dedication to Software Platforms: Rule Adequacy and the Moderating Role of Flexible and Benevolent Practices

Abstract [2]

Dedicated complementors are devoted and faithful to a platform and continuously invest in the underlying partnership with the platform owner. This dedication promises ongoing generation of add-on value to the platform. However, little is known about how complementor dedication is affected by the design of ecosystem-wide rules and by the practices through which platform owners enact these rules. To answer this question, we develop and test four hypotheses on how platform owners can strengthen complementor dedication. In doing so, we acknowledge the unique multilateral nature of governance in platform ecosystems by contextualizing established concepts from the governance literature. Explicitly, we incorporate the yet overlooked complementor perspective in the design calculus of effective platform governance and acknowledge the importance of dyadic level variations in rule performances. Building on survey results from 181 complementors, we show that to strengthen complementor dedication, governance design should not exclusively strive for standardization but remain sensitive to complementor needs. Moreover, accommodating complementor needs through governance design is not enough. In order to maximize complementor dedication, rules also need to be practiced situationally in both a flexible and a benevolent way. Our findings contribute to the literature on platform governance and broader governance literature.

Keywords: Software platform ecosystems, complementor dedication, platform governance, rule adequacy, governance practices, flexibility, benevolence, three-way interaction

[2] The research project has been conducted in collaboration with Thomas Huber, Jens Dibbern, and Oliver Krancher. Thomas Hurni was the main contributor.

3.1. Introduction

In the past decade, major software companies, including Apple, Google, Microsoft, and SAP, have begun to offer their solutions as software platforms, thereby becoming platform owners (Parker, Van Alstyne, & Choudary, 2016; Tiwana et al., 2010). In their new role as platform owners, these companies have attracted large numbers of complementors that offer wide varieties of complementary software applications (Anderson Jr., Parker, & Tan, 2014; Boudreau, 2010; Iansiti & Levien, 2004; Parker, Van Alstyne, & Jiang, 2017). Given the unprecedented number of these complementors, platform owners face the challenge of effectively and efficiently governing their ecosystems (Tiwana et al., 2010; Wareham et al., 2014). Hereof, one fundamental, yet under-studied managerial objective is complementor dedication, i.e., the extent to which a complementor is devoted and faithful to a particular platform owner, and continuously willing to invest in the partnership with the platform owner. As such, complementor dedication is a highly desirable governance objective that comes with the promise of an ongoing generation of add-on value to the platform (Benlian et al., 2015; Boudreau & Haigu, 2009; Sarker et al., 2012; Tiwana, 2013).

Governing toward complementor dedication is an extremely challenging task because dyadic contracts and other conventional governance mechanisms are not readily applicable to the platform ecosystems context. Instead, governing platform ecosystems requires platform owners to strike a balance between standardizing across many dyadic partnerships while still being sensitive to the local needs of individual complementors (Ghazawneh & Henfridsson, 2013; Huber et al., 2017; Pouloudi & Whitley, 1997; Wareham et al., 2014; Xiao, Xie, & Hu, 2013). As such, governance in platform ecosystems is not a dyadic one-to-one problem but a multilateral one-to-many problem. To solve this problem, platform owners design highly scalable governance mechanisms (Tiwana et al., 2010), referred to as rules (Huber et al., 2017). These rules are standardized but also designed to secure the interests and to address the needs of a multitude of complementors. Even the most adequate rules can reach their limits when confronted with unforeseen circumstances (Huber et al., 2017; Wareham et al., 2014). To overcome these adaptive limits, recent research suggests that it is imperative to vary situationally how rules are practiced in particular partnerships (Huber et al., 2017; Wareham et al., 2014). For example, a platform owner may stretch the ecosystem-wide rules in a particular situation to provide a complementor with additional resources that go beyond the stipulated. In return, the complementor may reciprocate by making additional investments in its partnership and thus become more dedicated (Huber et al., 2017). Even though prior research is indicative of the importance of variation in both designing and practicing rules, the question of how these

two aspects of governance jointly drive complementor dedication has yet to be understood. Therefore, we ask the following research question: *How does the interplay between designing rules and how these rules are practiced influence complementor dedication to a platform?*

To address this research question, our study adapts key concepts from broader research on the governance of more traditional inter-firm relationships to the new context of platform ecosystems. Specifically, we (1) transform the traditional constructs of contractual and relational governance into the novel contextualized concepts of rule adequacy and rule practices and (2) develop context-sensitive hypotheses predicting a complementary relationship between rule adequacy and benevolent and flexible rule practices on complementor dedication. We test our hypotheses using survey data from 181 complementors collaborating with a platform owner each. Our results show that rule adequacy independently strengthens complementor dedication. However, this relationship is strongest if rule practices are simultaneously benevolent and flexible in contrast to being either benevolent or flexible. Our work contributes to research on platform ecosystems by introducing the novel concept of rule adequacy and pointing to its complex and symbiotic interplay with benevolent and flexible rule practices. Our findings contribute to a better understanding of platform governance by showing how to design ecosystem-wide rules to govern complementor dedication effectively, whose practices fully actualize the potential of ecosystem-wide rules, and by providing new insights to the debate on the complementary vs. substitutional relationship of governance mechanisms.

The remainder of this paper is organized as follows. First, we adapt classic concepts from the inter-organizational governance literature to the context of platform ecosystems and then build on this theory contextualization to develop our hypotheses. Then we describe our research method, followed by the presentation of results and the discussion of our findings. We end our article by highlighting the contributions, implications, and limitations of the study.

3.2. Theory Contextualization

Our theory development draws on recent advances in the IS and management discipline that stress the importance and value of context-specific theories (Hong, Chan, Thong, Chasalow, & Dhillon, 2014; Johns, 2006). We follow Hong et al.'s (2014) guidelines for context-specific theorizing in IS by adapting established governance concepts (i.e., contractual and relational governance) that are relevant to the research domain of interest (i.e., software ecosystems), but not directly applicable because governance in this context is ripe with "unorthodox twist[s]" (Tiwana et al., 2010, p. 680). Specifically, we contextualize this theory by using past research

on platform ecosystems to decompose core constructs into contextual factors and to incorporate contextual factors as moderators of relationships (Hong et al., 2014).

3.2.1. Contextualizing the Objective of Governance: Complementor Dedication in Platform Ecosystems

An important governance objective in more traditional inter-organizational arrangements, such as joint ventures or outsourcing partnerships, is to mitigate agency hazards (Eisenhardt, 1985; Kirsch, 1996). For example, the vendor in a software outsourcing relationship acts as a principal who creates and exercises governance mechanisms, such as formal contracts, with the goal to safeguard against opportunistic behaviors on the part of the vendor who acts as an agent (Benaroch, Lichtenstein, & Fink, 2016). In the context of platform ecosystems, however, platform owners and complementors are not in a traditional principal-agent relationship, i.e., "the platform owner does not hire module developers to do a task specified by the former" (Tiwana et al., 2010, p. 680). Instead, complementors decide for themselves what they will do as members of the ecosystem. For example, complementors determine themselves what kind of software product they develop (such as a game, a productivity app, or a health app), the characteristics this product should have (e.g., its features and qualities), and how they will achieve these goals. So yet governance is ubiquitous in platform ecosystems, making it plausible that it serves an objective other than mitigating agency hazards faced by the platform owner (Tiwana et al., 2010).

Prior research in the context of platform ecosystems suggests that one crucial governance objective is to influence the complementors' willingness to join an ecosystem. For example, research has shown that by providing a modular platform with standardized interfaces, platform owners can attract a plethora of complementors to join an ecosystem (Anderson Jr. et al., 2014; Boudreau, 2010; Iansiti & Levien, 2004; Parker et al., 2017). Moreover, recent research has found that by partitioning decisions rights in a way that is congruent with the microarchitecture of an application, platform owners can prevent complementors from deserting their platform (Tiwana, 2015). We follow the central idea of this most recent research by investigating complementor dedication as an essential governance objective in the context of platform ecosystems. To some extent, complementor dedication can be seen as the inverse of deserting the platform, i.e., while platform desertion is about abandoning a platform (Tiwana, 2015), dedication refers to the extent to which a complementor is devoted, faithful, and willing to invest in the partnership with a platform owner. For platform owners, dedicated complementors are of vital importance, because dedicated complementors are more likely to continually acquire and create new platform-specific resources and thereby continuously generate additional value

for the platform (Boudreau & Haigu, 2009; Tiwana, 2013). However, because complementors are relatively small companies that partner with considerably larger and more powerful platform owners, dedicating to a platform makes complementors vulnerable for opportunistic behavior on the part of the platform owner (Kude et al., 2012). Therefore, when platform owners want to govern toward complementor dedication, they need to consider this vulnerability.

3.2.2. Contextualizing the Scope of Governance Mechanisms: Multilateral Governance in Platform Ecosystems

In traditional inter-organizational arrangements, such as joint ventures and outsourcing partnerships, governance mechanisms are dyadic. As such, governance involves two actors (e.g., an outsourcing client and an outsourcing vendor), where one actor (e.g., the client) regulates and adjusts the other actor's (e.g., the vendor) behavior by selecting and enacting contractual and relational governance mechanisms (Goo, Kishore, Rao, & Nam, 2009; Huber, Fischer, Dibbern, & Hirschheim, 2013). While contractual governance emphasizes the importance of contracts and their exercise as formal control, relational governance relies on informal control based on shared norms (Bensaou & Venkatraman, 1996; Goo et al., 2009; Huber et al., 2013). Research on relational governance emphasizes the importance of cooperative relational norms such as flexibility and benevolence explicitly (Goo et al., 2009; Huber et al., 2013; Ring & Van de Ven, 1994b).

However, in the context of platform ecosystems, governance is not a dyadic one-to-one problem but a multilateral one-to-many problem (Huber et al., 2017; Tiwana et al., 2010), i.e., one platform owner needs to govern hundreds or even thousands of complementors (see Figure 4). Consequently, conventional dyadic governance mechanisms such as an IS outsourcing contract or historically grown informal relationships may not be feasible to address this multilateral one-to-many problem. Rather than being tailored to the needs of one specific dyad, governance mechanisms have to be standardized across a large number of dyads (Huber et al., 2017).

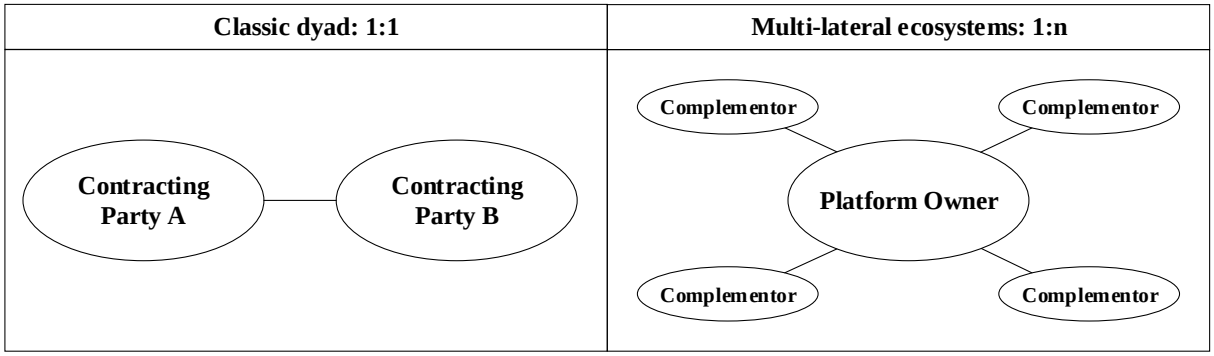

Figure 4: Classic Dyadic vs. Multilateral Governance

3.2.3. Contextualizing Contractual Governance: Rule Adequacy in Platform Ecosystems

Prior research in the context of platform ecosystems has shown that rather than governing platform partnerships through dyadic contractual mechanisms, platform owners resort to more "scalable" mechanisms (Tiwana et al., 2010, p. 676), including technical interface standards, standard partner contracts, and partner programs (Huber et al., 2017; Wareham et al., 2014). We refer to such scalable formal governance mechanism as *rules*, which are defined as the generalized mechanisms that uniformly regulate the behaviors of all complementors in the ecosystem (Huber et al., 2017). In line with prior research, we focus on those rules that regulate resource access between platform owner and complementor (Huber et al., 2017; Wareham et al., 2014). This focus entails stipulations about property rights, the resources complementors and platform owners gain access to, and the conditions under which access needs to be granted (Huber et al., 2017). Platform owners are usually powerful enough to unilaterally impose standardized rules on all complementors of their ecosystem (Wareham et al., 2014). We build on most recent research, suggesting that the crux to adequate rule design is to strike a balance between standardizing across contexts to efficiently orchestrate large ecosystems *and* being sensitive to the local needs of individual complementors (Huber et al., 2017). This broad perspective, which acknowledges both the platform owners' desire toward ecosystem-wide standardization and the complementors' desire toward dyadic localization, goes beyond the majority of prior research that has predominantly taken a platform owner perspective, factoring out the needs of complementors (Boudreau, 2010, 2012; Boudreau & Haigu, 2009; Boudreau & Lakhani, 2009; Wareham et al., 2014). A recent review of the platform literature emphasized that "the perspective of complementors, and their incentives to link with a specific platform, is an often overlooked but important area of research" (McIntyre & Srinivasan, 2017, p. 142).

A critical incentive for complementors to enter a collaboration with a platform owner is protection. Collaborating with a platform owner always requires some investment on the part of the complementor (such as acquiring certificates or building-up platform-specific resources) and hence bears the risk that the investment may not pay off. For example, a certification for a specific platform may become worthless if the platform does not gain traction with customers, or is discontinued by the platform owner. From a complementor perspective, protection of interests is therefore highly desirable in a platform partnership (Huber et al., 2017; Kude et al., 2012). Complementors are independent companies that are free to accept or reject the rules of an ecosystem (e.g., by joining or abandoning it). When designing rules, platform owners, therefore, need to factor the complementors' desire for interest protection into their standardization calculus. We capture this in our concept of *rule adequacy*, defined as the extent

to which complementors perceive the standardized ecosystem-wide rules as securing their interests as opposed to only securing the interests of the platform owners and their aspirations for standardization.

3.2.4. Contextualizing Relational Governance: Practicing Rules in Platform Ecosystems

Given their standardized nature, ecosystem-wide rules are neither sensitive to all local needs of individual complementors, nor anticipate all future eventualities. In traditional inter-firm arrangements, relational governance mechanisms would compensate for this weakness (Huber et al., 2013). Such relational governance is to a lesser extent characterized by specific controller prescriptions and refers to informal interactions based on trust, shared norms, and values (Goo et al., 2009; Huber et al., 2013; Lioliou, Zimmermann, Willcocks, & Gao, 2014). However, relational governance that is entirely independent of specific controller prescriptions is unlikely to occur in a 1:n setting. Instead, relational governance manifests as variations in practicing ecosystem-wide rules (Huber et al., 2013; Wareham et al., 2014). The notion of variation in practicing ecosystem-wide rules acknowledges that rules are carried out in specific actions by specific people in specific places, times, and situations. Even though the written formal rules always serve as a basis for these actions (Goo et al., 2009), actors still have some leeway regarding the particular courses of action (Feldman & Pentland, 2003). Platform owners can use this leeway to adapt governance practices to the particular needs of the situation or dyad (Huber et al., 2017).

Prior research in the context of platform ecosystems has shown that as trust and shared norms develop in a partnership, platform owners use their leeway to practice rules with more or less benevolence and flexibility (Huber et al., 2017). *Flexible rule practices* refer to the extent to which complementors perceive the practice of ecosystem-wide rules by the platform owner as responsive (based on Huber et al. (2017)). They are about giving complementors access to resources just when they need them. For example, platform owners can proactively grant access to resources just when a complementor is about to exploit a specific business opportunity. *Benevolent rule practices* describe the extent to which complementors perceive the practice of the ecosystem-wide rules as kind and generous (based on Huber et al. (2017)). They are about granting complementors access to resources that exceed the resources stipulated by the rules. For example, platform owners can grant complementors access to particularly valuable resources that are just right to solve a business problem at hand (Huber et al., 2017).

Although case study-based evidence has made various suggestions concerning the suitability of practice variations to resolve the tension between keeping governance costs low and

maximizing co-creation value (Huber et al., 2017), the general effects of practice variations on complementor dedication are to be examined. In the following section, we develop hypotheses on how the adequacy of ecosystem-wide rules and variations in practicing ecosystem-wide rules from a complementor's perspective symbiotically influence complementor dedication. Table 4 provides the contextualized definitions of the study's core constructs.

Table 4: Core Constructs and Definitions

Construct	Definition	Role in Nomology
Perceived Rule Adequacy	The extent to which complementors perceive the ecosystem-wide rules to secure their interests as opposed to only securing the interests of the platform owner. • Based on Child, Chung, and Davies (2003); Gefen and Pavlou (2012) • Contextualized with Huber et al. (2017); Tiwana et al. (2010); Wareham et al. (2014)	Predictor
Perceived Flexibility in Practicing Rules	The extent to which complementors perceive the enactment of ecosystem-wide rules (e.g., rules, codes of conduct, or partnership charters) by the platform owner as responsive to the complementor's needs. • Based on Boyle, Dwyer, Robicheaux, and Simpson (1992); Heide and John (1992) • Contextualized with Huber et al. (2017); Wareham et al. (2014)	Moderator
Perceived Benevolence in Practicing Rules	The extent to which complementors perceive the enactment of the ecosystem-wide rules (e.g., rules, codes of conduct, or partnership charters) by the platform owner as kind and generous. • Based on McKnight, Choudhury, and Kacmar (2002) • Contextualized with Huber et al. (2017); Wareham et al. (2014)	Moderator
Complementor Dedication	The extent to which a complementor is devoted, faithful, and willing to invest in the partnership with a platform owner • Based on Anderson (1985); Heide and John (1992) • Contextualized with Tiwana (2015)	Dependent Variable

3.3. Hypotheses Development

Our hypotheses about the symbiotic interplay between rule adequacy and rule practices build on the theoretical argument that to successfully foster complementor dedication, platform governance needs to find a balance between satisfying the local needs of individual partnerships and the global needs of the entire ecosystem. Specifically, we hypothesize that higher degrees of rule adequacy will lead to higher levels of dedication. However, due to their standardized nature, rules are limited in effectively addressing complementors' needs in all conceivable situations (Huber et al., 2017), which lends importance as to how ecosystem-wide rules are practiced in particular partnerships. We argue that the positive relationship between rule

adequacy and complementor dedication is stronger if rules are practiced flexibly and benevolently (see Figure 5). In the following, we justify our hypotheses.

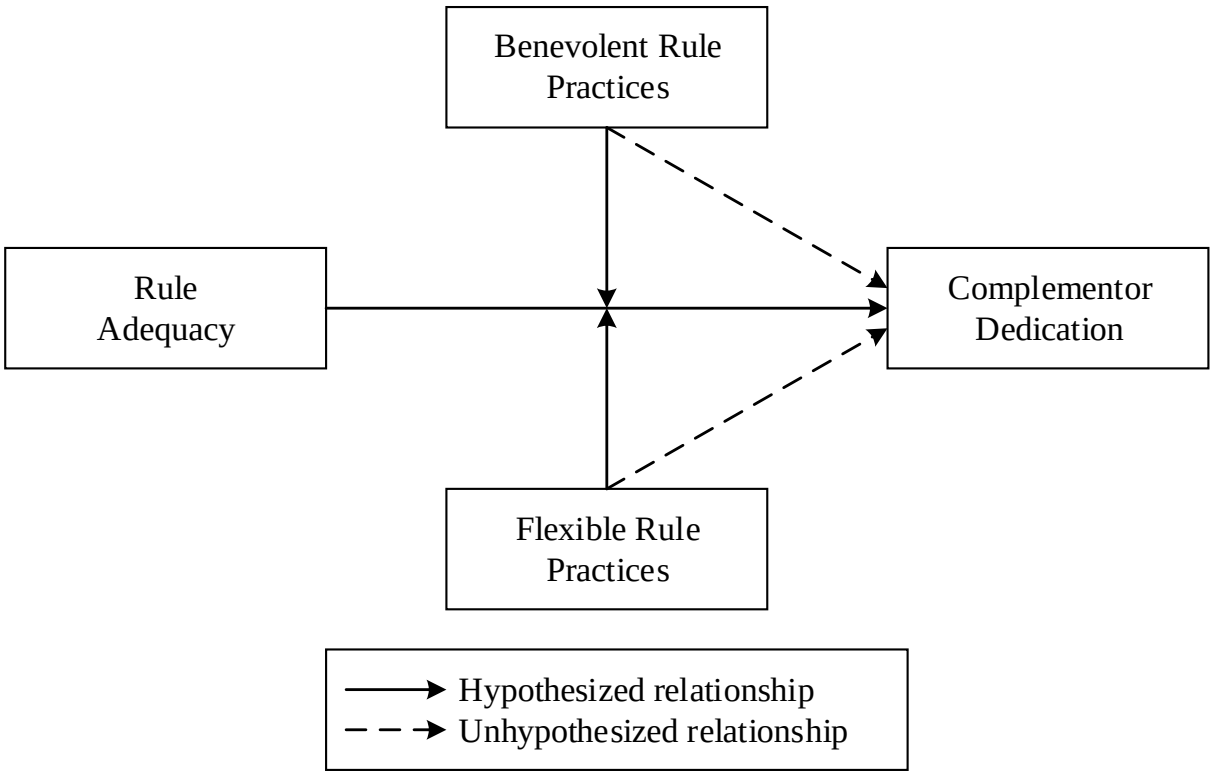

Figure 5: Research Model

3.3.1. The Direct Effect of Perceived Rule Adequacy

Due to the 1:n network structure of platform ecosystems, partnerships between platform owners and complementors are characterized by asymmetric resource dependencies (Kude et al., 2012). On the one hand, platform owners make ecosystem investments with the goal to create and maintain ecosystem resources that are valuable for many, if not all, complementors within a respective ecosystem (Boudreau & Haigu, 2009; Ghazawneh & Henfridsson, 2013; Kude et al., 2012; Wareham et al., 2014). Such ecosystem resources entail the software platform, development suites, code repositories, and marketing tools (Ghazawneh & Henfridsson, 2013; Kude et al., 2012; Wareham et al., 2014). On the other hand, complementors make platform-specific investments by creating and maintaining resources that are significantly more valuable in a particular partnership with a platform owner than outside of it (Dyer & Singh, 1998). For example, complementors acquire platform-specific technological knowledge, make platform-specific certifications, and build up networks of interpersonal relationships with the staff of the platform owner (Kude et al., 2012; Wareham et al., 2014).

Due to these asymmetric resource investments, platform owners hardly depend on individual complementors but rather on the ecosystem as a whole, while complementors highly depend on

the focal platform owner (Huber et al., 2017; Kude et al., 2012). This asymmetric dependence, in turn, means that platform owners only face minor threats from opportunistic behavior on the part of individual complementors, while complementors face significant threats of opportunistic behavior on the part of a platform owner (Kude et al., 2012). For example, once a complementor has made a platform-specific investment, this investment is not readily transferable to another platform, which makes the complementor vulnerable vis-à-vis the platform owner, as the platform owner can withhold valuable resources from the complementor.

Complementors that feel threatened by their platform owner are likely to become less dedicated (Foss & Foss, 2005; O. E. Williamson, 1985). For instance, if a complementor feels threatened by a platform owner, it is less likely that this complementor will be willing to acquire additional platform-specific certifications (Huber et al., 2017). In traditional inter-firm partnerships, risks associated with specific investments would be safeguarded by the creation of dyadic contracts (Foss & Foss, 2005; O. E. Williamson, 1985). In platform partnerships, however, platform owners avoid dyadic contracting. Instead, they impose standardized rules on all of the complementors in their ecosystem (Boudreau & Haigu, 2009; Wareham et al., 2014). Since platform owners have a genuine interest in dedicated complementors (Tiwana, 2015), they design the rules in such a way that they lower the complementors' fear of opportunism on the part of the platform owner (Wareham et al., 2014).

The perceived adequacy of these rules, however, may vary across partnerships for two reasons. First, rules can be designed in varying ways across ecosystems (Gulati et al., 2012). Specifically, rules can promise more or less valuable resources to complementors (Ghazawneh & Henfridsson, 2013; Wareham et al., 2014) and they can make this promise with varying legal certainty (Foss & Foss, 2005; O. E. Williamson, 1985). For example, the rules of one ecosystem may promise highly sophisticated development resources as part of the legally binding ecosystem contract, whereas the rules of another ecosystem may promise less sophisticated development resources in the form of a non-binding declaration of intent. Second, even if rules are the same—as is the case for the complementors within an ecosystem—perceptions of adequacy may still vary across complementors because complementors can develop their understanding of these rules (Feldman & Pentland, 2003). Such development of subjective understandings is likely to occur in platform ecosystems because they are populated by large numbers of highly heterogeneous complementors (Boudreau, 2012). For example, while the resources promised by the rules may be highly valuable for complementors acting in one niche, they could be useless for complementors in another niche (Huber et al., 2017). In a similar vein, legal provisions may effectively safeguard the specific investments of one complementor but

not of another. Thus, the more valuable complementors perceive the promised resources to be and the higher they perceive their legal protection, the less they fear opportunistic behavior on the part of the platform owner. Therefore, we expect complementors to be more prone to intensifying a partnership with a platform owner if adequate rules are in place to protect them from opportunistic threats. Hence, we hypothesize:

H1: Higher perceived rule adequacy is associated with higher complementor dedication.

3.3.2. The Moderating Effects of Flexible and Benevolent Practices

Because rules are standardized, they are limited in their ability to foresee and respond to every future eventuality that may be caused by the unpredictability and instability of the external environment (Rindfleisch & Heide, 1997; O. E. Williamson, 1985). Thus, even though adequate rules may safeguard complementors from behavioral uncertainty, they do expose them to environmental uncertainty.

To capture how platform owners react to the heterogeneous and changing contexts of specific dyads within their ecosystem, we build on the idea that platform owners situationally adjust the way they practice rules. For example, rapidly changing customer needs or unexpected business opportunities can require a specific complementor to enhance its software application in a way that requires support from the platform owner beyond the support stipulated by the rules. In such a situation, the platform owner may decide to stretch these rules by giving the complementor privileged access to scarce ecosystem resources (Huber et al., 2017).

However, even though platform owners have leeway as to how they practice governance in specific situations and partnerships, these governance practices are usually not detached from the ecosystem-wide rules either (Huber et al., 2017). This insight points to an interplay between rule adequacy and rule practices—which is similar to the discussion on the broader governance literature on the complementarity and substitutional relationships of formal contractual and informal relational governance (Huber et al., 2017; Poppo & Zenger, 2002). According to the substitution perspective, practices would replace or dampen the original rules, whereas, according to the complementarity perspective, rule practices would compensate for the weaknesses of rules (Huber et al., 2013). Prior research in the context of software ecosystems has shown that when platform owners show variations in practicing rules, the rules still serve as a reference point (Huber et al., 2013). For example, rather than to informally figure out solutions that are independent of the rules, they look for smart ways of repurposing the existing rules (Huber et al., 2013). Thus, we do not expect rule practices to replace the rules. Nor do we expect them to dampen the rules—that would be the case if practice variations were as

widespread in the ecosystem that they would undermine the premise of standardized governance. However, prior research provides little evidence for such widespread use and the consequent dampening effect. Quite the opposite is the case, as variations in practicing rules appear to be highly localized and limited to specific situations. Thus, a substitutional interplay between rule adequacy and rule practices appears unlikely.

While prior research provides no support for the substitution perspective, there is some evidence pointing to a complementary interplay. Specifically, prior research suggests that rules and rule practices have unique but jointly valuable strengths that can compensate for the weaknesses of the other (Huber et al., 2013). On the one hand, rules are particularly strong in economizing on governance costs but not in addressing local needs. On the other hand, rule practices are weaker in economizing on governance costs but stronger in addressing local needs of individual complementors (Huber et al., 2017). In other words, when rules reach their limits in addressing complementors' local needs, variations in practicing the rules may sometimes compensate for this weakness, thus complementing the rules (Huber et al., 2017; Sarker et al., 2012; Wareham et al., 2014).

This study investigates the complementary effect of two types of variations in practicing rules, i.e., benevolent and flexible rule practices. Benevolent practices imply that complementors are granted access to particularly valuable resources—i.e., just the right resources (Huber et al., 2017)—while flexible practices imply that complementors are granted access to resources at a particular point in time—i.e., just at the right time (Huber et al., 2017). We expect that the two rule practices strengthen the effect of perceived rule adequacy on complementors' dedication, as they help to leverage and actualize the potential benefits of rules. Therefore, we hypothesize:

> *H2a: The positive relationship between perceived rule adequacy and complementor dedication is stronger when rules are practiced with higher degrees of benevolence.*
>
> *H2b: The positive relationship between perceived rule adequacy and complementor dedication is stronger when rules are practiced with higher degrees of flexibility.*

Moreover, we expect variation in practicing rules to be the strongest if they are simultaneously benevolent and flexible, i.e., if complementors receive just the right resources at just the right time. Two arguments favor such a more complex (three-way) interaction: First, if practices are flexible but not benevolent, platform owners react at the right time, but not with the right resources. This condition will undermine the complementor's ability to respond to unforeseen circumstances effectively. Therefore, the complementor will be less prone to make additional

platform-specific investments and less faithful to the platform. Likewise, if practices are benevolent but not flexible, platform owners react with valuable resources but not at the right time. Again, this will undermine the complementor's ability to leverage the business opportunities entailed in unforeseen circumstances fully. In return, the complementor may suspend additional platform-specific investments and be less faithful to the platform owner. Thus, rule practices will only fully actualize the potential of rules if they are both benevolent and flexible.

Second, if a platform owner flexibly adapts governance practices to accommodate the needs of a complementor, it is vital for the platform owner to comply with the broader relational values of the ecosystem, such as benevolence. Otherwise, highly flexible governance practices can make the platform owner look like an arbitrary despot (Huber et al., 2017). If the platform owner leaves such a negative impression, it may lead to increased uncertainty on the part of the complementors, paralyzing their dedication. Thus, the potential of the ecosystem rules only actualizes completely, if complementors perceive flexible rule practices as benevolent. Therefore, we hypothesize:

> *H3: The positive relationship between perceived rule adequacy and complementor dedication will be strongest when both benevolence and flexibility are high (as opposed to either or both low).*

3.4. Method

3.4.1. Data Collection

Data was collected through an online survey as part of a larger research project. The survey was sent to software companies, i.e., companies operating in the software industry. Our target population was those software companies that currently act as complementors in software ecosystems. Our study was conducted in a single European country (Switzerland) to prevent confounding by cross-national differences such as cultural and legal norms. To ensure the highest possible coverage of software companies in Switzerland, we drew on a commercial contact database. Additionally, we matched the contacts from the commercial database with the available contact databases of multiple industry associations in Switzerland as well as with the contact database of a leading Swiss IT consulting firm to double check for a comprehensive list. Then we manually screened every single contact to verify each company's existence and relation to the broader software industry. The overall contact screening took place in the summer and fall of 2014. From initially about 15,000 contacts, 4,955 hand-sorted contacts remained in the database.

Data collection was initiated in May 2015 and relied on a commercial online survey tool (Qualtrics). Invitations for the survey were sent out by email to senior members of the companies. Overall, 632 surveys were completed (12.75% response rate). All 632 companies were asked to provide information on business development. We also asked all companies whether they were collaborating with a platform owner. For this purpose, we defined our intended understanding of what constitutes a software platform (e.g., *"Under software partner, we understand legally independent companies which develop own software based on a software platform [e.g. extension of SAP R\3], or configure an existing platform [e.g. parameterization of SAP ERP in customer projects], and are members of the partner program of the corresponding platform owner"*). From the 632 companies, 196 indicated to be in a relationship with a platform owner. These 196 companies were then asked questions about their relationship with their most important platform owner.

We screened the responses of the 196 companies that indicated to be in a relationship with a platform owner using the recommendations by Hair, Black, Babin, Anderson, and Tatham (2006). We dropped fifteen responses because they were either unengaged or showed missing values in more than 10% of the survey items (Hair et al., 2006, p. 36). This correction resulted in a final sample of 181 cases for our study. Of these 181 cases, one case exhibited a missing value in one response item, which we subsequently replaced using the hot deck imputation method (i.e., the missing value was replaced with valid values from similar observations) (Hair et al., 2006, p. 53). We graphically examined these 181 cases using a statistical software package (IBM SPSS Statistics 25). Skewness values below 1 and kurtosis values below 1.5 were considered acceptable (Hair et al., 2006, p. 36).

3.4.2. Measurement Development

Every construct as part of our hypotheses relied on multi-item, five-point Likert scales. These constructs built on established measures and were contextualized to our key concepts. The items for our predictor variable, *perceived rule adequacy* are rooted in the idea of standardized rules in platform ecosystems (Huber et al., 2017; Tiwana et al., 2010; Wareham et al., 2014). Moreover, existing related constructs from the broader governance literature guided our formulation of new items (Child et al., 2003; Gefen & Pavlou, 2012). Likewise, the items for our moderating variables, *perceived benevolence* and *perceived flexibility in practicing rules* were rooted in the idea of flexible and benevolent rule practices in platform ecosystems (Huber et al., 2017) and existing conceptualizations of similar concepts from the governance literature guided our formulation of items (Boyle et al., 1992; Heide & John, 1992; McKnight et al., 2002). The items for the dependent variable, *complementor dedication*, were adapted from

Heide and John (1992) and Anderson (1985) and contextualized using Tiwana (2015). The items for each construct and their origin are presented in the appendix.

To validate our contextualized measures, we followed the suggestions of MacKenzie, Podsakoff, and Podsakoff (2011) to establish content validity. Specifically, we conducted multiple rounds of internal assessments and refinements among the authors. After having completed the assessment and refinement process, we then invited four scholars and four practitioners (two consultants and two software business owners), all of them know about the platform topic, to screen our items for intelligibility. The feedback from this screening resulted in further refinements after which the authors concluded that the items had reached the necessary quality level for a formal pre-test. The pre-test was conducted in another German-speaking country with the goal to evaluate the reliability of the constructs statistically. Cronbach's Alphas above 0.78 indicated sufficient reliability (Hair et al., 2006), and a factor analysis of all items identified the envisaged constructs.

3.4.3. Control Variables

To ensure that our results on our four hypothesized relationships would not be confounded, we examined prior qualitative and quantitative research on platform ecosystems and related fields to identify relevant control variables. First, because relational norms usually emerge over longer periods of time (Ring & van de Ven, 1994a), we controlled for the *age of the relationship*, which we measured as the number of years a complementor had maintained a partnership with a platform owner (Lee & Kim, 1999; Tiwana, 2015). Second, because complementors might be more dedicated when they are assigned a dedicated partner manager (in contrast to being randomly assigned members of a partner management organization), we controlled for the existence of a *partner manager* (Huber et al., 2017). Third, because larger complementors are more likely to create the significant co-creation opportunities that make platform owners willing to vary rule practices, we controlled for the *complementor's size* using the self-indicated count of full-time employed equivalents in Switzerland (Roberts & Grover, 2012). Fourth, we controlled for whether the complementor is *multi-homing* its application (i.e., the simultaneous participation in more than one platform ecosystem) (Bakos & Katsamakas, 2008; Choi, 2010; Mantena & Saha, 2012; Tiwana, 2015). Fifth, we controlled for perceived *dependence*, which was measured using four items that assessed the dependence of a complementor on the platform owner (Ganesan, 1994; Lee & Kim, 1999; Lusch & Brown, 1996; Noordewier, John, & Nevin, 1990; Rao, Brown, & Perkins, 2007).

3.4.4. Instrument Validation

Since our constructs were conceptualized for our study, assessing their convergent and discriminant validity through factor analysis procedures was of utmost importance. To examine convergent validity, we calculated composite reliability (CR), Cronbach's Alpha (α), average variance extracted (AVE), and the standardized factor loadings using confirmatory factor analysis procedures (see Table 5) (Gefen & Straub, 2005). In support of convergent validity, CR- and α-values for all our multi-item constructs (i.e., perceived rule adequacy, perceived benevolence in practicing rules, perceived flexibility in practicing rules, and perceived dependence) were well above the threshold of 0.7 for multi-item constructs (Hong et al., 2014). Moreover, AVE was well above the threshold of 0.5 for all multi-item constructs. All standardized factor loadings were higher than 0.7. The results of an exploratory factor analysis further corroborate convergent validity (Campbell & Fiske, 1959; DeVellis, 2016, p. 153) by reproducing the five latent factors of our research model (see results in Appendix B).

Table 5: Confirmatory Factor Analysis Results

Construct Indicators	Item Loading (T-Values)	Cronbach's Alpha (α)	CR	AVE
Perceived Rule Adequacy		0.85	0.91	0.77
RuleAdeq_1	0.92 (43.445**)			
RuleAdeq_2	0.92 (47.580**)			
RuleAdeq_3	0.79 (16.416**)			
Perceived Benevolence in Practicing Rules		0.90	0.94	0.83
BenePrac_1	0.91 (46.04***)			
BenePrac_2	0.93 (32.54***)			
BenePrac_3	0.89 (17.79***)			
Perceived Flexibility in Practicing Rules		0.89	0.93	0.81
FlexPrac_1	0.940 (15.16***)			
FlexPrac_2	0.935 (16.72***)			
FlexPrac_3	0.827 (6.63***)			
Perceived Dependence		0.85	0.90	0.68
Dep_1	0.823 (4.49***)			
Dep_2	0.747 (3.80***)			
Dep_3	0.886 (5.62***)			
Dep_4	0.832 (17.77***)			
Complementor Dedication		0.89	0.92	0.75
Ded_1	0.874 (33.07***)			
Ded_2	0.919 (55.39***)			
Ded_3	0.909 (36.25***)			
Ded_4	0.749 (14.85***)			

***p<.01

To examine discriminant validity, we checked cross-loadings, AVE, and conducted an exploratory factor analysis. The results of these analyses strongly support discriminant validity. First, we scrutinized whether each item loaded higher on its construct than on any other

construct (Gefen & Straub, 2005). For each item, the difference between the loading of the item on its construct and the cross-loadings of the item on any other construct was well above 0.2. Second, the square roots of the AVE values exceeded correlations between latent constructs (Gefen & Straub, 2005). Specifically, the square root of the lowest AVE value (.68) was well above the highest correlation between the two latent constructs (.50) (see Table 5). Third, the exploratory factor analysis reproduced the five latent factors. Collectively, our factor analysis strongly indicates that our concept contextualization effort succeeded.

Given our reliance on a single instrument for gathering our data, common method bias is a potential threat to validity (Podsakoff, MacKenzie, Lee, & Podsakoff, 2003). However, it has been shown that tests of interaction effects, which are at the heart of our article, are not threatened by common method bias (Siemsen, Roth, & Oliveira, 2010). To examine the potential role of common method bias in testing the hypothesized main effect (i.e., H1), we applied the full collinearity variance inflation factors (VIF) technique, which was suggested by Kock (2009) and Kock and Lynn (2012).[3] For this purpose, we created a dummy variable based on random values from 0 to 1 on which we pointed at every construct of our model. Common method bias is indicated when the VIF is higher than an accepted conservative threshold of 3.3 (Kock, 2009). None of the VIF values was higher than 3.3 (with a range from 1.04 to 1.42), providing thus no evidence for common method bias.

Table 6: Discriminant Validity: Inter-Construct Correlations (Bold: Square Roots of AVE)

	1	2	3	4	5
1 Perceived Rule Adequacy	0.77				
2 Perceived Benevolence in Practicing Rules	0.50	0.83			
3 Perceived Flexibility in Practicing Rules	0.20	0.36	0.81		
4 Perceived Dependence	-0.15	-0.12	-0.12	0.68	
5 Complementor Dedication	0.37	0.36	0.19	0.14	0.75

3.4.5. Regression Approach

We relied on ordinary least squares (OLS) regression and used standardized average scores for all regression variables. Given our focus on interaction effects, we preferred OLS regression

[3] There is some disagreement among scholars regarding the likelihood and nature of common method bias as calculated with the correlation marker technique, the confirmatory factor analysis marker technique, or the unmeasured latent method construct technique (Chin, Thatcher, & Wright, 2012; Richardson, Simmering, & Sturman, 2009). The full collinearity VIF technique has recently been suggested as a new technique that may overcome the limitations of alternative approaches.

over alternative approaches, such as partial least squares and covariance-based structural equations modeling, because OLS regression offers comparatively high statistical power for detecting interaction effects (Goodhue, Lewis, & Thompson, 2007).

To test our hypotheses, we built upon a four-step hierarchical regression strategy (see Table 8). In the first step (Model 1), we exclusively included control variables. In the second step (Model 2), we added the main effects of the hypothesized predictors. In the third step (Model 3), we added the two-way interactions, and in the fourth step (Model 4) the hypothesized three-way interaction effect.

We scrutinized whether the assumptions of OLS were met (Wooldridge, 2009, pp. 104-105). Histograms and q-q plots showed that the residuals of all models followed normal distributions and indicated that the assumption of normally distributed error terms was met. VIF were below 2, suggesting that multi-collinearity problems were not salient in the data. Scatter plots that related residuals to complementor dedication showed no departure from the assumption of homoscedastic error terms. In sum, our use of OLS regression was well aligned with OLS regression assumptions.

3.5. Regression Results

Table 7 shows the correlation matrix. The regression results are presented in Table 8. The first column (Model 1) shows the results related to the control variables. Partner manager (ß=0.38, $p<0.001$), relationship age (ß=-0.14, $p<0.05$), and dependence (ß=0.18, $p<0.05$) were significant positive predictors of complementor dedication, while the other control variables were statistically insignificant. Together, the control variables explained 19.9% of the variance in complementor dedication.

The second column (Model 2) shows the main effects of the three predictors of our theoretical model. H1 predicted a positive relationship between perceived rule adequacy and complementor dedication. The results show a significant positive association (ß=0.24, $p<0.01$), which supports H1. The main effects of perceived benevolence and perceived flexibility on complementor dedication were not hypothesized. Model 2 shows a significant positive main effect of perceived benevolence in practicing rules (ß=0.18, $p<0.05$) and an insignificant main effect of perceived flexibility in practicing rules (ß=0.04, $p>0.05$). Model 2 explains 32.5% of the variance in complementor dedication, which is a substantial and significant increase ($\Delta R^2 = 0.127$, $p < 0.001$) relative to Model 1.

Table 7: Correlation Matrix

		M	SD	1	2	3	4	5	6	7	8
1	*Complementor Dedication*	3.40	0.91								
2	*Perceived Rule Adequacy*	3.37	0.89	0.37**							
3	*Perceived Flexibility in Practicing Rules*	2.99	0.91	0.18*	0.20**						
4	*Perceived Benevolence in Practicing Rules*	3.28	0.78	0.36**	0.49**	0.35**					
5	*No. of Employees*	25.08	56.06	0.12	-0.05	0.08	0.01				
6	*Multi-homing*	0.51	0.50	0.07	0.06	0.01	0.07	0.09			
7	*Partner Manager*	0.55	0.50	0.39**	0.23**	0.21**	0.19*	0.33**	0.07		
8	*Relationship Age*	11.64	7.98	-0.14	-0.06	-0.04	-0.11	-0.06	0.08	-0.05	
9	*Perceived Dependence*	3.07	1.06	0.13	-0.15*	-0.12	-0.12	-0.12	-0.29**	-0.05	0.04

n = 181 *p <.05, **p <.01

The third column (Model 3) includes the two-way interaction effects, which allowed testing H2a and H2b. H2a and H2b predicted that the relationship between rule adequacy and complementor dedication is stronger when rules are practices with a higher degree of benevolence (H2a) and flexibility (H2b), respectively. Model 3 shows insignificant two-way interactions between rule adequacy and benevolent and flexible practices, which leads us to reject H2a and H2b.

The fourth column (Model 4) includes the three-way interaction effect, which allowed testing H3. H3 predicted that the relationship between perceived rule adequacy and complementor dedication is strongest when both perceived benevolence and perceived flexibility in practicing rules are high. Model 4 shows a significant positive three-way interaction (ß=0.10, p<0.01). The significant three-way interaction effect provides support for H3. Model 4 explains 37.1% of the variance in complementor dedication, which is a substantial and significant increase ($\Delta R^2 = 0.05$, $p < 0.05$) relative to Model 3, which supports the three-way interaction hypothesis.

Table 8: Regression Results

	Model 1 Controls	**Model 2 + Main Effects**	**Model 3 + Two-way Interaction Effects**	**Model 4 +Three-way Interaction Effects**
Intercept	0.02 (0.07)	0.01 (0.06)	-0.02 (0.07)	-0.03 (0.07)
No. of Employees	-0.01 (0.07)	0.05 (0.07)	0.06 (0.07)	0.06 (0.07)
Multi-homing	0.10 (0.07)	0.09 (0.07)	0.09 (0.07)	0.09 (0.06)
Partner Manager	0.38*** (0.07)	0.27*** (0.07)	0.27*** (0.07)	0.27*** (0.07)
Relationship Age	-0.14* (0.07)	-0.11 (0.06)	-0.12 (0.06)	-0.10 (0.06)
Dependence	0.18* (0.07)	0.24*** (0.07)	0.24*** (0.07)	0.27*** (0.07)
Rule Adequacy		0.25** (0.08)	0.25** (0.08)	0.21** (0.08)
Flexibility		0.04 (0.07)	0.04 (0.07)	-0.01 (0.07)
Benevolence		0.19* (0.08)	0.18* (0.08)	0.14* (0.08)
Rule Adequacy × Flexibility			0.08 (0.06)	0.03 (0.06)
Rule Adequacy × Benevolence			0.07 (0.06)	0.09 (0.06)
Flexibility × Benevolence			-0.06 (0.06)	-0.02 (0.07)
Rule Adequacy × Flexibility × Benevolence				0.11** (0.04)
Adjusted R2	0.18	0.29	0.30	0.33
R2	0.2	0.33	0.34	0.37
ΔR2	0.2	0.13	0.02	0.03
F	8.68***	10.37***	7.98***	8.26***
F Change (d.f.)	8.68*** (5, 18)	10.77*** (3, 17)	1.40 (3, 17)	7.86 ** (1, 17)

*p <.05, **p <.01, ***p <.001, n = 181, standardized coefficients shown

The plot presented in Figure 6 illustrates the interaction effects, with low (high) values referring to values that are one standard deviation below (above) the sample mean. Regarding these interaction effects, two observations are noteworthy: the slopes of the lines and the absolute values of complementor dedication. First, the steeper a slope, the stronger adequacy contributes to complementor dedication. In this regard, the line referring to highly perceived benevolence and flexibility in practicing rules (see the black line with the black triangles in Figure 6) shows the steepest slope. This indicates that a highly perceived rule adequacy contributed the strongest to complementor dedication when complementors perceived the rule practices to be both flexible and benevolent. However, when complementors perceived that the rule practices were either only flexible, only benevolent, or neither, the perceived rule adequacy contributed less strongly to their dedication. In other words, perceived rule adequacy appears to have the strongest effect on complementor dedication if complementors perceive rule practices to be both benevolent *and* flexible.

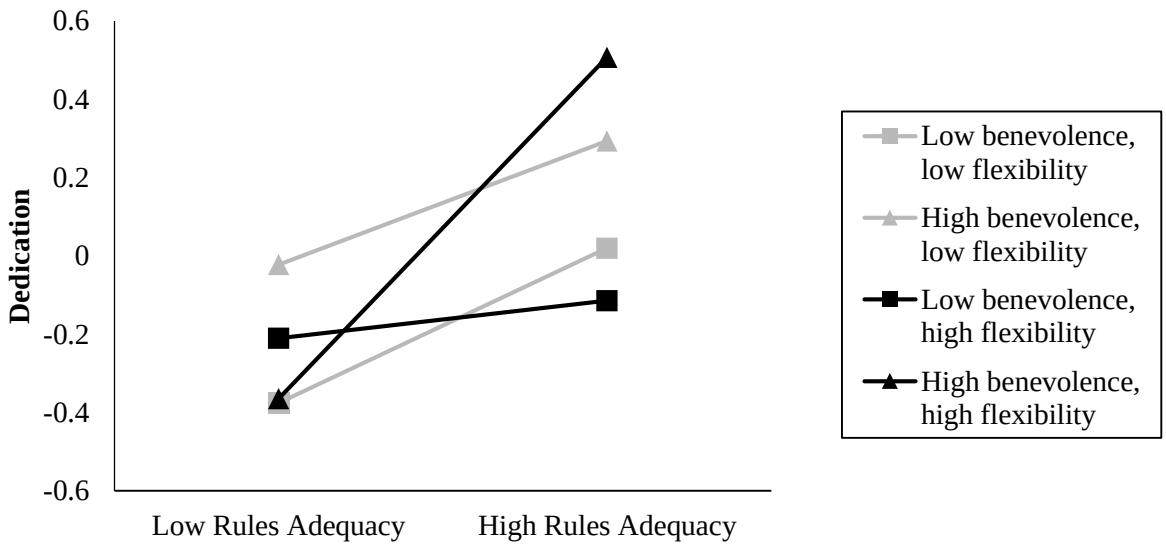

Figure 6: Interaction Plots

Second, complementor dedication is highest when the complementors perceive the rules as highly adequate and the rule practices as both highly flexible and highly benevolent (predicted standardized complementor dedication value of.51; see the black triangle in the upper right-hand area of the interaction plot). Importantly, this value is higher than the values predicted when any of the three governance dimensions is low. For instance, complementors are substantially less dedicated when they perceive the rule practices as being both highly flexible and highly benevolent but perceive the rules themselves as barely adequate (predicted complementor dedication value of -.36; see the black triangle in the lower left-hand area of the interaction plot). In a similar vein, complementors are also less dedicated when they perceive the rules as adequate and the rule practices as highly flexible but barely benevolent (predicted complementor dedication value of -.11; see the gray circle in the right-hand area of the interaction plot).

In sum, our analysis of interaction effects generally supports the idea of complementary interactions between rule adequacy and benevolent and flexible rule practices. However, this interplay is more complex than expected: We did not find support for two-way interactions (i.e., H2a and H2b) but only for three-way interactions. Thus, the benefits from an increase in rule adequacy are strongest when rules are practiced with high benevolence and high flexibility.

3.6. Discussion

The goal of this study is to theorize and test how the interplay between rules design and the way in which these rules are practiced influence complementor dedication to a platform. To achieve this goal, our study adapts key concepts from the governance literature to the context of

platform ecosystems (Hong et al., 2014). This contextualization incorporates the thus far overlooked perspective of complementors in the design calculus of effective platform governance, and it acknowledges the importance of dyadic level variations in rule performances. By doing so, we extend the applicability of established concepts from research on governance in more traditional inter-firm arrangements to ecosystems with a 1:n network structure. This theory contextualization provides the stage to develop hypotheses on the symbiotic effect of rule adequacy and rule practices on complementor dedication, which we tested using survey data from 181 complementors, each collaborating with a platform owner. Our results suggest that rule adequacy strengthens complementor dedication. This relationship is strongest when rule practices are simultaneously benevolent and flexible in contrast to being either benevolent or flexible. These findings contribute to research on the governance of platform ecosystems and the relationship between different governance mechanisms. Specifically, our findings contribute to a better theoretical understanding of how rules can be designed to effectively incentivize complementors to contribute to a platform, how the potential of ecosystem-wide rules can be fully actualized, as well as to the complements vs. substitutes debate.

3.6.1. Theoretical Contributions

Our results show that rule adequacy is a powerful predictor of complementor dedication (H1 confirmed). This finding extends research on the governance of platform ecosystems by investigating differences in the design of platform governance and the effects of these differences from the perspective of complementors—a perspective which prior research has paid “limited attention to” (McIntyre & Srinivasan, 2017, p. 150). Specifically, prior research has conceptualized effective governance design as a problem of standardizing rules (Baldwin & Clark, 2000; Boudreau, 2010, 2012; Gulati et al., 2012; Parker & van Alstyne, 2005). Our study broadens this perspective by acknowledging for the first time that governance design should not only strive for standardization across many partnerships in order to strengthen complementor dedication but also be sensitive to the local needs of individual complementors. The significant positive direct effect of rule adequacy on complementor dedication supports the—at first glance counter-intuitive—theoretical logic underlying our broader perspective: Even dominant international platform heavyweights such as Google and Apple should be sensitive to the needs of comparatively small complementors.

Prior research on platform governance has treated the relationship between platform owners and complementors as a “black-box” by focusing solely on dependent variables that are closely related to the sheer number of complements (McIntyre & Srinivasan, 2017). While this research

has provided valuable insights into why complementors join (Economides & Katsamakas, 2006; Huang et al., 2013; Kude et al., 2012) or abandon a platform (Tiwana, 2015), it has overlooked other vital attributes of platform owner–complementor relationships. Our dependent variable complementor dedication addresses this gap by capturing variation in the intensity and depth of the relationship between the platform owner and complementor. Our study is the first to show that the adequate design of governance mechanisms has a significant positive impact on desirable relational variables that go beyond the sheer number of complementors.

Our results also have significant implications for the problem of how to actualize the potential of ecosystem-wide rules. Here, recent qualitative research suggests that designing adequate rules is just one side of the governance coin because even the best rules may hinder complementors from leveraging situational co-creation opportunities, given the standardized nature of rules (Huber et al., 2017; Sarker et al., 2012; Wareham et al., 2014). This research indicates that in such situations, higher levels of co-created value can be reached if platform owners are willing to show governance practices that go beyond the rules. Our quantitative study builds on and tests this idea by conceiving of the adequate design of rules and the flexible and benevolent practice of rules as a system of interlocked conditions that jointly affect complementor dedication (see H2 and H3). Overall, our results support the idea that rule adequacy, flexible practices, and benevolent practices jointly drive complementor dedication in a complex and symbiotic interplay. Surprisingly, we find that flexible and benevolent practices alone are not sufficient to strengthen the relationship between rule adequacy and complementor dedication (i.e., H2a and H2b not confirmed); only their simultaneous combination is (i.e., H3 confirmed). Thus, our results clarify in which ways governance design, and governance practices interact. Specifically, we show that to actualize the benefits of adequate rules; platform owners need to practice rules with both flexibility and benevolence. Put another way, to realize the benefits of flexible and benevolent rule practices; the platform owners need to design adequate rules in the first place. Hence, the effective management of complementor dedication is a trifecta of designing adequate rules and practicing them with both flexibility and benevolence.

As a broader contribution, our findings add to the longstanding complements versus substitutes debate in the governance literature (Carson, Madhok, Varman, & John, 2003; Goo et al., 2009; Huber et al., 2013; Poppo, 1995; Tiwana, 2010). In the context of platform ecosystems, prior research implicitly took a substitutional view by arguing that sophisticated standards enable platform owners to orchestrate large ecosystems while keeping complementors at arm’s length

(Parker & van Alstyne, 2008; Wareham et al., 2014), which obviates the need for relational governance. Our findings strongly support the competing complementarity perspective that standards do not obviate relational governance. Quite the opposite, relational governance, as reflected in the concepts of flexible and benevolent rule practices, strengthens the effects of these standards. Moreover, research on complementarity versus substitution in other contexts such as IS outsourcing has established that norms of flexibility and benevolence complement the effects of formal contractual governance in two-way interactions (Goo et al., 2009; Poppo & Zenger, 2002; Tiwana, 2010). This implies that the interaction between formal governance and flexibility does not vary across levels of benevolence and that the interaction between formal governance and benevolence does not vary across levels of flexibility. In contrast, our findings only support a three-way interaction between those factors for the context of platform ecosystems. A potential explanation for this more complex interaction pattern could be that in contrast to dyadic governance settings, informal practices are still closely connected to rules in that they manifest as benevolent and flexible variations of the original rules. Thus, benevolent and flexible practices in the context of platform ecosystems are less independent from written prescriptions, which may constrain their power in independently strengthening the main effect of adequate rule design.

3.6.2. Managerial Implications

If platform owners fail to create an ecosystem of dedicated complementors, they will disappear and fade into obscurity (Tiwana, 2015). Our study provides two pieces of advice for nurturing complementor dedication and thereby preventing the collapse of platforms. First, our study confirmed that the more complementors perceive ecosystem-wide rules as being adequate, the more dedicated they are to the respective platform. Platform owners can capitalize on this insight by designing ecosystem-wide rules that secure the interests of complementors and ensure valuable benefits with high legal certainty. Second, our study points to the importance of flexible and benevolent rule practices. Platform owners could capitalize on this insight by deliberately giving their employees leeway in practicing ecosystem-wide rules.

3.6.3. Limitations and Future Research

This study does not come without limitations. First, our cross-sectional research design naturally limits the study of causal relationships. Thus, future research should rely on longitudinal or (quasi-)experimental methods to understand the dynamic and complex interactions between different governance mechanisms holistically. Second, we relied on data obtained from a single source, which may make our study vulnerable to common method bias. However, ex-post-tests suggest that this is unlikely to be a significant problem for this study.

Moreover, common method bias may not be a significant problem because interaction effects, which are at the heart of this study, are not susceptible to common method bias (Siemsen et al., 2010). Future research should further substantiate the relationships tested in this study using data from multiple sources of evidence. Third, while our measures focus on perceptions of rules and their practices, we did not examine what leads to these perceptions. Future research may examine how objective properties of rules and practices and their interplay with other factors (e.g., the platform architecture, technological change) affect perceptions. Such research may consider how dynamic changes in platforms (e.g., in terms of its architecture or feature set) may require respective governance adaptations in particular. For example, it was shown that platforms that undergo generational transitions might harm the ability of complementors to sustain their superior performances (Kapoor & Agarwal, 2017). Consequently, one may ask how platform governance should be adapted so that complementors can see a generational transition as an opportunity rather than a threat.

4. Emerging Innovation Ecosystems: The Critical Role of Distributed Innovation Agency

Abstract [4,5]

Innovation ecosystems are becoming increasingly important for the co-creation and modification of digital innovation by different and often competing organizational actors. However, how innovation ecosystems emerge between such organizational actors is yet unknown. This article addresses this gap by exploring how central organizational actors create innovation ecosystems, and how and why these innovation ecosystems emerge over time and through the interplay of all involved organizational actors that pursue both common (i.e., cooperate) and own goals (i.e., compete). To answer these questions, we opted for a single-case study of a large software development project, initiated by a major logistics company and implemented in collaboration with its independent IT department, six software vendors, and some field experts. This unique constellation with different coopeting (i.e., simultaneously cooperating and competing) organizational actors is particularly well suited to answer our research questions. Our results show that central organizational actors can create the basic structure and procedures of an innovation ecosystem. However, for an innovation ecosystem to progress in its emergence, central organizational actors need to stabilize the basic structure, while all other organizational actors need to help refine the basic procedures. The better adapted the structure and the procedures, the better organizational actors can exploit them to materialize coherent and customer-oriented digital innovation. We present our findings as a three-phase process model of innovation ecosystem emergence, in which innovation agency is distributed and redistributed among the organizational actors. Our findings have important implications for the literature on innovation ecosystems, the coopetition paradox, and digital innovation.

Keywords: Innovation Ecosystems, Digital Innovation, Innovation Agency, Innovation Outcome, Innovation, Process, Cooperation, Competition, Coopetition

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[4] This will appear in R. A. Hirschheim, A. Heinzl, & J. Dibbern (Eds.), Information Systems Outsourcing - the Era of Digital Transformation. Basel, CH: Springer International Publishing.
[5] The research project has been conducted in collaboration with Thomas Huber.
Thomas Hurni was the main contributor.

4.1. Introduction

Established companies are increasingly failing to keep up with disruptive digital innovation. To yet survive, more and more companies join forces with other organizational actors in innovation ecosystems, using their joint innovative power to co-create and modify digital innovation (Furr & Shipilov, 2018). We define innovation ecosystems as the alignment structure of a multilateral group of organizational actors that must cooperate for materializing coherent and customer-oriented digital innovation (Adner, 2006, 2017). To exploit the joint innovative power of multiple organizational actors, an innovation ecosystem must first emerge. However, the underlying emergence process of innovation ecosystems is mostly unknown.

So far, research on innovation ecosystems has contributed valuable insights into how they are orchestrated by central organizational actors (e.g., Giudici, Reinmoeller, & Ravasi, 2017), or how organizational actors balance their competitive and cooperative interests (e.g., Davis, 2016; Hannah & Eisenhardt, 2018) as well as develop and negotiate their identities over time (e.g., Lindgren, Eriksson, & Lyytinen, 2015). At the same time, little is known about the emergence of innovation ecosystems and the few studies that have investigated this important issue, have done that from the particular perspective of central organizational actors (e.g., Dattée et al., 2018; Giudici et al., 2017). Conclusions about why and how innovation ecosystems emerge were therefore extrapolated only from the perspective of these central organizational actors, neglecting the perspective of all peripheral organizational actors that are essential for understanding how and why innovation ecosystems progress in their emergence (Lumineau & Oliveira, 2018). This one-sided view on the emergence of innovation ecosystems does not do justice to their actual complexity for two particular reasons. First, organizational actors in innovation ecosystems not always pursue the same goals. While some central organizational actors undoubtedly seek to create and orchestrate innovation ecosystems (Dattée et al., 2018; Giudici et al., 2017; Paquin & Howard-Grenville, 2013), other peripheral organizational actors pursue common (i.e., cooperate) and own (i.e., compete) goals at the same or various times (Hannah & Eisenhardt, 2018). Second, organizational actors in innovation ecosystems are supposed to contribute to the materialization of coherent and customer-oriented digital innovation. The distribution and redistribution of innovation agency among those organizational actors is, therefore, an essential characteristic of innovation ecosystems, which can only be understood if the different goals, motives, and abilities of all relevant actors are acknowledged (Nambisan et al., 2017). Focusing on just one type of organizational actor is, therefore, not sufficient to understand how and why innovation ecosystems emerge over time and between all involved organizational actors that can pursue both common and own goals.

To make the best possible use of existing innovation agency, it is imperative to understand how and why innovation ecosystems progress to emerge between such different types of organizational actors. We, therefore, ask *how central organizational actors create innovation ecosystems and how and why such innovation ecosystems progress in their emergence over time and through the interplay of all involved organizational actors that pursue both common and own goals.*

To answer this question, we opted for a single-case study (Yin, 2009) of a large software development project, initiated by a major logistics company and implemented in collaboration with its independent IT department, six software vendors, and some field experts. This unique constellation is particularly well suited for understanding how a central organizational actor creates an innovation ecosystem, and why and how such an innovation ecosystem emerges over time and through the interplay of all involved organizational actors. More specifically, this setting allows understanding why and how an innovation ecosystem emerges around a desired coherent and customer-oriented digital innovation in a highly coopetitive environment (i.e., a simultaneously competitive and cooperative environment (Bengtsson & Kock, 2014)) with distributed innovation agency. Our results show that a central organizational actor can create the basic structure and procedures of an innovation ecosystem. However, for an innovation ecosystem to progress in its emergence, central organizational actors need to stabilize the basic structure, while all other organizational actors need to help refine the basic procedures. The better adapted the structure and the procedures, the better organizational actors can exploit them to materialize coherent and customer-oriented digital innovation. We present our findings as a three-phase process model of innovation ecosystem emergence, during which innovation agency is distributed and redistributed among central and peripheral organizational actors. The contributions of our study are threefold. First, we contribute to the literature on innovation ecosystems, as we find that innovation ecosystems emerge in three different phases through the creation, adaptation and exploitation of the structure and procedures. Second, we contribute to the literature on the competition and cooperation paradox, as we reveal that only a coexistence of common (i.e., cooperate) and own (i.e., compete) goals promote the emergence of innovation ecosystems. Third, we contribute to the literature on digital innovation, as we highlight the importance of distributing and redistributing innovation agency among organizational actors for the emergence of an innovation ecosystem and the materialization of coherent and customer-oriented digital innovation.

The structure of this article is as follows. First, we shed light on innovation ecosystems, the coopetition paradox, and digital innovation. Second, we provide detailed information about the

chosen method, including information about how we collected and analyzed our data, as well as how we derived our process model. Third, we illustrate the context of our case before we present the phases, and integrate them in a three-phase process model about how central organizational actors create innovation ecosystems and how and why such innovation ecosystems emerge over time and through the interplay of all involved organizational actors that pursue both common and own goals. We end with a discussion, where we elaborate on the theoretical contributions, the implications for practice, and promising paths for future research.

4.2. Background and Conceptual Foundations

4.2.1. Innovation Ecosystems

Innovation ecosystems describe *the alignment structure of a multilateral group of organizational actors that need to cooperate for coherent and customer-oriented digital innovation to materialize* (Adner, 2006, 2017; Adner & Kapoor, 2010). Despite their apparent similarity, innovation ecosystems are significantly different from other forms of inter-organizational collaboration (Adner, 2017). From platform ecosystems (e.g., Gawer & Cusumano, 2002; Tiwana et al., 2010), multisided markets (e.g., Boudreau & Haigu, 2009), and buyer-supplier relations (e.g., Porter, 1985), for example, innovation ecosystems differ in that they neither rely on one-to-one nor on one-to-many, but on many-to-many relations (Adner, 2017). Moreover, innovation ecosystems differ from alliances and networks (e.g., Gulati, 1998; Powell, Koput, & Smith-Doerr, 1996), in that they intend to materialize a coherent and customer-oriented digital innovation (Adner, 2017).

Innovation ecosystems were first mentioned in practitioner-oriented management literature in the mid-1990s (Moore, 1993), and have since become a key concept for IS, management, and organizational scholars (Autio & Thomas, 2014). Especially in recent years, this growing importance has enhanced our understanding of innovation ecosystems, such as how organizational actors reconcile their competitive and cooperative interests (e.g., Davis, 2016; Hannah & Eisenhardt, 2018), and how they develop and negotiate their identities over time (e.g., Lindgren et al., 2015). Innovation ecosystems, however, do not come out of thin air but rather emerge over time and based on the initiative of one or more central organizational actors. We define the emergence of innovation ecosystems as the progressive formation of an alignment structure in which a multilateral group of organizational actors can co-create and modify digital innovation that are only possible in collaboration. Unfortunately, there is little research into the creation and emergence of innovation ecosystems. One notable exception is Dattée et al. (2018) that shows how central organizational actors (i.e., organizational actors that

deliberately seek to create innovation ecosystems around their organizations) compel other organizational actors to commit to a creation effort in situations where uncertainty is high. Closely related is Giudici et al. (2017) that focuses on the orchestration of innovation ecosystems by 'other' organizational actors, including business incubators and venture associations. A third example is Paquin and Howard-Grenville (2013) that shows how central organizational actors move from 'blind dating' other organizational actors toward 'arranged marriages' among them. Both studies have in common that they focus on one specific type of organizational actor – more specifically, on central organizational actors that strive to create an innovation ecosystem – from which conclusions are drawn (Lumineau & Oliveira, 2018). However, this focus on one particular type of organization actor does not do justice to the complexity of innovation ecosystems for two reasons. First, although all organizational actors in innovation ecosystems should pursue common goals, they often pursue their own. Thus, while some organizational actors undoubtedly seek to create and orchestrate innovation ecosystems (e.g., Dattée et al., 2018; Giudici et al., 2017; Paquin & Howard-Grenville, 2013), others are likely to pursue both common (i.e., cooperate) and own goals (i.e., compete) at the same or different times (Hannah & Eisenhardt, 2018). Second, although digital technologies facilitate the coordination in innovation ecosystems (Adner, 2006), they also allow a distribution of innovation agency among organizational actors with distinct objectives, motives, and capabilities, which further increases the coordination effort (Nambisan et al., 2017). So far, it is largely unknown how and why this complexity created by cooperating and competing organizational actors with distributed innovation agency influences the creation and emergence of innovation ecosystems. Before we address this lack of knowledge, we first discuss the two underlying causes in more detail and introduce a possible approach for tackling the complexity.

4.2.2. Coopeting Innovation Agents

Although organizational actors in innovation ecosystems need to cooperate for the materialization of coherent and customer-oriented digital innovation, they may also pursue own goals or even compete with one another (Davis, 2016; Hannah & Eisenhardt, 2018). Cooperation in this context describes the process by which individuals or organizational actors work with each other for the mutual benefit, while competition describes the process by which individuals or organizational actors rival each other for the purpose of selfish benefit (Bengtsson & Kock, 2000). As such, cooperation and competition are often considered as two poles of the same continuum (Tjosvold & Choy, 1994), meaning that the more individual or organizational actors compete with each other, the less they cooperate and vice versa. This perception contradicts, however, the paradox nature attributed to coopetition, as paradoxes

denote the persistent contradiction between independent elements (Schad, Lewis, Raisch, & Smith, 2016) that "seem logical when considered in isolation but irrational, inconsistent, and even absurd when juxtaposed" (Smith & Lewis, 2011, p. 386). Thus, cooperation and competition are not the ends of the same continuum but their own continuums (Bengtsson & Kock, 2014), where coopetition only exists if individuals or organizational actors both cooperate and compete (Luo, 2007).

Coopetitive relations, as found in innovation ecosystems, do not necessarily thrive. Indeed, about 50% of all coopetitive relations fail (Lunnan & Haugland, 2008; Park & Ungson, 2001). Reasons for these failures are the dynamics of the underlying process (Pathak, Wu, & Johnston, 2014; P. J. Williamson & de Meyer, 2012) with actors that simultaneously pursue own and common benefits (Khanna, Gulati, & Nohria, 1998), share and protect knowledge (Ho & Ganesan, 2013), and learn from each other (Kale, Singh, & Perlmutter, 2000). The dynamics of the underlying processes, therefore, pose serious threats to the emergence of innovation ecosystems. Understanding how and why these dynamics affect the emergence of innovation ecosystems is therefore crucial and requires a closer look.

4.2.3. Distributed Innovation Agency

At the heart of innovation ecosystems is the materialization of coherent and customer-oriented innovations by multilateral groups of organizational actors (Adner, 2017). As these innovations are typically created with the help of digital technologies and are mostly digital technologies themselves (Adner, 2006; Adner & Kapoor, 2010; Mantovani & Ruiz-Aliseda, 2016), we regard them as digital innovations (Nambisan et al., 2017). Digital innovation differs in at least two respects from traditional innovation, which describe the invention, development, and implementation of new ideas or solutions to specific problems (Garud, Tuertscher, & Van de Ven, 2013). First, in digital innovation, digital technologies facilitate the distribution of innovation agency (Nambisan et al., 2017). In other words, digital technologies allow the involvement of far more innovation agents with own objectives, motives, and capabilities than in traditional settings, known from research and development departments with predefined innovation agents. Although such a distribution of innovation agency to a large number of organizational actors is appealing, it also increases the coordination effort throughout the innovation process. Second, in digital innovation, the innovation processes are increasingly blurring with the underlying innovation outcomes, which is especially true if the innovation outcomes themselves are digital (Nambisan et al., 2017). The reason for the increasingly blurring boundaries between the innovation processes and outcomes lies in the uniqueness of digital technologies, with regard to their malleability, editability, or transferability (Yoo,

Henfridsson, & Lyytinen, 2010). This uniqueness of digital technologies allows continuous improvements of the innovation outcome during and even beyond the innovation process (Lyytinen, Yoo, & Boland Jr, 2016). Although appealing, this increasingly blurred boundary between the innovation processes and outcomes increases the coordination effort. Thus, despite the obvious benefits of digital innovation, the increased coordination effort could jeopardize the emergence of innovation ecosystems. Understanding how and why the characteristics of digital innovation influence the emergence of innovation ecosystems is, therefore, crucial and requires a closer look.

4.2.4. Artifact Centered Orchestration

Innovation ecosystems are inherently complex in view of the coopetitive relations between the organizational actors, the distributed innovation agency, and the increasingly blurred boundaries between the innovation processes and outcomes. For innovation ecosystems to progress in their emergence, and for materializing coherent and customer-oriented digital innovations, overcoming this complexity is essential. In this regard, previous research on innovation networks has proposed the concept of orchestration with one or few organizational actors taking responsibility for coordinating the value co-creation (Dhanaraj & Parkhe, 2006; Nambisan & Sawhney, 2011), or matching solutions with problems so that innovations can be materialized (Nambisan et al., 2017). However, unlike other forms of inter-organizational collaboration, the many-to-many relations make innovation ecosystems inherently more complex (Adner, 2017). Although this complexity allows for the initial creation and orchestration of innovation ecosystems by central organizational actors (e.g., Dattée et al., 2018; Giudici et al., 2017; Paquin & Howard-Grenville, 2013), their orchestration becomes more difficult as they emerge. This increased complicity indicates the need for further orchestration entities. Ironically, the increasingly blurred boundaries between the innovation processes and outcomes could play a significant role in this regard (Nambisan et al., 2017).

Digital technologies are increasingly blurring the boundaries between innovation processes and outcomes, which is especially true if the innovation outcomes themselves are digital (Nambisan et al., 2017). This increased blurring can be explained by the peculiarities of digital technologies, such as malleability, editability, or transferability (Yoo et al., 2010), which allow the continuous improvement of innovation outcomes during and even beyond the innovation process (Lyytinen et al., 2016). While innovation ecosystems aim to materialize such continuously improving innovation outcomes, they strive for both coherence and customer-orientation. For this purpose, an orchestration of the multilateral groups of organizational actors in innovation ecosystems is essential (Adner, 2006, 2017; Adner & Kapoor, 2010). As

previously noted, central organizational actors can create innovation ecosystems and thus orchestrate them initially (e.g., Dattée et al., 2018; Giudici et al., 2017; Paquin & Howard-Grenville, 2013). However, this orchestration by central organizational actors is not enough to obtain coherent and customer-oriented digital innovations, as innovation ecosystems progress in their emergence. This need for more orchestration entities could be countered by technology artifacts that allow matching solutions to problems and joint sensemaking during the innovation process (Nambisan et al., 2017). In the following, we refer to these orchestration entities as common innovation artifacts. Examples for common innovation artifacts are design guidelines, standardized development methods, or shared infrastructures that help materialize coherent and customer-oriented digital innovations. The better these common innovation artifacts complement the organizational actors as orchestrating entities for matching solutions to problems and joint sensemaking, the more progressed an emerging innovation ecosystem is.

4.3. Method

We conducted a longitudinal single-case study (Yin, 2009) about the unique software development project REMO (short for Reorientation Mobile Computing) at the major logistics firm LogCH. This unique case enabled us to understand how central organizational actors create innovation ecosystems and how and why such innovation ecosystems progress in their emergence over time and through the interplay of all involved organizational actors that pursue both common and own goals. Project REMO is particularly well suited to answer these questions, as it pursued the goal of materializing a coherent and customer-oriented digital innovation through the ongoing collaboration of one client (LogCH), its independent IT department (IT LogCH), six competing software vendors with nearly identical capabilities, and a group of field experts.

To ensure that LogCH supports the conduction of a longitudinal study, we first turned to the member of the executive board responsible for project REMO. This member of the executive board then brought us in contact with the responsible project manager. Based on both their assured support, we began purposefully sampling the involved organizational actors. Specifically, we focused on nine different organizational actors, namely the project team (LogCH), its independent IT department (IT LogCH), the six competing software vendors, and the group of field experts. Table 9 provides an overview of these nine organizational actors and the 33 interviewed individuals. Every organizational actor was actively contributing throughout project REMO and part of the emerging innovation ecosystem.

Table 9: Studied organizational actors and interviewed individuals

Organizational Actor	Description	Interviewees
LogCH	LogCH is a major logistics company. Three of its business units commissioned project REMO. Division A took over the project management and appointed a scrum expert and three product owners, each responsible for two software vendors.	• Project Manager[1] • Product Owner 1 • Product Owner 2 • Product Owner 3 • Scrum Expert
IT LogCH	IT LogCH is the independent IT division at LogCH. During project REMO, IT LogCH was responsible for providing the software development infrastructure and the framework that acted as an intermediary layer between the applications and the software platform.	• Team Leader • Scrum Master • Lead Developer
Field Experts	The field experts were users of the old system or very experienced employees of the three divisions who knew their way around with the old system. They took on the roles of requestors, testers and controllers.	• Field Expert 1 (Division A) • Field Expert 2 (Division A) • Field Expert 3 (Division B) • Field Expert 4 (Division C)
Vendor 1	Vendor 1 is a large international software vendor, assigned in the first round of software vendors. During project REMO, product owner 1 supervised vendor 1. Vendor 1 partially developed 2 applications.	• Swiss CEO • Scrum Master
Vendor 2	Vendor 2 is a large Swiss software vendor, assigned in the first round of software vendors. During project REMO, product owner 2 supervised vendor 2. Vendor 2 developed 4 applications.	• Key Account Manager • Architect • Scrum Master • Business Analyst 1 • Business Analyst 2
Vendor 3	Vendor 3 is a large Swiss software vendor, assigned in the first round of software vendors. During project REMO, product owner 3 supervised vendor 3. Vendor 3 developed 5 application and partially developed another application.	• Scrum Master 1 • Scrum Master 2 • Scrum Master 3 • Business Analyst • Developer 1 • Developer 2 • Developer 3
Vendor 4	Vendor 4 is a large Swiss software vendor, assigned in the second round of software vendors. During project REMO, product owner 1 supervised vendor 4. Vendor 4 developed 2 applications and partially developed another application.	• Scrum Master • Business Analyst
Vendor 5	Vendor 5 is a large international software vendor, assigned in the second round of software vendors. During project REMO, product owner 2 supervised vendor 5. Vendor 5 developed 5 applications.	• Key Account Manager • Scrum Master • Business Analyst • Developer
Vendor 6	Vendor 6 is large international software vendor, assigned in the second round of software vendors. During project REMO, product owner 3 supervised vendor 6. Vendor 6 developed 2 applications.	• Scrum Master

[1] We interviewed the Project Manager twice

4.3.1. Data Collection

For triangulation (Eisenhardt, 1989; Yin, 2009), we collected three types of qualitative data, namely semi-structured interviews, archival data, and observational data. We initiated data collection in November 2014 after the responsible member of the executive board and the project manager assured us to support the conduction of a longitudinal study. Following an

informal interview with the project manager, we purposefully sampled (Yin, 2011) interview partners from all nine involved organizational actors in project REMO. Following each purposefully sampled interview, we requested the respective interviewee to name additional interview partners worthwhile for our investigation in the sense of a snowball sampling (Yin, 2011). The resulting 34 semi-structured interviews[6] lasted 1.5 hours on average, with a range from 55 minutes to 2 hours and 15 minutes. Every interview was conducted in accordance with the recommendations of Myers and Newman (2007) for qualitative interviews and – except for one Skype interview with a shored employee in Germany – conducted on site in the interviewees' native language (i.e., German or Swiss German). Each interview was tape recorded and transcribed immediately after the conduction. We supplemented our interview data with archival data, including project documentations that provided us with rich insights into the overall project, the initial requirements, or involved key personnel, and presentations about the project that provided us with rich insights about the final state. Eventually, we observed a scrum meeting to understand how the software vendors, LogCH, IT LogCH, and the field experts interacted in the predefined meetings.

4.3.2. Data Analysis

We began with continuous data analysis following the first informal interview with the project manager in November 2014. This continuous data analysis allowed us to react early on to new insights and to adapt our semi-structured interview guideline accordingly. To analyze the collected data, we used the NVivo 11 software solution and followed the recommendations by Charmaz (2006) for an iterative coding procedure. In an initial step, we coded each piece of data line-by-line, using process codes and descriptive sub codes. Process codes rely on gerunds to connote observable and conceptual action in the data (Miles et al., 2013). Gerunds ('-ing' words) are particularly well suited for initial coding, as they curb human tendencies to make conceptual leaps and to adopt extant theories before a necessary analysis (Charmaz, 2006). Descriptive sub codes are second-order tags assigned to a primary code – in our case process codes – to enrich their significance (Miles et al., 2013). This line-by-line coding procedure offered two distinct advantages. First, line-by-line coding allowed us to identify both beneficial and obstructive events during the emergence of the innovation ecosystem, and second, to order these events chronologically. The identification of both beneficial and obstructive events and

[6] The project manager was interviewed twice

their chronological order gave us a first holistic picture of how LogCH, as the central organizational actor, initially created the innovation ecosystem and how it progressed in its emergence over time and through the interplay of all involved organizational actors.

To grasp whether the innovation ecosystem progressed in its emergence or not, we followed the notion of orchestration. Orchestration is performed by orchestrating entities and manifests in a more or less effective matching of solutions to problems as well as a more or less facilitated joint sensemaking (Nambisan et al., 2017). Thus, the more effective orchestration entities match solutions to problems and the better they facilitate joint sensemaking, the more progressed the innovation ecosystem emergence. Accordingly, we have coded the emergence of ecosystems as progressive when the orchestration entities have facilitated both the matching of solutions to problems and joint sensemaking. In this regard, we not only considered the orchestrating roles of the involved organizational actors but also paid particular attention to common innovation artifacts. This focus on both organizational actors and common innovation artifacts as orchestrating entities is particularly well suited for our study, given the complexity of innovation ecosystems with coopeting organizational actors and distributed innovation agency.

In the next step, we proceeded with a more focused coding of our data. For this purpose, we decided about which of our initial codes make the most analytic sense to categorize our data incisively and completely (Charmaz, 2006). We then focused on exploring relations in our codes via axial coding, with the goal to identify general patterns. For this purpose, we systematically compared the dynamics within our case using replication logic, memo writing and tables (Miles et al., 2013). This resulted in three major phases that explain how the central organizational actor initially created the innovation ecosystem and how the innovation ecosystem emerged over time and through the interplay of all involved organizational actors, that pursued both common and own goals. We finalized our analysis by theoretically coding our data. This final step allowed us to identify the theoretical mechanisms underlying the three identified phases (Charmaz, 2006). By synthesizing and abstracting these findings, we constructed our final process model of innovation ecosystem emergence that explains how central organizational actors create innovation ecosystems and how and why innovation ecosystems emerge over time and through the interplay of all involved organizational actors that pursue both common and own goals.

4.4. Results – Creation and Emergence of an Innovation Ecosystem

The initial trigger for the creation and the emergence of the analyzed innovation ecosystem was the approaching end-of-life of the mobile computing devices used by around 20,000 LogCH

employees during their day-to-day tasks of receiving, processing, transporting, and distributing deliveries. Having a long tradition of supporting its employees with such devices (Figure 7 illustrates the prior devices), LogCH introduced the most recent device in the same year as Apple released its first iPhone (Block, 2007). Despite this long tradition, LogCH was unable to foresee the revolutionary developments triggered by the release of this first mainstream multi-touch smartphone. For example, even though transmission technology was rapidly evolving, LogCH stuck with an outdated standard that was unsuitable for contemporary business applications, geolocation, or encrypted payments. The core of the problem, however, was not the rapid evolution, but the monolithic system architecture that made it impossible to replace the hardware while maintaining the software and vice versa. Against this backdrop, LogCH decided to revolutionize its mobile computing strategy.

Figure 7: Past Mobile Computing Devices at LogCH

4.4.1. Phase 1 – Creating Basic Structure and Procedures

In 2012, LogCH launched project REMO to replace the dated mobile computing devices and their monolithic system architecture. The stated goal was the materialization of an innovative, coherent, yet flexible system with strictly modular components (i.e., hardware, software platform, framework, and features) and features (i.e., applications), as has already been the case with contemporary consumer smartphones. To achieve this goal, LogCH invited four consulting companies to leverage their expertise on system architectures. From the resulting proposals, LogCH opted for a modular cross-compiler architecture with independent components and features. This system architecture was the first common innovation artifact defined to set initial procedures – i.e., it specified how the individual components are divided and related.

The modular cross-compiler architecture required a framework as an intermediary layer between the applications and the software platform, as well as multiple applications to support both the employees in their fieldwork and the management in its executive function. However, LogCH alone lacked the expertise to develop such a framework and to specify the applications. For the development of the framework, LogCH therefore decided to distribute innovation agency to its independent IT department, IT LogCH. For the definition of the applications, LogCH carried out a business process redesign, where selected employees of the project team and from the field (i.e., field experts) obtained innovation agency and gathered the business processes in use, to align them with those implemented in the previous systems. This business process redesign allowed LogCH to fathom a target state for defining twenty applications:

> *"We [LogCH] conducted a business process redesign, where we, or rather the field experts, had a look at the existing processes and gathered the processes in use. We moderated it and abstracted the process model in a spreadsheet, with each process briefly described in 1-2 sentences, in terms of its function, the potential for improvement and critical weaknesses. This procedure eventually resulted in a target process model, which was broken down into several applications." (LogCH – Product Owner 2)*

The distribution of innovation agency to IT LogCH and the field experts for developing the framework and defining applications had two implications. First, by distributing innovation agency to IT LogCH and the field experts, Log CH shaped the structure of the innovation ecosystem in terms of the entered cooperation with them. Second, by developing the framework, IT LogCH defined a common innovation artifact that set additional procedures – i.e., it specified interfaces to the components and features.

The fast-approaching end-of-life of the previous system further complicated the situation for LogCH. Still, LogCH endeavored a highly innovative and high-quality system that stays within budget and complies with the World Trade Organization rules for public tenders. For this purpose, LogCH decided to divide project REMO into subprojects. One of these subprojects explicitly dealt with the application development by six selected software vendors. Thus, LogCH distributed innovation agency to six software vendors, each with the same capabilities to design, build, test, deploy, and run the twenty previously defined applications:

> *"An important success factor was the tender. They [LogCH] have not tendered requirements, but software vendor skills. […] Because of that, the selection of software vendors was significantly better than if they would have taken just the cheapest ones. We can assume that they [the assigned software vendors] were the best." (Scrum Expert)*

Distributing innovation agency to six software vendors for developing the twenty applications had paradoxical consequences for the structure of the innovation ecosystem. On the one hand, their involvement increased the need for cooperation in obtaining the desired, coherent system, and on the other hand, their equal capabilities built the basis for competition.

To obtain twenty coherent applications despite this paradoxical coopetitive setting, LogCH needed to take additional measures. One of these measures was the default agile scrum development method, which LogCH hoped would help to detect problems, dissatisfactions, and errors early on. Besides, LogCH considered it somewhat unrealistic to specify all requirements beforehand. However, it quickly became evident that the general understanding of the agile scrum development method was somehow inconsistent and partially incomplete:

> *"IT LogCH and the software vendors have confirmed to us: "Yes, we do know scrum!" On closer examination, however, it turned out that it was not scrum or that they simply had a different understanding of scrum than we did." (LogCH - Project Manager T1)*

To avoid potential issues arising from these inconsistent and partially incomplete understandings, LogCH hired an external scrum expert. This scrum expert had to define an agile scaled scrum development method and enforce it among all involved organizational actors. The resulting method required all software vendors and IT LogCH to develop in bi-weekly sprints and to attend meetings on a team-, functional-, and project level. Figure 20 in the appendix illustrates the participating individual actors during these meetings. On a team level, the software vendors and IT LogCH had to gather with their product owners and the field experts for a retrospective of the past sprint, a sprint review, and a sprint planning for the following two weeks. On a functional level, the business analysts, architects, scrum masters, and quality managers had to meet with their peers in alignment meetings. On a project level, the software vendors had to present their development increments to the other software vendors, LogCH, IT LogCH, and the field experts. By defining and enforcing this agile development method, the scrum expert defined various common innovation artifacts that set additional procedures – i.e., it specified how the applications had to be developed. At the same time, the definition of these common innovation artifacts increased the transparency between all organizational actors, thereby further shaping the coopetitive setting.

Defining a development method with three different meetings every other week further increased the coordination effort for all organizational actors. LogCH aimed to reduce this coordination effort and shape the coopetitive setting between the organizational actors by providing the needed localities and infrastructures:

> *"We wanted the software vendors to work on our platforms, which means that the documentation is with us, development is with us, and testing is with us. […] We also set up a project office near our headquarters and asked the software vendors to be there with their key roles." (LogCH - Project Manager)*

More specifically, LogCH rented a floor in an empty business complex close to its headquarters, with individual offices for the organizational actors, and shared areas for informal interactions and the scheduled meetings. Figure 21 in the appendix provides a floor map of the shared office space. Besides, LogCH provided a standard technology stack for the application design, development, and testing and made the code and documentation repositories accessible to all organizational actors for complete transparency. By providing the needed localities and infrastructures, LogCH defined additional common innovation artifacts that set additional procedures – i.e., it specified by which means the applications had to be developed. At the same time, defining these common innovation artifacts aimed to shape the coopetitive setting among all organizational actors.

Although LogCH has defined multiple common innovation artifacts for materializing the desired, coherent innovation outcome, it chose to ensure the coherence of the desired system even better through guidelines: *"One has chosen a technocratic approach with guidelines and templates." (LogCH – Product Owner 3).* More specifically, LogCH stipulated architecture, coding, documentation, design, usability, and testing guidelines. In doing so, LogCH defined several common innovation artifacts that shaped meaningful cooperation through clear rules and regulations despite the coopetitive environment.

Based on the created basic structure and procedures, LogCH assumed it had created a functioning innovation ecosystem: *"From the beginning, it was communicated that it should become an [innovation] ecosystem." (Vendor 5 – Developer).* However, the innovation ecosystem was still in its infancy and not far progressed in its emergence.

4.4.2. Phase 2a – Refining Basic Procedures

The involvement of six software vendors after two consecutive kick-off meetings significantly increased the scope of and the coordination effort within the emerging innovation ecosystem. Conducting two consecutive kick-off meetings instead of one became necessary as LogCH initially intended to work with only three of the six software vendors, but shortly after that added the other three for mastering the tasks on time. The aim of the meetings, however, remained the same: to prepare all organizational actors and to involve them actively in order to exploit their expertise, thus to take advantage of the distributed innovation agency:

> *"In the first part of the kick-off meeting, we provided some background information – how do we intend to proceed, what was the past, and what do we want to do in the future? To convey our vision and emphasize the already made progress. […] In the second part, we conducted various workshops. There we asked them to get involved: "Now that we have provided you with some background information, do you have questions? Do you have any suggestions regarding the architecture? Do you have ideas regarding the test procedure?" etcetera." (Scrum Expert)*

Based on their expertise, all organizational actors critically eyed the defined common innovation artifacts. Particularly the six software vendors quickly identified overlooked deficiencies that hindered them in materializing the desired system: *"Well, I have already seen many agile scrum development projects. For us, or at least for me, that was nothing new. My experience certainly allowed me to emphasize things like "this is a definition of ready that will not work in this project – it simply lacks detail."" (Vendors 2 – Scrum Master).* However, the distributed innovation agency not only enabled the software vendors to detect deficiencies, but also to propose innovative solutions to remedy them and refine the common innovation artifacts. Vendor 3 was particularly fast and active in this regard: *"Vendor 3, that is something we have noticed, has taken a different approach to the project than we did. That was obvious from the beginning. For example, while we entered into this project and accepted the way LogCH wanted us to work, vendor 3 joined and wanted to work in its own way." (Vendor 2 – Scrum Master).* One of the many examples where vendor 3 proposed an innovative solution, related to the guidelines for structuring and testing the use cases:

> *"We had a certain influence there, and one or the other of my feedbacks on structuring and testing the use cases was adopted and set as standards for all vendors. That was not because we were incredibly innovative, but because we were fast. It is likely that I was the first from whom they [LogCH] received feedback." (Vendor 3 – Scrum Master 2)*

Its expertise and speed enabled vendor 3 to help remedy various deficiencies of the defined common innovation artifacts. Its solution for refining the guidelines for structuring and testing use cases, for example, helped to guarantee meaningful cooperation through clear rules and regulations. For vendor 3, doing so had paradox consequences. On the one hand, supporting all organizational actors to materialize the desired coherent system with a refined common innovation artifact was cooperative in itself. On the other hand, enforcing an innovative solution while all other organizational actors had to follow suit was competitive. Since the other

organizational actors had innovative solutions to propose themselves, this competitive aspect was particularly problematic:

> *"Vendor 3 had a certain pioneering role, this certainly because they were among the first to participate. They have suggested some of their procedures early on, which made it difficult to change them – this caused some disagreements." (Vendor 6 – Scrum Master)*

For the progress of the innovation ecosystem emergence, such acts had two consequences. First, distributed innovation agency enabled identifying deficiencies in common innovation artifacts earlier and proposing innovative solutions to refine them faster. For all organizational actors, refined common innovation artifacts meant a further homogenization of the basic procedures, which also shaped the coopetitive setting. Second, the fact that most organizational actors themselves had innovative solutions to the same deficiencies steadily increased competition for proposing innovative solutions:

> *"We had to get involved and show that we are here now. That is why we have attached a poster saying 'deliver or die', which is one of the many sayings at vendor 6. True to this motto – we delivered and performed after a certain ramp-up. Therefore, the other companies have also realized that vendor 6 is here and is ready to work. It is like a new student coming into an existing class. You have to prove yourself and show that you can do something." (Vendor 6 – Scrum Master)*

Whether proposed solutions have led to refined common innovation artifacts or not, however, built on LogCH's decision. The example of the design guidelines shows that this was not always the case – although the organizational actors identified deficiencies and proposed innovative solutions for refinements, LogCH decided to keep them unrefined: *"In terms of user interaction design, LogCH had no need... or wanted to have no need." (Vendor 3 – Scrum Master 1).*

Even though many organizational actors proposed innovative solutions to the same deficiencies, often only one organizational actor had the necessary expertise in a particular domain. One organizational actor that repeatedly used its superior expertise to propose innovative solutions for refining common innovation artifacts was vendor 4 – the first time already shortly after the second kick-off meeting. At that time, vendor 4 noticed that the internet in the shared office space was not working correctly. Access to the internet and the networks was, however, essential for the development of the applications:

> *"The infrastructure was always an issue, especially in the beginning. We had to work with our hardware, which was a requirement by LogCH, but because they did not allow us access*

to their network, we had to deal with a malfunctioning guest network. That meant that we had to work with the guest Wi-Fi, which was slow and half the time did not work, making it impossible for us to develop." (Vendor 2 – Scrum Master)

Due to its informal behavior, vendor 4 quickly discovered that the malfunctioning internet also hindered the other organizational actors: *"In the beginning, we were the only ones who always had an open door – such that at least sometimes one dared to look inside. We also stood around the coffee machine, as we were encouraged to exchange information during informal 'coffee talks'." (Vendor 4 – Business Analyst).* Since vendor 4, unlike the other organizational actors, already had some experience in providing internet access, it remedied this deficiency: *"They somehow got the internet up and running." (Vendor 3 – Scrum Master 1).* In doing so, vendor 4 refined a common innovation artifact, namely the shared office space. For vendor 4, refining this common innovation artifact had paradox consequences. On the one hand, it was cooperative in itself and supported all organizational actors in materializing the desired coherent system. On the other hand, it gave vendor 4 a competitive advantage over all other organizational actors.

A short time later, the flawed automated test infrastructure hindered all organizational actors. This mainly since testing was a vital deliverable to finish a sprint: *"One had imagined the testing differently. We had to redefine it during the project – at the latest when we realized that we needed a higher level of automated testing for the intended development pace. Testing was one part of every sprint – a deliverable." (LogCH – Product Owner 3).* As with the malfunctioning internet access, vendor 4 quickly discovered that the other organizational actors also suffered from the flawed automated test infrastructure. Given its experience in this domain, vendor 4 offered LogCH and IT LogCH its support to refine the common innovation artifact:

"The helpfulness among each other was something! We had issues with the test platform – it just did not work well. At the same time, it was a requirement of the set definition of done. One of the partners [vendor 4] that knew quite a bit about it, eventually agreed to take over: "I do it for you all, so we get going!" I mean, that was something – and it was not that they had to do this free of charge. It was very pleasing that one was able to let the whole crew – I mean all other partners – take advantage of it." (LogCH – Project Manager)

Vendor 4, however, not only left it at refining the common innovation artifact but also actively approached the others to teach them with the set up testing infrastructure and had an open door for their questions and concerns: *"Then, we also had an open door and conducted stand-up Q&A meetings regarding the test infrastructure. That way, we interacted and were able to talk to the developers. Thus, they were standing in our room, and one was able to exchange ideas*

with them and to see how they solved certain other things." (Vendor 4 – Business Analyst). In doing so, vendor 4 refined a common innovation artifact, namely the automated test infrastructure. Again, refining a common innovation artifact had paradox consequences for vendor 4. On the one hand, it was extremely cooperative in itself and again helped all organizational actors to materialize the desired coherent system. On the other hand, it gave vendor 4 a competitive advantage over all other organizational actors.

The example of vendor 4 demonstrates how superior expertise can help identify hindering deficiencies in common innovation artifacts and to propose innovative solutions to refine them. Such cooperative actions, which gave one organizational actor competitive advantages over all others, had two consequences for the progress of the innovation ecosystem emergence. First, the refinements of the basic common innovation artifacts meant a further homogenization of the basic procedures, which facilitated the orchestration of innovation agency. Second, innovative solutions that have become standards, such as those of vendor 4, have made the proposing vendors indispensable organizational actors within the innovation ecosystem: *"Sure, they cannot let vendor 4 go – I suppose. Without them, the test thing would probably not run as it should." (Vendor 2 – Architect).*

4.4.3. Phase 2b – Stabilizing Basic Structure

The innovation ecosystem progressed in its emergence with the creation of the basic structure and procedures, as well as the refinement of these procedures. In some cases, however, LogCH also needed to stabilize the basic structure of the innovation ecosystem to ensure it progressed in its emergence. One such incident occurred with vendor 6.

Vendor 6 ignored the defaults regularly and caused additional work for LogCH due to its uncooperative behavior: "*There I did a lot more than my role had foreseen and I had to compensate for things that did not exist." (LogCH – Product Owner 3).* Thus, instead of cooperating with the other organizational actors to capitalize on their expertise or bring in its own expertise, vendor 6 isolated itself and focused exclusively on its own tasks. In other words, vendor 6 destabilized the coopetitive setting:

> *"Their attitude was not that they valued it [the cooperation with other organizational actors] much – regardless of whether it was us or others. Their participation during the joint or vertical meetings [the meetings on a functional level] … well, there they often shone with their absence." (Vendor 2 – Scrum Master)*

It did not even help that LogCH repeatedly urged vendor 6 to attend meetings with the other organizational actors: *"He [the scrum master at vendor 6] attended the meetings because he had to – but he rarely rose to speak. That was not motivating at all. […] It quickly became clear that we are not continuing [to work with vendor 6]." (LogCH – Product Owner 3).* In summer 2014, LogCH considered a further engagement of vendor 6 no longer meaningful. Vendor 6 was not actively contributing with its innovation agency to the progress of the emerging innovation ecosystem, and particularly to the materialization of the desired coherent system. LogCH thus stabilized the basic structure of the innovation ecosystem by excluding vendor 6:

> *"Back then, we foresaw them to complete this first app, and when performing well, this second app. However, since the remaining apps were already assigned, there was no more work left, and it made no sense to assign vendor 6 to something other vendors had already started." (LogCH – Product Owner 3)*

Vendor 6's lack of cooperativeness destabilized the coopetitive setting and risked to prevent the innovation ecosystem emergence from progressing. However, since the two apps developed by vendor 6 were of reasonable quality and only used by a particular type of user, its uncooperative behavior hardly compromised the overall success of project REMO.

In the case of vendor 1, however, LogCH faced a much more threatening situation. Vendor 1 stood out for its boastful behavior during the first kick-off meeting. Interestingly, this competitive behavior led to the task of developing the most significant and central application:

> *"We arrived there, I would say, in quite a fulminant fashion and with quite some people. This because we said that it is important to get to know each other. For that reason, we took all the potential candidates for our team with us and arrived with 7 to 8 people. The entire team presented itself, at which point they [LogCH] assigned us to develop the largest application." (Vendor 1 – Scrum Master)*

Right from the beginning, however, vendor 1 had to realize that project REMO was not just about boasting and competing, but also about cooperating with the other organizational actors for the sake of an innovative, high-quality, coherent, and customer-oriented system: *"I mean the largest and most complex application, that's the app used 80% of the time. Everything else is garnishing. Therefore, one was well aware to hinge on the viability of this very app." (Vendor 4 – Scrum Master).* Confronted with all other organizational actors, it did not take long until vendor 1 considered itself a victim of this situation and began to isolate itself:

> *"In the beginning, us – but certainly me – were victims in this regard, in the sense that we said: "Yes, we take us some time for the other vendors." Eventually, however, we noticed that we could isolate ourselves much more, and in doing so, better reach our own goals." (Vendor 1 – Scrum Master)*

Instead of cooperating with the other organizational actors and bringing in its innovation agency, vendor 1 thus began to isolate itself and to focus on its own goals. In doing so, vendor 1 destabilized the coopetitive setting, which did not prevent its scrum master from boasting about *"how big its achievements [the achievements of vendor 1] were for LogCH" (LogCH – Product Owner 1)*. However, all the boasting and isolating neither hid the fact that vendor 1 was struggling to develop the assigned application nor its multi-week deviation from the schedule: *"Well, there... that's what I sometimes say about vendor 1. They were… I found… They did not start well." (Vendor 3 – Scrum Master 1)*. To make matters worse, vendor 1 also faced the development of a second application that further limited its capacities for the first one:

> *"We not only had to develop the largest and most complex application but also a second one. For that reason, we had to split the team in two for putting the requirements for the second application in place. There were [user] stories that we had to put together. Anyway, very demanding! It was not optimal and left much room for optimizations, I have to admit. That's for sure!" (Vendor 1 – Scrum Master).*

As the other organizational actors increasingly suffered from the deficiencies of the largest and most complex application, LogCH had to act. Since vendor 1 isolated itself and did not seek support from other organizational actors, LogCH stabilized the basic structure of the innovation ecosystem by redistributing the workload of the second application to vendor 4. In doing so, LogCH redistributed innovation agency from vendor 1 to vendor 4. Interestingly enough, while this allowed vendor 1 to focus on the development of the largest and most complex application, it caused neither a behavioral change at vendor 1 nor an improvement of the situation:

> *"Others have barely managed to reach their sprint targets – one sprint after another […] but also transparency-wise – the acknowledgment and the transparency of the progress […] that was also the case with this escalation concerning the largest and most complex application." (LogCH – Project Manager)*

This time, however, it took LogCH a moment to find out about the ongoing issues at vendor 1. Once LogCH learned about them, it was therefore already too late to redistribute the application and innovation agency – the already built-up expertise was too large and too irreplaceable. For

this simple reason, LogCH chose another approach and urged vendor 1 to seek support from another organizational actor, which vendor 1 refused to do in the first place:

> *"We then encouraged vendor 1 "You have to reinforce yourself with a partner [a competing software vendor]." In the first place, they [vendor 1] refused, but then we urged them to do so." (LogCH – Project Manager)*

After some additional pressure from LogCH, vendor 1 eventually recognized its impasse, relented, and accepted the support from vendor 3: *"[...] one has realized that the largest and most central application is too big and that we would need help" (vendor 1 – Scrum Master).* The helping function, however, whetted the appetite of vendor 3 for more. Thus, once vendor 3 knew enough about the largest and most complex application, it offered to take over the entire development. LogCH willingly accepted, thus stabilized the structure of the innovation ecosystem by redistributing the application form vendor 1 to vendor 3 and thereby the entire innovation agency. Surprisingly, even this second seizure and the factual exclusion from project REMO did not cause vendor 1 to behave uncooperatively:

> *"I thought I would feel a little offended in their position. During the transition phase, one had to choose its words carefully – one always had to pay attention to its wording. Nevertheless, I believe they have taken it professionally. In the end, they were not so happy with our PO [product owner 1] – the chemistry was not right. So I do not believe that they were sad being forced to surrender." (Vendor 3 – Developer 2).*

Given vendor 1's isolating and whitewashing behavior risked the materialization of the desired system, it also risked to hinder the innovation ecosystem emergence from progressing. Its exclusion was thus inevitable for stabilizing the basic structure of the innovation ecosystem.

4.4.4. Phase 3 – Exploiting Stabilized Structure and Refined Procedures

The creation and adaptation (i.e., refinement and stabilization) of both the basic structure and procedures for materializing the desired coherent innovation outcome has led to steady progress in the emergence of the innovation ecosystem. This steady progress continuously facilitated the coherent materialization of the desired system with all its components and features, which is why the organizational actors together became more innovative as an ecosystem. Thus, although all organizational actors were eager to find innovative solutions themselves, they were also more and more willing and able to harness the coopetitive setting for conserving their own resources or taking advantage of existing innovations:

> *"Yes, there were certain elements where one realized: "Oh, those two apps need the same ingredient, the same building block they [another vendor] already have while we still need it. Let us wait for them to complete it or let us use their most current version to test and improve it." One has definitively done that – at least if one has realized that there were dependencies and similar issues." (Field Expert – PV)*

The biggest challenge was the identification of existing innovative solutions, thus the orchestration. This identification of existing innovative solutions was, however, more and more facilitated by the created and adapted basic structure and procedures, such as the scaled agile scrum method with all its meetings and involved organizational actors:

> *"That is why the scrum meetings were so vital for observing what the others were doing. This was particularly true for the vendors, as they were able to observe what the other vendors did: "We will have to do something where they already have a solution. Let us approach and ask them how they did it and whether we could borrow and adapt." Therefore, the communication took place – especially between the vendors who worked in the same place." (Field Expert – PV).*

Interestingly, the organizational actors then harnessed other common innovation artifacts to exploit the identified innovative solutions. In this respect, the freely accessible code and documentation repositories, which made it possible to copy the innovative solutions from each other without cooperating much, became increasingly popular: *"I remember they copied a sequence in one application [the developers of vendor 2] - just copied and adapted. Since we had access to each other's code, they did not have to interact much." (Vendor 2 – Business Analyst 2).* Certain common innovation artifacts have therefore made it possible to replace intensive interpersonal cooperation through the simple duplication of digital resources. In many cases, however, the organizational actors did not manage to copy innovative solutions without cooperating with the innovating actor: *"First of all, there was no unpleasant competition. There might have been even some stories where product owner 2 said to us: "Look, they've [vendor 2] already solved that." [..] One just walked over [and asked them]: "Hey, how did you approach that?"" (Vendor 5 – Project Leader).*

An example in which an organizational actor found an innovative solution and later shared it with another was vendor 5's geolocation feature. Interestingly, even vendor 5 had little experience in implementing such a feature in the first place. However, vendor 5 was able to leverage the expertise of an expert in this field, who happened to be on a sabbatical:

> *"During the implementation of the last app, we had to integrate a geolocation function. That is something I have no experience with it. Fortunately, we had access to our own expert […] he just lived in Geneva for a year, and we were able to involve him. That was just great! The first day he was on site, he looked at the device and knew exactly what is going to work. This spared many issues." (Vendor 5 – Business Analyst)*

Vendor 5 thus found an innovative solution on its own. A short time later, vendor 2 was not as fortunate when it faced a similar challenge. However, vendor 2 learned about this innovative solution from product owner 2. In other words, product owner 2 orchestrated the problem and the innovative solution:

> *"I remember a situation at the beginning where one of our partners [vendor 2] did something in the same area [geolocation]. However, this did not work out, and the first day our expert [for geolocation] was on site, their scrum master and product owner 2 came over to talk to him. Only after two minutes, he was able to tell them why their solution is not working, and he hit bulls' eye!" (Vendor 5 – Business Analyst)*

Vendor 2 was therefore able to bridge its lack of expertise and to find an innovative solution to a faced challenge thanks to the help of vendor 5. In doing so, vendor 2 harnessed both common innovation artifacts and the coopetitive setting for materializing the desired coherent innovation outcome. At the same time, this increased the competitiveness of vendor 5, as it was able to differentiate itself from the other organizational actors with its superior expertise in a specific domain: *"Well, that was certainly something! We were able to bring in a 'vendor 5 differentiator'. I believe not everyone [the other vendors] would have had the skills to do something similar." (Vendor 5 – Project Lead).* Eventually, its cooperativeness that increased its competitiveness paid off, as LogCH assigned vendor 5 to develop two more applications:

> *"It was pleasing – back then two additional apps were popping up on the horizon. We did not expect that but then we were able to implement them. Back then, I would say, the tough competition was… well, I never had the feeling that another vendor was taking anything from us; let us put it like that. It was clear that one has to deliver; otherwise, there was somebody else that made it better." (Vendor 5 – Business Analyst)*

Table 10, Table 11, Table 12, Table 13, and Table 14 provide further illustrative evidence for the four stages. Figure 13, Figure 14, Figure 15, Figure 16, Figure 17, Figure 18, and Figure 19 in the appendix illustrate the emergence of the innovation ecosystem.

Table 10: Illustrative Evidence for Phase 1

Stage	Trigger	Innovation Agency	Structure / Procedures	Cooperation / Competition
Phase 1 Creating	**Rigid System Architecture** Before project REMO, LogCH supported its employees in their day-to-day tasks with mobile computing devices. The architectures of these devices were ***monolithic and did not allow the replacement of individual components or features.***	***LogCH*** had to find a system architecture with independent components (i.e., hardware, software platform, framework, features) and features (i.e., applications).	**Modular System Architecture** LogCH opted for a ***modular cross-compiler architecture (structure & procedures)*** with independent components and features. LogCH ***involved IT LogCH*** to contribute to the framework ***and the Field Experts*** to revise the processes and define 20 apps.	Opting for a flexible cross-compiler architecture enabled the definition of independent components and features. However, to obtain a coherent system, the components and features had to be aligned, which ***assumed the cooperation of the involved organizational actors.***
	Limited Time Horizon Until the approaching end-of-life of the old mobile computing device, ***LogCH had only a little time to implement project REMO*** for supporting its employees with a new mobile computing device in the future.	***LogCH*** had to find a solution to develop the twenty predefined applications, evaluate multiple hardware devices, roll out the new mobile computing system, and train its employees in just about two years.	**Division of Labor** LogCH divided project REMO into subprojects and ***involved six software vendors (structure)***, each with identic capabilities to design, build, test, deploy, and run the twenty predefined applications.	Choosing six software vendors with the identic capabilities to design, build, test, deploy, and run the twenty predefined applications ***enabled the competition between these six software vendors.***
	Methodological Hurdles Before project REMO, LogCH relied on the waterfall model for developing software. Given the complexity of project REMO with a variety of organizational actors and a limited time horizon, however, this ***waterfall model was inappropriate and too risky.***	***LogCH*** had to find a development method that could cope with both the complexity of the new system with all its components and features and the multitude of development partners. For that purpose, LogCH leveraged the expertise of a hired ***scrum expert***.	**Scaled Scrum Method** LogCH opted for an ***agile scaled scrum development method*** with ***two-weekly sprints and meetings at the team-, functional-, and project level (procedures)***. The scrum expert, who also trained the other organizational actors, specified this method.	Opting for an agile scaled agile scrum development method with two-weekly sprints and meetings at the team-, functional-, and project level, made the organizational actors more comparable, which ***facilitated the cooperation and the competition*** between them in project REMO.
	Missing Guidelines The division of labor among multiple organizational actors and the agile scaled scrum development method confronted LogCH with a ***potential threat of proliferation***.	***LogCH*** had to find a solution to coordinate the work of the multiple organizational actors in a way that resulted in a coherent and innovative system for its employees in the field.	**Standardized Guidelines** LogCH stipulated ***standardized guidelines for the architecture, design, development, documentation, and testing of the applications and other software components (procedures).***	Stipulating guidelines to coordinate the work of the organizational actors in a way that resulted in a coherent and innovative system led to a ***means for ensuring meaningful cooperation despite the coopetitive setting***.
	Inconsistent Development Means The division of labor among multiple organizational actors implied the use of different development means, which confronted LogCH with a ***potential threat of proliferation.***	***LogCH*** had to find a solution that reduced the potential threat of proliferation caused by the organizational actors using different and potentially inconsistent development means.	**Standardized Development Means** LogCH ***defined and provided a stack of software (procedures)*** and ***made the code- and documentation repositories freely accessible (procedures)*** to all organizational actors.	Defining and providing a stack of software and making the code- and documentation repositories freely accessible, further ***facilitated the cooperation and the competition*** between the organizational actors.
	Geographical Distribution The division of labor among multiple organizational actors implied a geographical distribution, which ***potentially increased the coordination effort*** for LogCH.	***LogCH*** had to find a solution that allowed to reduce the possible negative consequences of the geographical distribution of the organizational actors and in particular the own coordination effort.	**Co-Location** LogCH ***co-located the organizational actors in a shared office space (procedures)*** with individual and shared rooms. Besides, LogCH also provided the vendors with a coffee machine.	Co-locating the organizational actors and providing a coffee machine facilitated the interaction between them, which further ***facilitated the cooperation and the competition*** between them.

Table 11: Illustrative Evidence for Phase 2a

Stage	Trigger	Innovation Agency	Procedures	Cooperation / Competition
Phase 2a Refining	**Unfinished Framework** The framework built by IT LogCH was incomplete when the application development began, which caused overlaps that led to ***incompatibilities and numerous issues and complaints from the six software vendors***.	***LogCH*** had to find solutions to reduce the incompatibilities and the related issues and complaints of the ***six software vendors***, as the six software vendors themselves were unable to do much to counter them.	**Postponement & Co-Location** LogCH ***postponed IT LogCH's scrum cycle by one week*** for detecting threatening incompatibilities earlier and ***urged IT LogCH to join the six software vendors in the shared office space*** for remedying issues faster.	Facing similar incompatibilities, the ***six software vendors cooperated*** or rather fraternized. Therefore, LogCH postponed IT LogCH's scrum cycle and co-located them, thus ***facilitated the cooperation between IT LogCH and the six software vendors***.
	Vague Documentation Guidelines The stipulated documentation guidelines were ***unknown to all organizational actors and found to be particularly inadequate*** by the six software vendors.	The ***six software vendors*** found themselves constrained to make proposals to remedy the identified inadequacies of the documentation guidelines. Ultimately, however, ***LogCH*** decided on these proposals.	**Remedied Guidelines** ***Vendor 3 and Vendor 2 made proposals*** to remedy the identified inadequacies of the documentation guidelines, and ***LogCH set them as default*** for all organizational actors.	Making proposals to remedy identified inadequacies, LogCH set as standards, ***gave vendor 3 and vendor 2 a competitive advantage*** and ***improved the means for ensuring meaningful cooperation despite the coopetitive setting.***
	Vague Design Guidelines The stipulated usability and design guidelines were found to be ***mostly inadequate to obtain a state-of-the-art, coherent system*** developed by multiple organizational actors, including six competing software vendors.	The ***six software vendors*** fund themselves constrained to make proposals to remedy the identified inadequacies of the design and usability guidelines. Ultimately, however, ***LogCH*** decided on these proposals.	**Unremedied Guidelines** ***The six software vendors made proposals*** to remedy the identified inadequacies of the usability and design guidelines. However, ***LogCH decided to leave the usability and design guidelines mostly unchanged.***	Realizing that LogCH left the usability and design guidelines mostly unchanged – this despite the remedies proposed – the ***six software vendors began competing*** for the best, but not necessarily the most consistent designs and usability logics.
	Malfunctioning Internet Access The shared office space provided by LogCH had only poor and error-prone access to the internet, ***hindering all organizational actors in their work*** – particularly the six software vendors in developing their applications.	***Vendor 4*** noticed that all organizational actors suffered from the same inadequate and error-prone internet access. Against this backdrop, Vendor 4 fund itself constrained to find a solution and therefore approached ***LogCH.***	**Functioning Internet Access** ***Vendor 4*** used its experience to ***provide more reliable internet access to all organizational actors.*** Thus, instead of complaining about the status quo, Vendor 4 took one for the team and helped everybody.	Providing more reliable internet access was a ***highly cooperative act of vendor 4*** that helped all organizational actors to proceed with their tasks. At the same time, it ***gave vendor 4 a competitive advantage*** over all other organizational actors.
	Malfunctioning Test Infrastructure The agile scaled scrum method required the six software vendors and IT LogCH to test their sprint increments with an ***immature and error-prone test infrastructure for complying with the definition of done***.	***Vendor 4*** noticed that all organizational actors suffered from the same immature and error-prone test infrastructure. Against this backdrop, Vendor 4 fund itself constrained to find a solution and therefore approached ***LogCH***.	**Functioning Test Infrastructure** ***Vendor 4*** used its experience to support IT LogCH in ***providing a more reliable test infrastructure and training the other organizational actors*** in its use. Thus, Vendor 4 took one for the team and helped everybody.	Providing a more reliable test infrastructure and training all organizational actors in its use were ***highly cooperative acts of vendor 4*** that helped all organizational actors. At the same time, these acts ***gave vendor 4 a competitive advantage.***
	Neglected Feature Library IT LogCH increasingly ***neglected the maintenance and enhancement of the feature library*** for which it was responsible. This neglect primarily affected the six software vendors.	***LogCH*** had to find solutions for the poorly maintained and barely extended feature library, as the ***six software vendors*** themselves were unable to do much to counter this neglect.	**Copy and Own Policy** ***LogCH introduced a copy and own policy***, which allowed the six software vendors to copy features from each other without having to cooperate and to own these features after that.	Facing similar issues, the ***six software vendors cooperated*** or rather fraternized. Therefore, LogCH introduced a ***copy and own policy that fostered cooperation and competition among the six software vendors.***

Table 12: Illustrative Evidence for Phase 2a (continued)

Stage	Trigger	Innovation Agency	Procedures	Cooperation / Competition
Stage 2a Refining	**Unknown Hardware** The device was initially unknown, which did not ***prevent the six software*** vendors from developing their applications but ***from testing their performance on the device***.	***LogCH*** needed to look for bridging solutions for the initially unknown devices. The ***six software vendors*** themselves could not do much about it but still had to test the device performance of their applications.	**Bridging Solution** ***LogCH bought devices that met the requirements stated in the call for tenders***, which allowed the software vendors to test their applications' performance on a device.	Facing similar issues, the ***six software vendors cooperated*** or rather fraternized. Therefore, LogCH bought devices that ***facilitated the cooperation between the software vendors and the Field Experts***.
	Immature Integration ***IT LogCH struggled to integrate all software components and hardware***, which prevented the software vendors from running their applications on the device.	***Vendor 4*** noticed that all organizational actors suffered from immature hardware-software integration. Against this backdrop, Vendor 4 offered to support ***LogCH*** and ***IT LogCH*** in this regard.	**Mature Integration** ***Vendor 4*** used its experience to ***support IT LogCH with a mature integration and to train everybody else***. Thus, vendor 4 took one for the team and helped everybody.	Supporting IT LogCH in integrating all software components and hardware, and training all, were ***highly cooperative acts of Vendor 4.*** At the same time, these acts ***gave Vendor 4 a competitive advantage.***
	Cognitive Boundaries The ***Field Experts were not very experienced in software development, which particularly hampered the mutual understanding*** between them and the six software vendors during the joint sprint reviews and planning.	***Vendor 2*** noticed the cognitive boundaries between its employees and the Field Experts. Against this backdrop, Vendor 2 fund itself constrained to find solutions for bridging these cognitive boundaries.	**Visual Mock-ups** ***Vendor 2*** came up with the idea of ***using mock-ups to visualize the visions of their software developers*** for subsequent sprints, allowing field experts to more easily understand and comment on these visions.	Using mock-ups to visualize the software developers' visions for future sprints was adopted by the other software vendors and not only ***facilitated the cooperation with the Field Experts*** but also ***increased the competitiveness of Vendor 2.***
	Inadequate Backend Involvement ***The backend systems maintained by IT LogCH were not included from the beginning.*** However, the six software vendors had to build interfaces to the backend systems early on.	The ***six software vendors*** and ***IT LogCH*** needed to find solutions for bridging the previously not included backend systems to ensure a coherent system with functional access to the backend system.	**Backend Interface Emulation** ***The six software vendors began to emulate the interfaces*** of the backend systems, while ***IT LogCH supported them with backend integrators***.	Receiving support from backend integrators while emulating the backend interfaces allowed the six software vendors to proceed with their development and ***eased the cooperation with IT LogCH***.

Table 13: Illustrative Evidence for Phase 2b

Stage	Trigger	Innovation Agency	Structure	Cooperation / Competition
Stage 2b Stabilizing	**Issues of vendor 1** Vendor 1 developed the most central and complex application with interdependencies to all organizational actors. However, ***vendor 1 had more and more difficulty dealing with this complexity***, which primarily affected the development of the application.	***Vendor 1*** needed to find solutions to address the complexity while ensuring the development of its applications. Dissatisfied with Vendor 1, ***LogCH*** had to intervene and reduce the development backlog of the most central and sophisticated application.	**Redistributing Application** Vendor 1 initially chose to lie about its difficulties and isolated itself for focusing on the development of the most central and sophisticated application. ***LogCH noticed these ongoing difficulties and reassigned a second application to vendor 4***.	Lying over its difficulties ***did not help vendor 1 to maintain its competitiveness***, that initially led to the assignment of the most central and sophisticated application. The opposite was the case, as ***vendor 1 had to cooperate with vendor 4*** for handing over a second application.
	Continued Issues of vendor 1 After having handed over a second application to vendor 4, vendor 1 continued to develop the most central and sophisticated application. Unsurprisingly, ***vendor 1 continued to face similar difficulties as before***.	***Vendor 1*** needed to find solutions to address its difficulties. Dissatisfied with the solutions of Vendor 1, ***LogCH*** had to intervene a second time and find its solutions to reduce the development backlog of the most central and sophisticated application.	**Redistributing App & Excluding** Vendor 1 chose to lie about its difficulties and isolated itself. ***LogCH noticed these difficulties and urged vendor 1 to seek support***. Vendor 1 did so by approaching ***vendor 3 that eventually took the application over***.	Lying over its difficulties ***did not help Vendor 1 to maintain its competitiveness.*** The opposite was the case, as ***Vendor 1 had to cooperate with Vendor 3*** for its support and for handing over a second application.
	Isolation of vendor 6 Vendor 6 early on focused exclusively on its tasks and only reluctantly, if ever, participated during the meetings with the other organizational actors. Although vendor 6 progressed with its applications, ***LogCH had to compensate this uncooperativeness.***	***LogCH*** had to find solutions to reduce its efforts, which resulted from the uncooperativeness of Vendor 6. This need to find solutions to reduce its efforts was especially critical, as Vendor 6 was not aware of any misconduct whatsoever.	**Excluding Organizational Actor** LogCH repeatedly urged vendor 6 to participate more actively in the joint scrum meetings. However, this did not help much, and vendor 6 continued to isolate itself. Ultimately, ***LogCH decided to exclude vendor 6*** after the development of two applications.	***Urging vendor 6 to cooperate*** more actively in the joint scrum meetings did not work. Given the fact that other software vendors were more cooperative in these joint scrum meetings than vendor 6 and still more competitive, ***LogCH excluded vendor 6*** after just two applications.
	Staff Fluctuations Vendor 2 and vendor 5 experienced staff fluctuations caused either by internal decisions or by LogCH. Such fluctuations were particularly problematic as ***they led to knowledge losses that hindered development***.	***LogCH*** had to find solutions to bridge such staff fluctuations, which is primarily to reduce the loss of knowledge and to obtain a coherent system within the short period before the end-of-life of the previous system.	**Compensating Staff Fluctuations** Since vendor 2 and vendor 5 were unable to compensate for the loss of knowledge on their own, ***LogCH stabilized it with training sessions for the new staff***.	Bridging the lost knowledge caused by staff fluctuation with training sessions ***helped to maintain the cooperativeness and competitiveness of Vendor 2 and Vendor 5*** following such staff fluctuations.

Table 14: Illustrative Evidence for Phase 3

Stage	Trigger	Innovation Agency	Structure / Procedures	Relation Mode
Stage 3 Exploiting	**Development Issues** The six ***software vendors and IT LogCH repeatedly faced issues within their development tasks they were unable to remedy on their own***. These inabilities presented risks to the schedule and the coherent system.	The ***six software vendors*** and ***IT LogCH*** had to find solutions to faced issues they were unable to remedy on their own. Supporting the vendors in doing so was of interest to LogCH and the Field Experts, as both aimed for a coherent system.	**Supporting Each Other** Since the six software vendors and IT LogCH were not always able to solve faced issues on their own, they ***identified solutions or supporters themselves (procedures) or were pointed to them by LogCH and the Field Experts (structure)***.	Identifying potential supporting organizational actors led to either ***cooperation for solving faced issues***, which also ***increased the competitiveness of the supporter***, or to mere replications of solutions found in the open repositories.
	GPS Functionality Issue Both vendor 2 and vendor 5 faced the issue of having to implement a geolocation feature in some of their applications. However, ***while vendor 5 had the necessary expertise to do so, vendor 2 did not***.	***Vendor 2*** was not as fortunate as ***vendor 5*** and had to find a solution for implementing the geolocation feature in its application. Since ***LogCH*** aimed for a coherent system, it was in its very interest to support vendor 2 in the quest for a solution.	**Supporting vendor 2** ***LogCH became aware of vendor 5's geolocation expertise and informed vendor 2 about this (structure)***. As a result, ***vendor 2 turned to vendor 5 in the shared office (procedure)*** for support in implementing the geolocation feature in its application.	Identifying vendor 5's geolocation feature, ***vendor 2 approached vendor 5 and began to cooperate*** for finding a solution to its issue. That way vendor 2 was able to remedy its issue, while ***vendor 5 was able to show its competitiveness to LogCH***.

4.5. Analytical Summary – Developing a Process Model

Our results indicate that an innovation ecosystem progresses to emerge in three different phases, from the (1) creation, over the (2) adaptation (i.e., (a) refinement and (b) stabilization), toward the (3) exploitation of the underlying structure and procedures. Figure 8 illustrates the resulting process model. In the first phase, one or a few central organizational actors desire a coherent digital innovation. However, they lack the expertise to materialize this coherent digital innovation on their own, which is why they create both the basic structure and procedures of an innovation ecosystem. Concerning the basic structure, the central organizational actors first specify their desires. To materialize these desires, the central organizational actors then determine the necessary capabilities to involve peripheral organizational actors and distribute innovation agency among them. In doing so, the central organizational actors shape the coopetitive setting. In project REMO, LogCH (i.e., the central organizational actor) desired a coherent mobile computing system with a modular cross-compiler architecture. To materialize this system, LogCH needed the capabilities of its independent IT department to develop a framework, field experts to specify applications, and multiple software vendors to build these applications on time. At the same time, LogCH had to distribute innovation agency and to ensure continued cooperation among the peripheral organizational actors. To ensure such continuous cooperation, central organizational actors need to create basic procedures in terms of common innovation artifacts. These common innovation artifacts determine how all involved organizational actors have to materialize a desired digital innovation. In project REMO, these common innovation artifacts included, among others, a standard development method, various development guidelines, and a stack of development tools. Interestingly, not only LogCH defined such common innovation artifacts but also the peripheral organizational actors, for example, IT LogCH that defined the framework.

Once the basic structure and procedures have been created, any hindering or even threatening deficiencies can be identified. In these cases, the basic structure and procedures require adaptations to ensure the materialization of a desired, coherent and customer-oriented digital innovation. More specifically, the procedures require refinements and the structure stabilization. Concerning the basic procedures, distributed innovation agency enables all organizational actors to identify hindering deficiencies of common innovation artifacts and propose innovative solutions to their remedy. The decision whether these innovative solutions lead to refinements of common innovation artifacts, and thus the basic procedures, lies with the central organizational actors. In project REMO, several organizational actors proposed innovative solutions to remedy hindering deficiencies of common innovation artifacts. If

LogCH accepted an innovative solution, the refinement of the common innovation artifact was generally very cooperative and made the innovation ecosystem progress in its emergence. At the same time, the refinement of the common innovation artifact also increased the competition between the organizational actors healthily, thereby shaping the coopetitive setting. Besides procedural deficiencies, however, emerging innovation ecosystems may also face structural ones. As with procedural deficiencies, all organizational actors can identify them. However, different from procedural deficiencies, peripheral organizational actors can hardly make innovative solutions to remedy structural deficiencies. It is therefore up to the central organizational actors to stabilize them. Thus, while all organizational actors can detect structural deficiencies, only the central organizational actors decide on a possible redistribution of innovation agency to stabilize the coopetitive setting. In project REMO, LogCH needed to stabilize the coopetitive setting multiple times, which eventually led to the exclusion of two peripheral organizational actors and the redistribution of their innovation agency to others. In both illustrated cases, the structural deficiency manifested in the intense competitive thinking of the two peripheral actors and their lack of cooperation, which risked the coherent materialization of the desired digital innovation.

Once the basic structure and procedures of an innovation ecosystem have been adapted, all organizational actors can exploit them to materialize a desired digital innovation. More specifically, all organizational actors can harness both the refined common innovation artifacts and the stabilized coopetitive setting as orchestration entities to match problems with innovative solutions. Concerning the stabilized coopetitive setting, this means that the organizational actors are cooperative enough to share innovative solutions and support others, even if they compete with them. In project REMO, the stabilized coopetitive setting resulted in exactly this – it facilitated and even promoted the cooperation between the vendors despite their own goals. Based on the stabilized structure, for example, LogCH was able to match the innovative solution of vendor 5 to the problem of vendor 3 and to foster the cooperation between them. This example and others illustrate how a stabilized coopetitive setting acts as an orchestration entity that fosters the materialization of a desired and coherent digital innovation. The same applies to refined basic procedures in terms of refined common innovation artifacts. Based on refined basic procedures, all organizational actors can exploit an innovation ecosystem better in terms of matching solutions to problems with the help of refined common innovation artifacts. In project REMO, for example, certain refined common innovation artifacts enabled the organizational actors to identify and borrow or duplicate innovative solutions from others to solve their own problems.

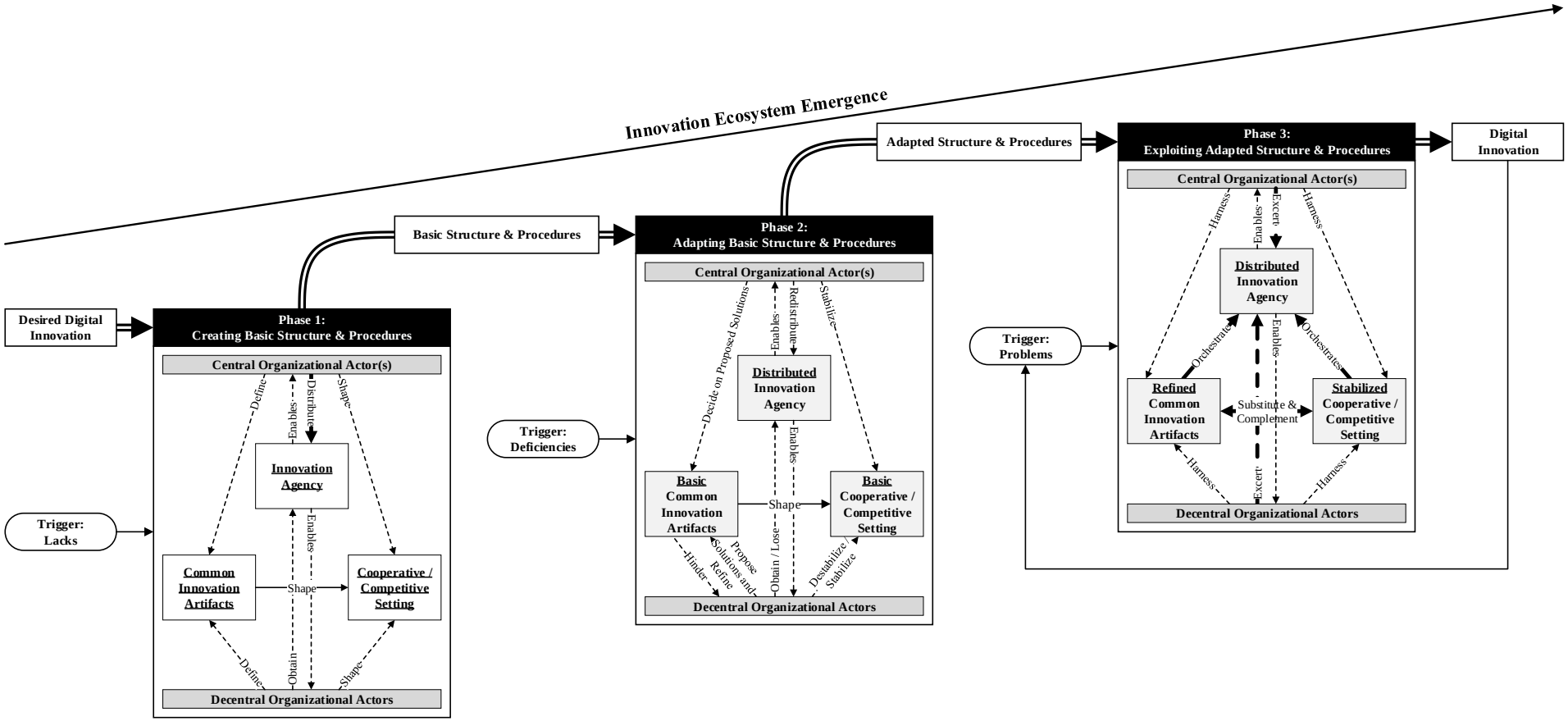

Figure 8: Process Model of Innovation Ecosystem Emergence

4.6. Discussion

The goal of this study was to answer the research questions of (1) how central organizational actors create innovation ecosystems and (2) how and why such innovation ecosystems progress in their emergence over time and through the interplay of all involved organizational actors that pursue both common and own goals. To answer these questions, we chose to conduct a longitudinal single-case study about the software development project REMO with nine partially competing organizational actors that had to cooperate for a coherent and customer-oriented mobile computing system to materialize. This constellation has proved to be uniquely suited to answer our research questions for three particular reasons. First, the created basic structure of project REMO was initially competitive and only became cooperative, or rather coopetitive, over time. Such a development from competitive to coopetitive is particularly well suited to understand why and how organizational actors with their own goals begin to join forces for materializing a coherent and customer-oriented digital innovation together. Interestingly enough, such evolutions from competitive to coopetitive structures are rarely found in previous research on inter-organizational collaboration (Majchrzak, Jarvenpaa, & Bagherzadeh, 2014). Second, project REMO relied on the distribution of innovation agency to all organizational actors in the innovation ecosystem. Such a distribution of innovation agency is a prerequisite for understanding how central organizational actors create innovation ecosystems and distribute innovation agency, as well as how and why all organizational actors subsequently innovate together and materialize a coherent and customer-focused digital innovation. Setting with distributed innovation agency can hardly be found in traditional research on innovation (Nambisan et al., 2017). Third, the desired mobile computing system was both innovation outcome and an essential part of the innovation process. This circumstance is barely known from traditional literature on innovation, but it is increasingly the case with digital innovations (Nambisan et al., 2017). In innovation ecosystems, however, this increasingly blurred boundary between the innovation process and outcome is essential to materialize coherent and customer-oriented digital innovations.

In response to our first research question, our findings highlight the creative role of central organizational actors regarding the basic structure and procedures. In terms of the basic structure, central organizational actors first specify the desired digital innovation. Based on this desired digital innovation, the central organizational actors then derive the necessary competencies, select organizational actors with these competencies, and distribute innovation agency among them. In project REMO, the central organizational actor aimed at materializing a coherent mobile computing device with a modular cross-compiler architecture. To achieve

this goal, LogCH required the capabilities of its independent IT department to develop a framework, field experts to specify applications, and multiple software vendors to build these applications on time. In terms of the basic procedures, central organizational actors and selected peripheral organization actors define common innovation artifacts that determine how desired digital innovations are to be materialized by all organizational actors in an innovation ecosystem. In the REMO project, these common innovation artifacts included, for example, a standardized development method, a stack of development tools, and guidelines.

In response to our second research question, we find that innovation ecosystems progress to emerge in three different phases, from the (1) creation, over the (2) adaptation (i.e., (a) refinement and (b) stabilization), toward the (3) exploitation of the underlying structure and procedures. In the first phase, as described above, central organizational actors create the basic structure and procedures of an innovation ecosystem. However, these basic structures and procedures are usually not ideally suited for the materialization of digital innovation by multiple organizational actors with their own goals. For this reason, they are adapted in a second phase. More specifically, the central organizational actors stabilize the basic structure by distributing and redistributing innovation agency, while the peripheral organizational actors help refine the basic procedures. In terms of the basic procedures, the peripheral organizational actors thus assume their innovation agency to refine common innovation artifacts. Once the basic structure and procedures are adapted to the needs of an innovation ecosystem, all organizational actors can exploit them. More precisely, the adapted basic structure and procedures act as orchestration entities for matching solutions with problems during the materialization of desired coherent and customer-oriented digital innovations. Together, these findings theoretically contribute to the literature on innovation ecosystems, digital innovation, and broader research on the coopetition paradox.

4.6.1. Implications for Theory

Our study has important implications for research on innovation ecosystems, in particular on their emergence. So far, research on innovation ecosystems has investigated how central organizational actors compel other organizational actors to commit to creative efforts in situations where uncertainty is high (Dattée et al., 2018) or move from ‘blind dating’ toward ‘arranged marriages’ among themselves (Paquin & Howard-Grenville, 2013). While this research has broadened our understanding of the creation of innovation ecosystems, it has focused exclusively on the perspective of central organizational actors (Lumineau & Oliveira, 2018). Our results differ from these one-sided insights into innovation ecosystems by looking at several and partially competing organizational actors that, over time, cooperate for a coherent

and customer-oriented mobile computing system to materialize. This more sophisticated view on the creation and emergence of an innovation ecosystem allowed us to shed light on the procedural dynamics without limiting ourselves to the potential orchestrating actions of central organizational actors. Notably, this more sophisticated view has enabled us to show that innovation ecosystems emerge in three different phases, from the (1) creation, over the (2) adaptation (i.e., (a) refinement and (b) stabilization), toward the (3) exploitation of the underlying structure and procedures. In contrast to earlier studies, we explicitly emphasize the importance of peripheral organizational actors during these phases and particularly concerning their innovative solutions for refining the basic procedures. Only if the common innovation artifacts effectively support the organizational actors in materializing coherent and customer-oriented digital innovation, an innovation ecosystem progresses to emerge. Besides, however, we also emphasize the importance of stabilizing adaptations of the basic structures of innovation ecosystems by central organizational actors. Coherent and customer-oriented digital innovation can only be materialized if the structure of an innovation ecosystem is stable in terms of the composition of the organizational actors. Thus, the better adapted the structure and the procedures, the better organizational actors can exploit them to materialize coherent and customer-oriented digital innovation.

Our study also has important implications for research on digital innovation. In particular, our findings help to understand how and why innovation agency is distributed and redistributed among organizational actors in innovation ecosystems. So far, traditional research on innovation has focused on predefined sets of focal innovation agents, such as the employees in research and development divisions. In doing so, traditional research on innovation has broadly neglected questions regarding how and under which conditions innovation agency becomes distributed and redistributed among large numbers of organizational actors (Nambisan et al., 2017). Such a general distribution of innovation agency, which makes every single organizational actor a potential innovator, is at the center of innovation ecosystems. However, our results show that it is not just about the distribution of innovation agency, but also about its redistribution over time and its actual use by organizational actors. More specifically, we show that central organizational actors need to stabilize the basic structure of an innovation ecosystem by reassigning innovation agency from organizational actors that refrain from actively contributing during the materialization of a desired digital innovation. The absence of such self-defense mechanism would hinder an innovation ecosystem from progressing in its emergence, which would also prevent the materialization of a desired digital innovation. Besides, our results also shed light on the orchestration of digital innovation in terms of a dynamic matching of

innovative solutions to problems through the structure and procedures of an innovation ecosystem. More specifically, we were able to show that organizational actors, as well as common innovation artifacts, can act as orchestration entities for matching innovative solutions to problems. Thus, the better the structure and procedures help to match innovative solutions to problems, the more progressed an innovation ecosystem is in its emergence.

As a final contribution, our study has important implications for the broader literature on coopetition and especially on the aspect of the balancing cooperation and competition (Bengtsson & Kock, 2014). So far, the call for exploring the optimal blend between cooperation and competition has remained unaddressed (Ketchen Jr, Snow, & Hoover, 2004). We contribute to this gap in two ways. First, we show that both cooperation and competition are essential ingredients for the emergence of innovation ecosystems. Cooperation is essential in situations where organizational actors do not have the required knowledge to solve problems on their own. In these situations, cooperation between organizational actors is crucial for identifying innovative solutions fast to continue with the materialization of coherent and customer-oriented digital innovation. Competition is essential for the ongoing search for innovative solutions but must not harm the coherent and customer-oriented materialization of a desired digital innovation. Second, we show that coopetition is not naturally existent in innovation ecosystems, which urges organizational actors to establish coopetitive situations.

4.6.2. Practical Implications

Established companies are increasingly joining forces with other organizational actors in innovation ecosystems. In doing so, these companies use their collective innovative power to co-create and modify digital innovation for reducing the risk of disruptive technologies and unexpected competitors (Adner, 2006, 2017). In this regard, our results provide meaningful guidance for practitioners on how to create innovation ecosystems and how to promote the emergence of an innovation ecosystem over time for materializing coherent customer-oriented digital innovation. First, we show that central organizational actors can create the basic structure and procedures of an innovation ecosystem. To this end, central organizational actors must create the basic structure of an innovation ecosystem by specifying the desired digital innovation, deducting the required capabilities for materializing this digital innovation, and involving organizational actors with these required capabilities. At the same time, central organizational actors must also create the basic procedures in terms of common innovation artifacts that determine how a desired digital innovation is to be materialized by and between the involved organizational actors. Examples for such common innovation artifacts include, for example, guidelines, prescribed development tools, or standardized development methods.

Second, we show that for an innovation ecosystem to progress in its emergence, central organizational actors must consider the innovative solutions of peripheral organizational actors for refining the common innovation artifacts, as well as constantly stabilize the basic structure. In other words, while central organizational actors can create the basic structure and procedures of an innovation ecosystem, they should by no means ignore the innovative solutions of the peripheral actors to adapt them. The better adapted the structure and the procedures of an innovation ecosystem, the better organizational actors can exploit them to materialize coherent and customer-oriented digital innovation.

4.6.3. Future Research

Future research can extend our findings in at least two promising directions. First, our study focused on how central organizational actors create innovation ecosystems and how and why such innovation ecosystems progress in their emergence over time until they are well balanced and running to the satisfaction of all organizational actors. In other words, the organizational actors within an innovation ecosystem can exploit the structure and procedures to materialize coherent and customer-oriented digital innovations. However, we still know little about how such innovation ecosystems continue to emerge once they are well balanced and running, particularly if new organizational actors join. This raises the question of how additional organizational actors should be included in innovation ecosystems with well-adapted structures and procedures. For example, should the existing organizational actors consider the potential agendas and strategies (i.e., Hannah & Eisenhardt, 2018) of these newcomers? If so, how could the existing organizational actors identify and respond to these agendas and strategies for guaranteeing a continuous emergence of their innovation ecosystem? Second, our study shows that created and refined procedures are essential drivers for the emergence of an innovation ecosystem. However, we still know little about how the specific natures of the underlying common innovation artifacts contribute to the emergence of an innovation ecosystem. This raises the question of how specific types of common innovation artifacts contribute to the coherent and customer-oriented materialization of digital innovations. For example, are guidelines more efficient common innovation artifacts for achieving coherent and customer-oriented digital innovations than prescribed infrastructures? If so, how could these differences be exploited?

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Appendix A to Chapter 2: Case Drawings

CB-1 – The Flagship Complementor that Merged to Average

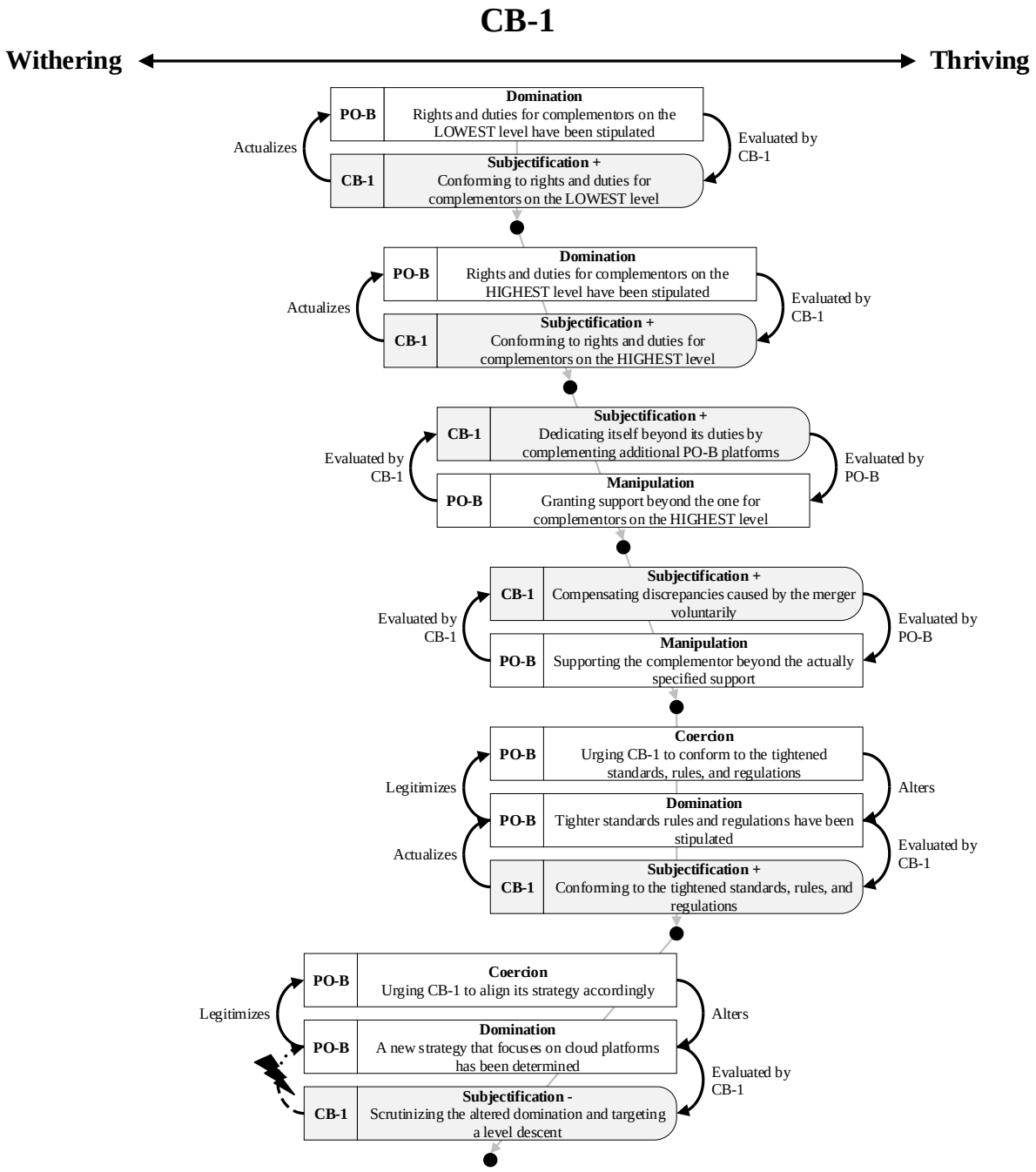

Figure 9: CB-1 – The Flagship Complementor that Merged to Average

CB-2 – The Former Subsidiary that Alienated

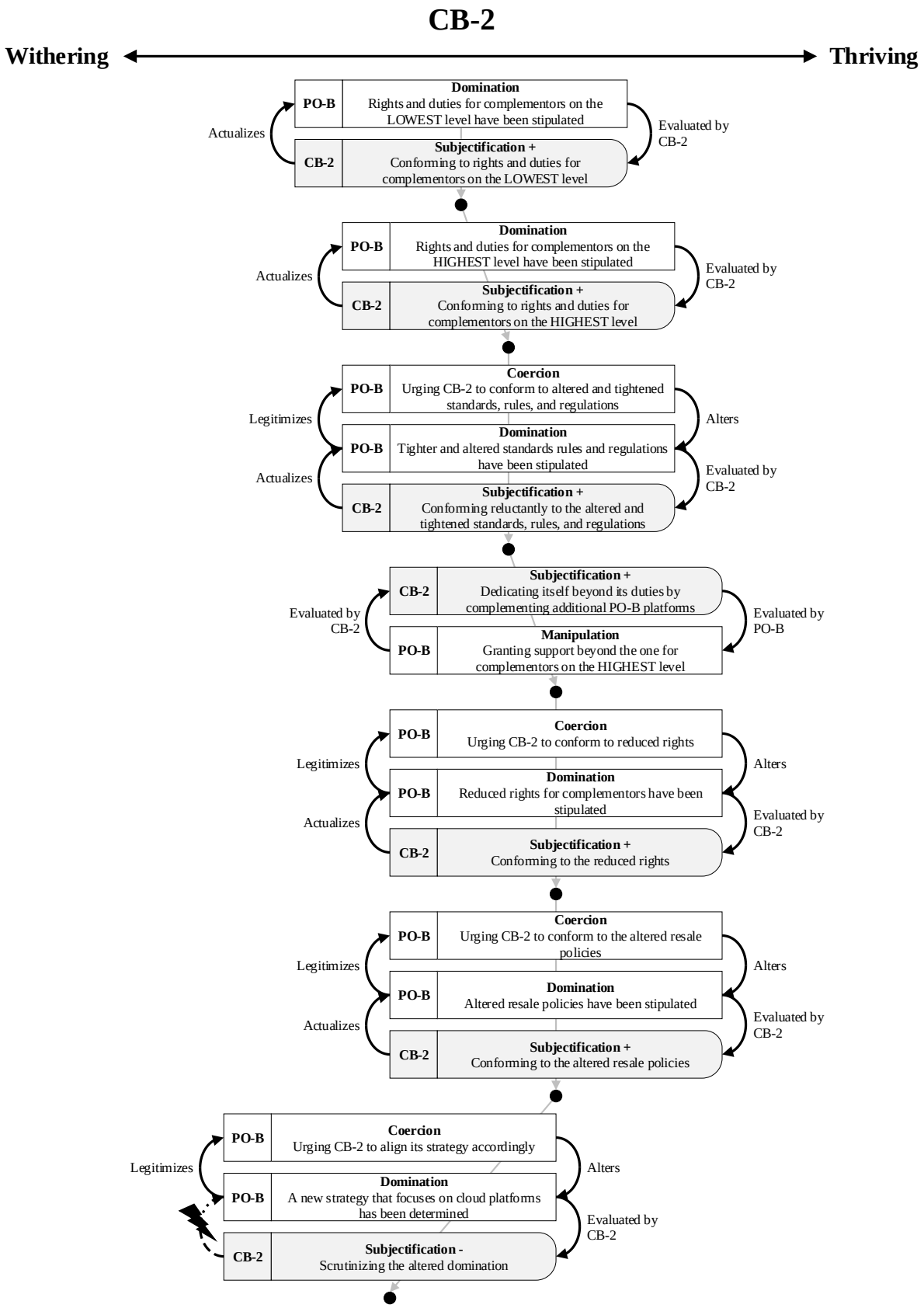

Figure 10: CB-2 – The Former Subsidiary that Alienated

CC-1 – The Deceived Complementor that Stayed

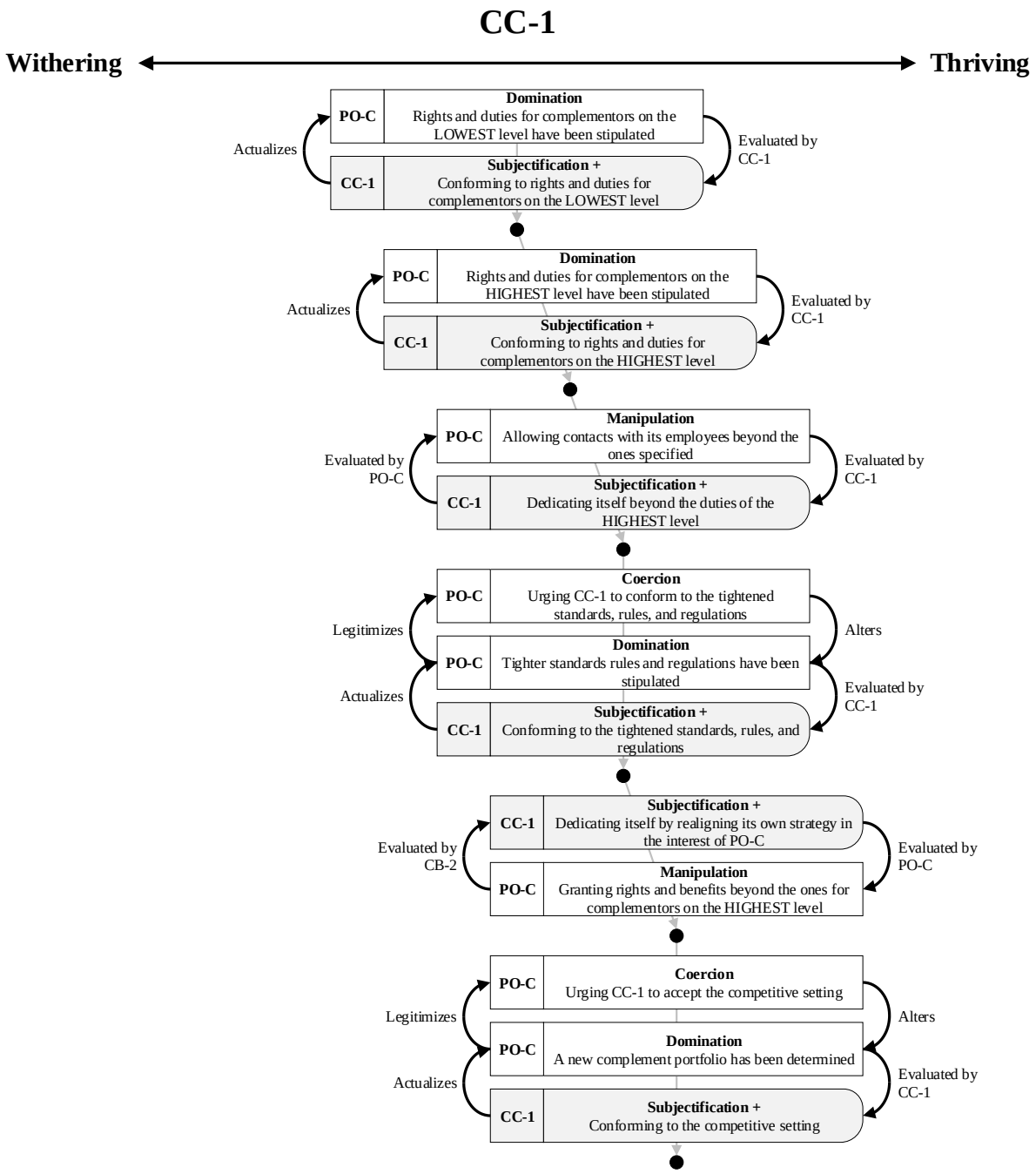

Figure 11: CC-1 – The Deceived Complementor that Stayed

CC-2 – The Co-financed Complementor that Alienated

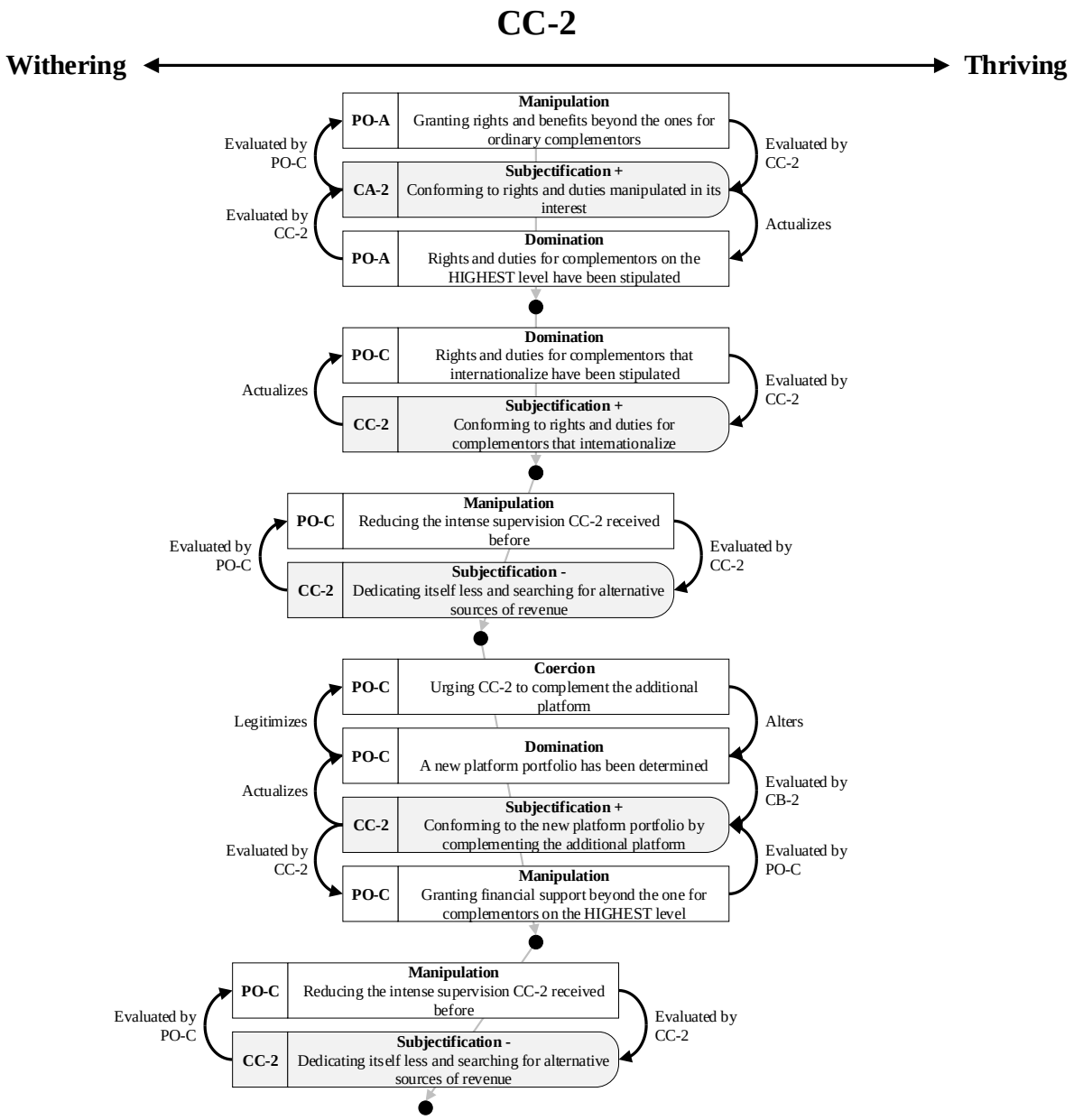

Figure 12: CC-2 – The Co-financed Complementor that Alienated

Appendix B to Chapter 3: Construct Measures

The constructs used were embedded in an industry-wide survey with a special focus on partnerships in the software industry. First, the respondents were asked to complete questions about the nature of their company (e.g., standard software manufacturer, custom software manufacturer, software integrator, etc.) and operating numbers (e.g., revenue, R&D expenditures, number of employees, etc.). Second, software partnerships were defined. Third, the respondents were asked to identify all the platform owners they maintain partnerships with. Fourth, the respondents were asked to identify the most important platform owner among the previously listed. The name of the most important platform owner subsequently replaced the term *platform owner* in the measurements. All independent and dependent constructs used multi-item five-point Likert measures, from strongly disagree to strongly agree anchors.

Independent Variables

Table 15: Perceived Rule Adequacy

Perceived Rule Adequacy		
Definition:	The extent to which complementors perceive the ecosystem-wide rules to secure their own interests as opposed to only securing the interests of the platform owner.	
Measures:	The rules of conduct in the partner network (e.g., standard partnership agreement, guidelines, code of conduct) …	
	...protect the interests of our firm vis-à-vis platform owner.	Based on Child et al. (2003); Gefen and Pavlou (2012) Contextualized with (Huber et al., 2017); Tiwana et al. (2010); Wareham et al. (2014)
	...prevent inappropriate behavior on the part of platform owner.	Based on Child et al. (2003); Gefen and Pavlou (2012) Contextualized with (Huber et al., 2017); Tiwana et al. (2010); Wareham et al. (2014)
	...ensure that our company will receive the promised partnership benefits from platform owner.	Based on Child et al. (2003); Gefen and Pavlou (2012) Contextualized with (Huber et al., 2017); Tiwana et al. (2010); Wareham et al. (2014)
Cronbach's α:	0.850	
CR:	0.910	
AVE:	0.771	

Table 16: Perceived Flexibility in Practicing Rules

Perceived Flexibility in Practicing Rules		
Definition:	The extent to which complementors perceive the enactment of ecosystem-wide rules (e.g., rules, codes of conduct, or partnership charters) by the platform owner as responsive.	
Measures:	The rules of conduct of the partner network (e.g., standard partnership agreement, guidelines, code of conduct)...	
	…are interpreted flexibly.	Based on Boyle et al. (1992); Heide and John (1992) Contextualized with Huber et al. (2017); Wareham et al. (2014)
	…are handled as needed in a given situation.	Based on Boyle et al. (1992); Heide and John (1992) Contextualized with Huber et al. (2017); Wareham et al. (2014)
	…allow room for interpretation.	Based on Boyle et al. (1992); Heide and John (1992) Contextualized with Huber et al. (2017); Wareham et al. (2014)
Cronbach's α:	0.886	
CR:	0.929	
AVE:	0.814	

Table 17:Perceived Benevolence in Practicing Rules

Perceived Benevolence in Practicing Rules		
Definition:	The extent to which complementors perceive the enactment of ecosystem-wide rules (e.g., rules, codes of conduct, or partnership charters) by the platform owner as kind and generous.	
Measures:	The interpretation of the rules of conduct in the partner network (e.g., standard partnership agreement, guidelines, code of conduct) is always …	
	…in the interest of our partnership.	Based on McKnight et al. (2002) Contextualized with Huber et al. (2017); Wareham et al. (2014)
	…in favor of our partnership.	Based on McKnight et al. (2002) Contextualized with Huber et al. (2017); Wareham et al. (2014)
	…beneficial to our partnership.	Based on McKnight et al. (2002) Contextualized with Huber et al. (2017); Wareham et al. (2014)
Cronbach's α:	0.897	
CR:	0.935	
AVE:	0.829	

Dependent Variable

Table 18: Complementor Dedication

Complementor Dedication		
Definition:	The degree to which a complementor is devoted, faithful, and willing to invest in the partnership with a platform owner.	
Measures:	Our company intends to…	
	...intensify its partnership with platform owner.	Based on Anderson (1985); Heide and John (1992) Contextualized with Tiwana (2015)
	...intensify existing personal contacts with employees of platform owner.	Based on Anderson (1985); Heide and John (1992) Contextualized with Tiwana (2015)
	...establish new personal contacts with employees of platform owner.	Based on Anderson (1985); Heide and John (1992) Contextualized with Tiwana (2015)
	...acquire additional certificates from platform owner.	Based on Anderson (1985); Heide and John (1992) Contextualized with Tiwana (2015)
Cronbach's α:	0.886	
CR:	0.922	
AVE:	0.749	

Control Variables

Table 19: Control Variables

Variable:	Measures:	References:
Partnership Age:	The number of years the complementor was in a partnership with the platform owner	Based on Lee and Kim (1999); Tiwana (2015) modified to reflect our particular context.
Multi-homing:	The simultaneous participation in more than one platform ecosystem	Based on Bakos and Katsamakas (2008); Choi (2010); Mantena and Saha (2012); Tiwana (2015) to reflect our particular context.
Partner Manager:	Dummy coded as 1 if the complementor is provided with an individual partner manager; 0 if the complementor is not provided with an individual partner manager	Based on Huber et al. (2017) to reflect our particular context.
Size:	The self-indicated count of employed full-time equivalents in Switzerland	Based on Roberts and Grover (2012) to reflect our particular context.
Dependence:	Our company… ...is dependent on platform owner. ...has no good alternative to platform owner. ...would have difficulty in replacing platform owner. ...would have difficulty achieving its own goals in the event of the dissolution of the partnership with platform owner.	Based on Ganesan (1994), Lee and Kim (1999) Lusch and Brown (1996), Noordewier et al. (1990), and Rao et al. (2007) modified to reflect our particular context.
	Cronbach's α: 0.846	
	CR: 0.894	
	AVE: 0.678	

Appendix C to Chapter 3: Exploratory Factor Analysis

Table 20: Exploratory Factor Analysis Results

	Factor 1	Factor 2	Factor 3	Factor 4	Factor 5
Ded_1	.840	.037	-.086	.016	.081
Ded_2	.943	-.056	.030	.064	-.098
Ded_3	.951	.009	.003	-.009	-.075
Ded_4	.707	.036	.046	-.091	.116
Dep_1	.025	.806	-.034	.003	-.002
Dep_2	-.054	.819	.037	.057	-.071
Dep_3	.048	.861	.019	-.009	-.021
Dep_4	.004	.816	-.007	-.063	.105
FlexPrac_1	-.003	.067	.909	.093	-.039
FlexPrac_2	.008	-.065	.917	.000	.006
FlexPrac_3	-.009	.012	.884	-.095	.012
BenePrac_1	.030	.037	.111	.755	.169
BenePrac_2	.006	-.053	-.126	.969	.007
BenePrac_3	-.035	.019	.045	.950	-.083
RuleAdeq_1	.067	-.087	.036	.030	.831
RuleAdeq_2	.003	-.058	.069	-.054	.918
RuleAdeq_3	-.054	.131	-.112	.045	.858
% Variance Explained	30.391%	18.334%	12.179%	9.394%	7.023%
Eigenvalue	5.166	3.117	2.070	1.597	1.194

Appendix D to Chapter 4: Timeline

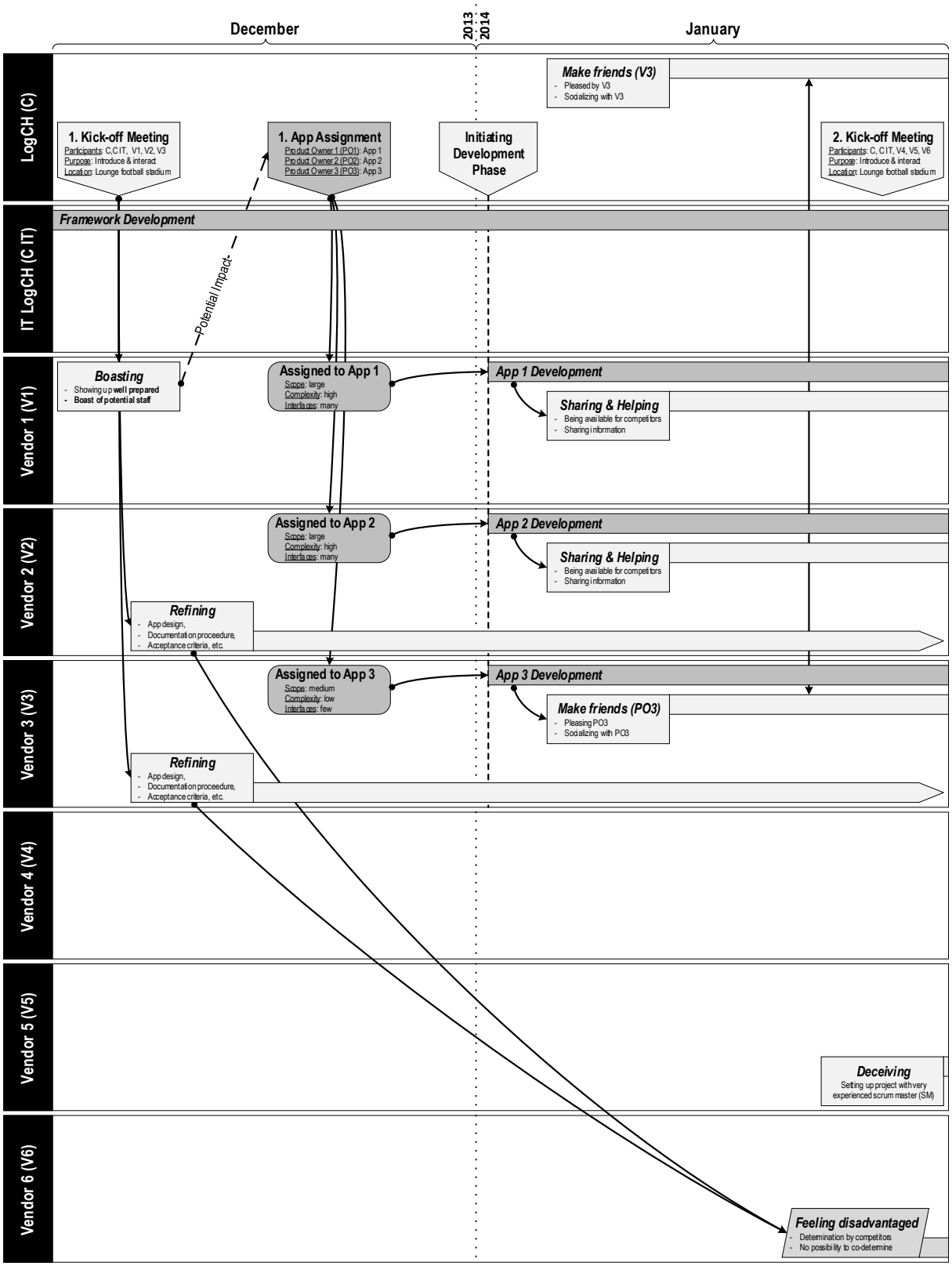

Figure 13: Timeline December 2013 and January 2014

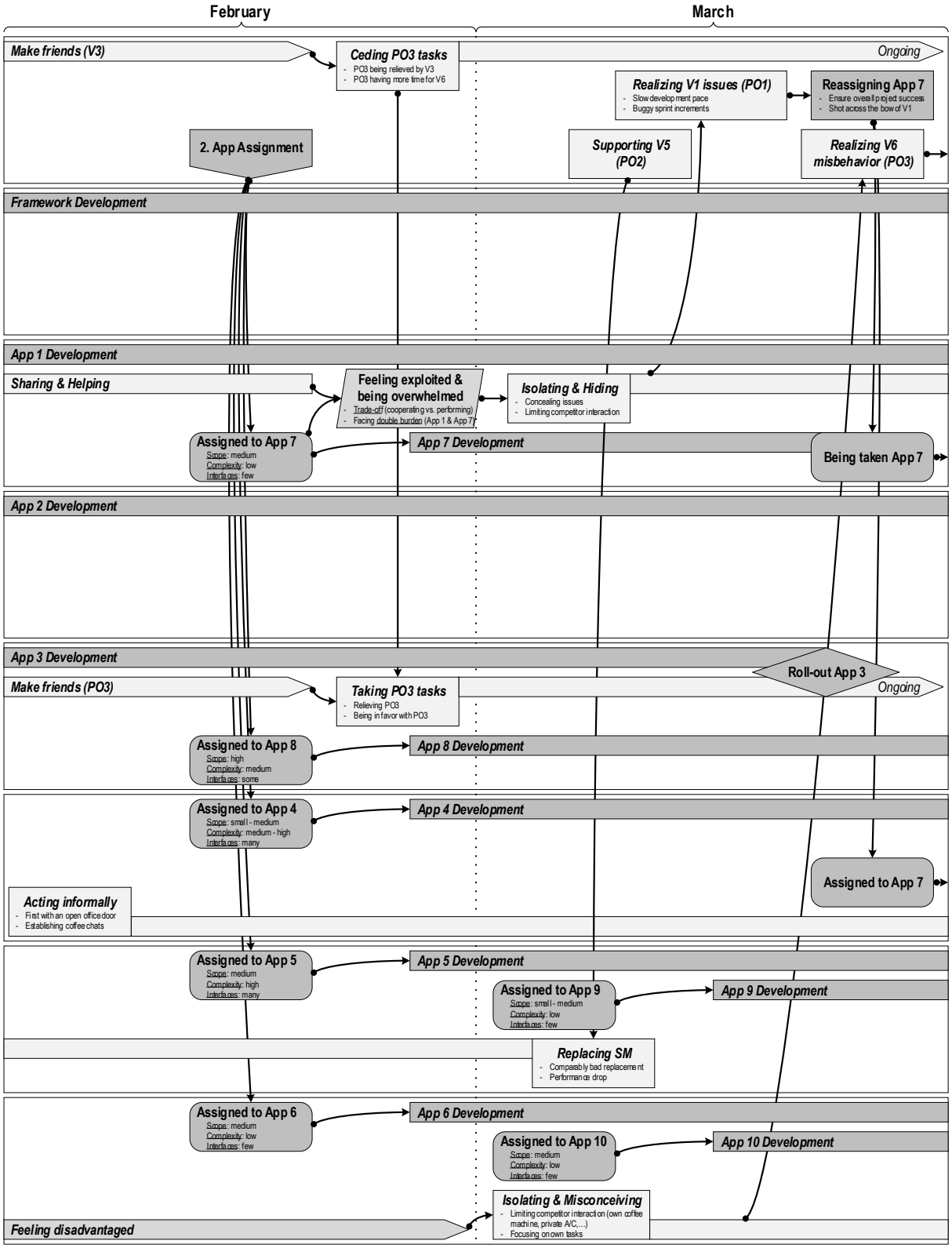

Figure 14: Timeline February and March 2014

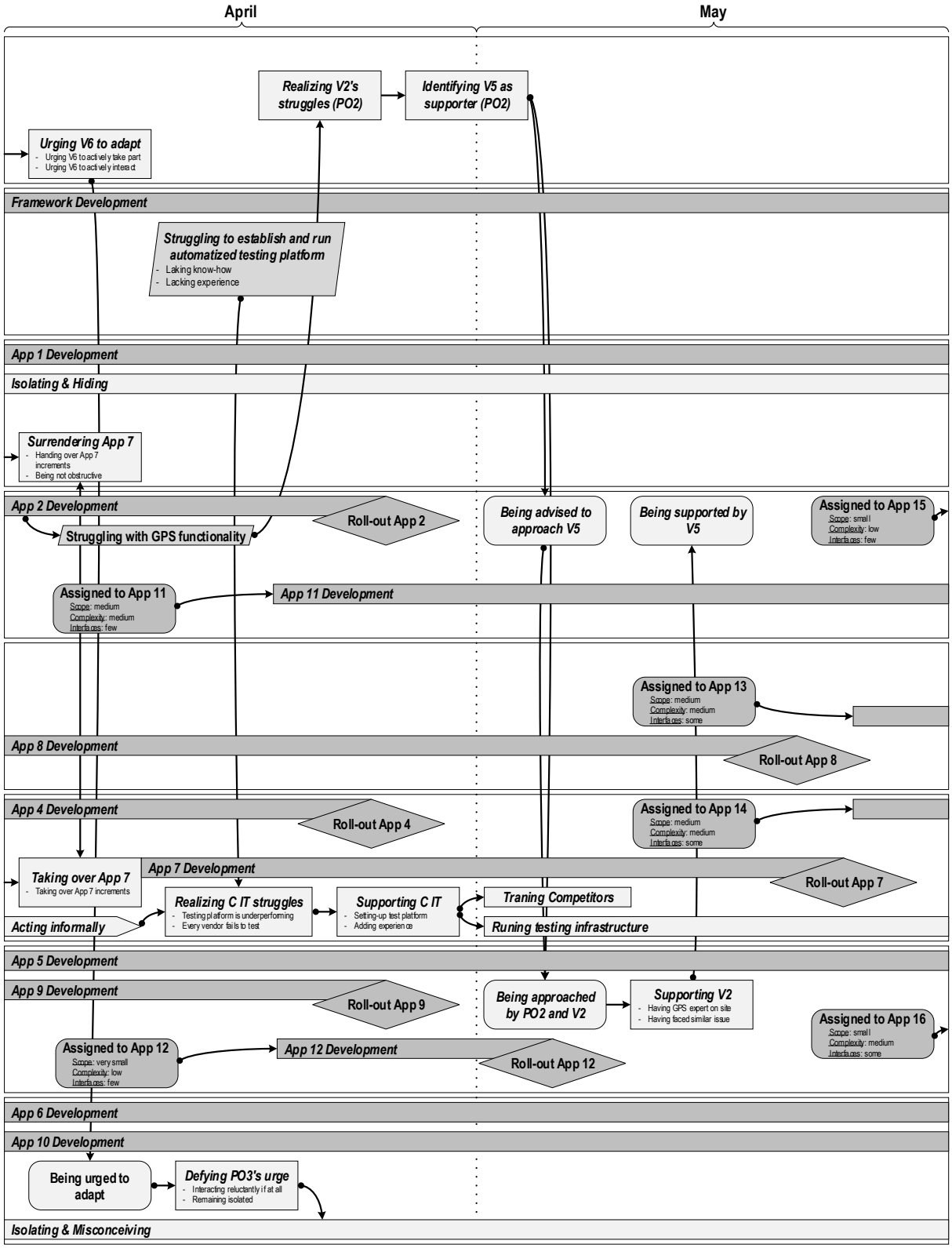

Figure 15: Timeline April and May 2014

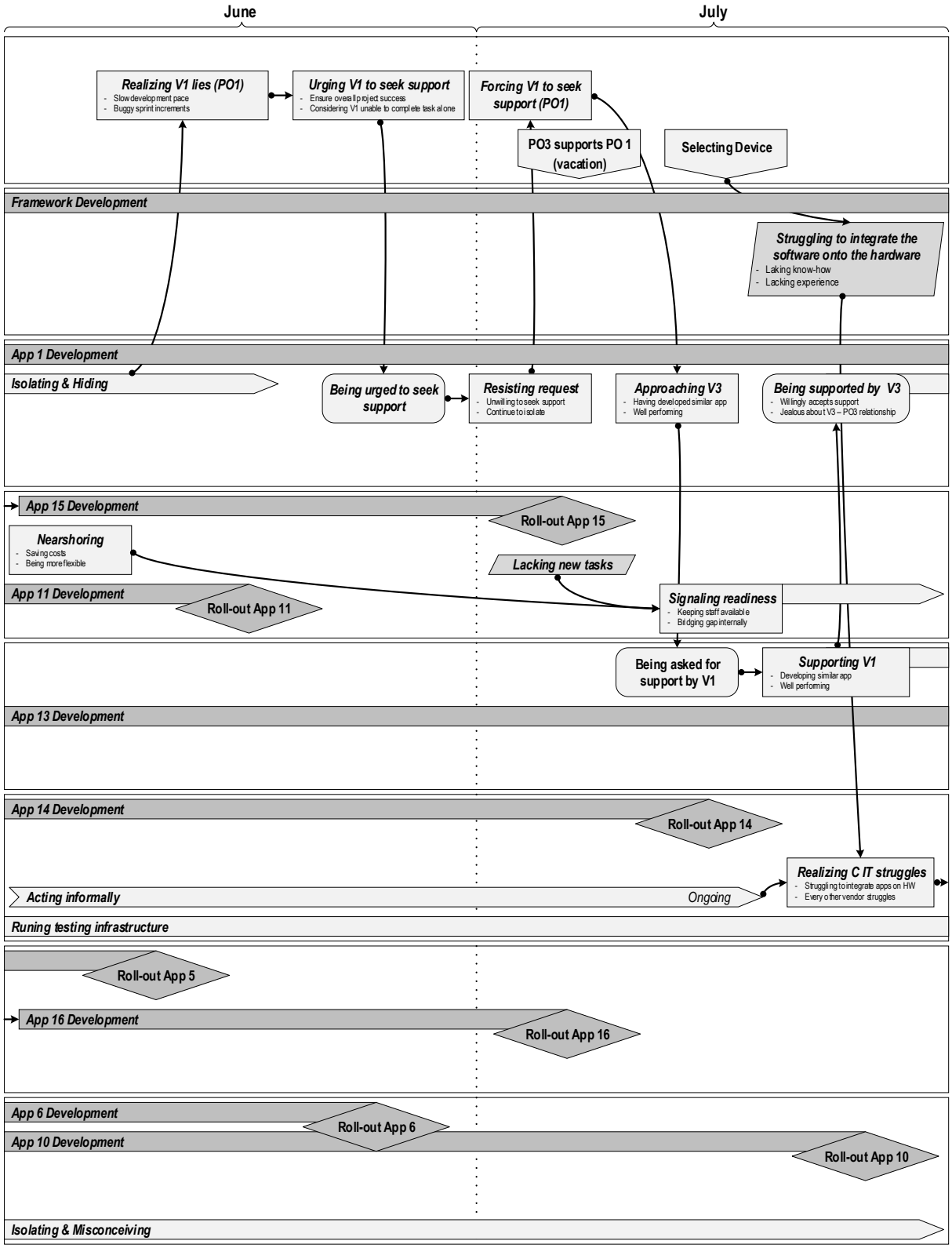

Figure 16: Timeline June and July 2014

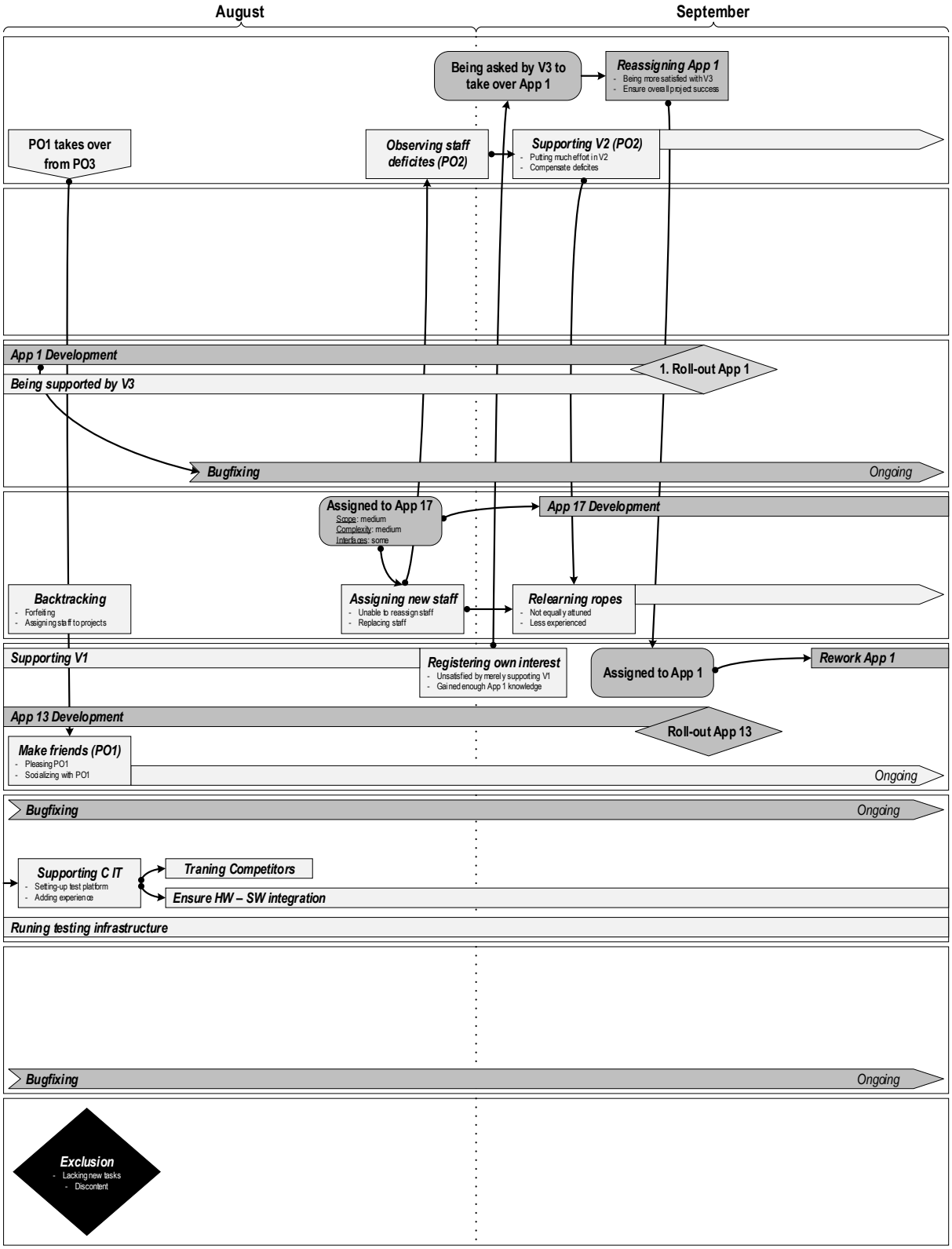

Figure 17: Timeline August and September 2014

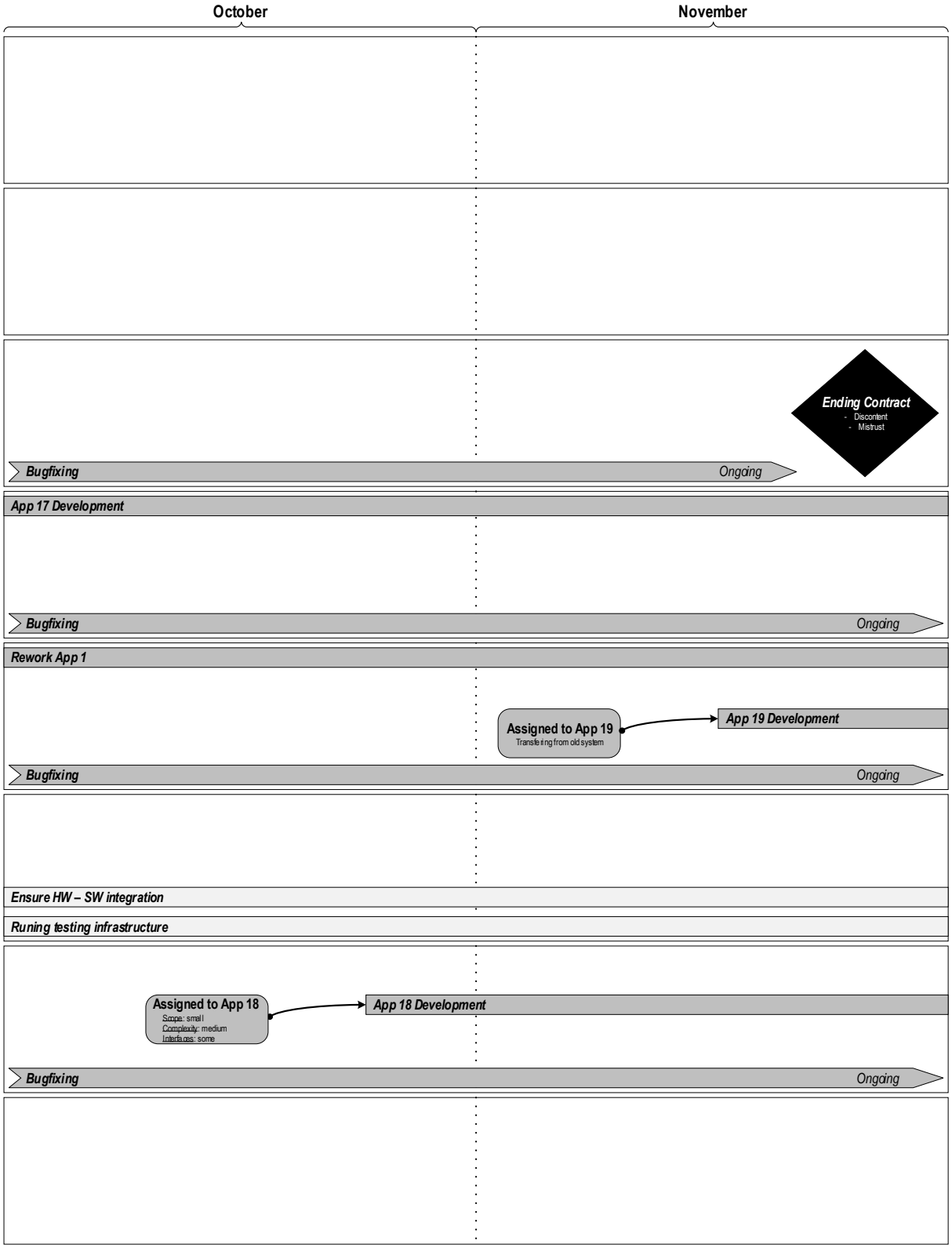

Figure 18: Timeline October and November 2014

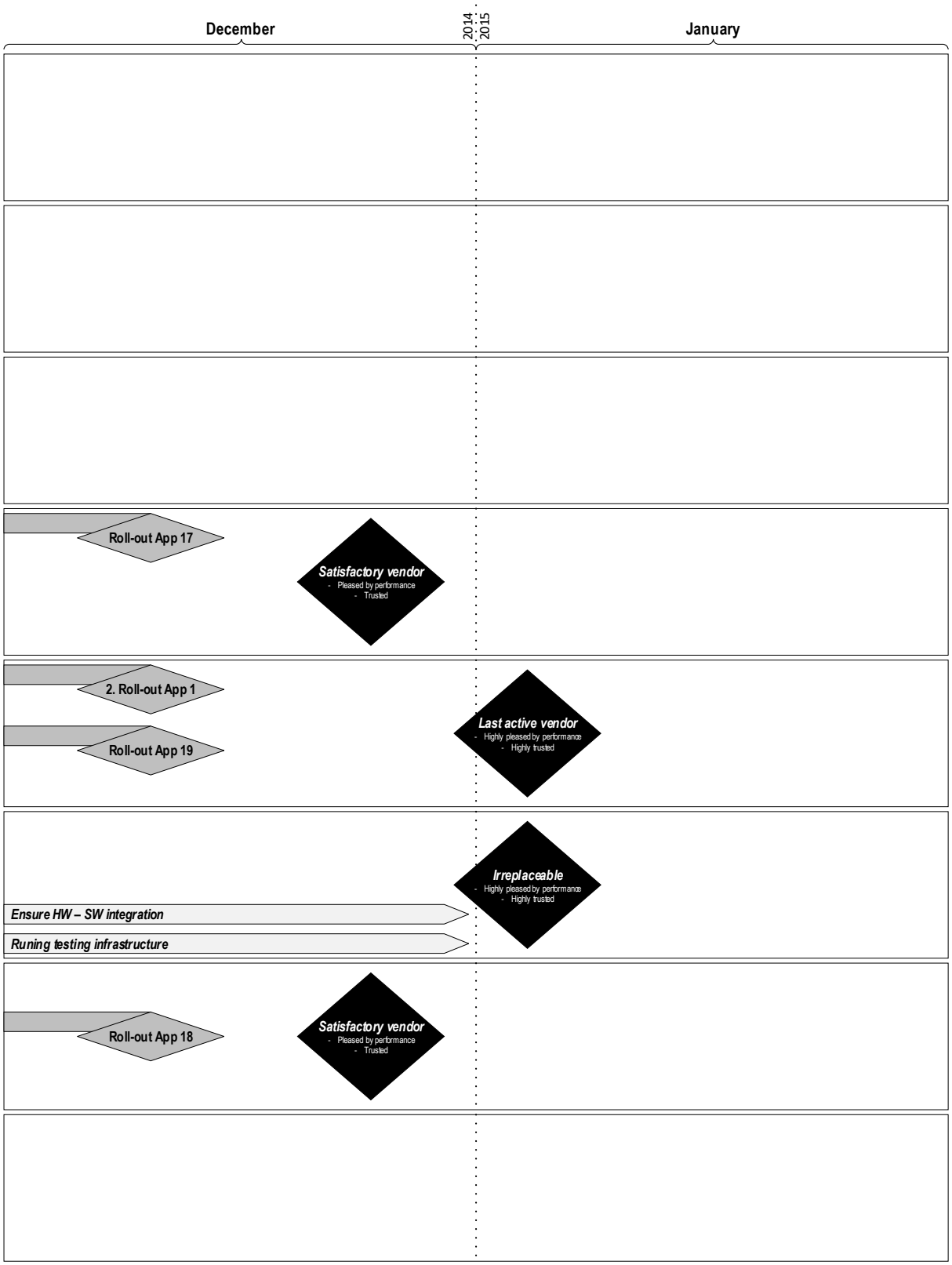

Figure 19: Timeline December 2014 and January 2015

Appendix E to Chapter 4: Organizational Actors and Roles

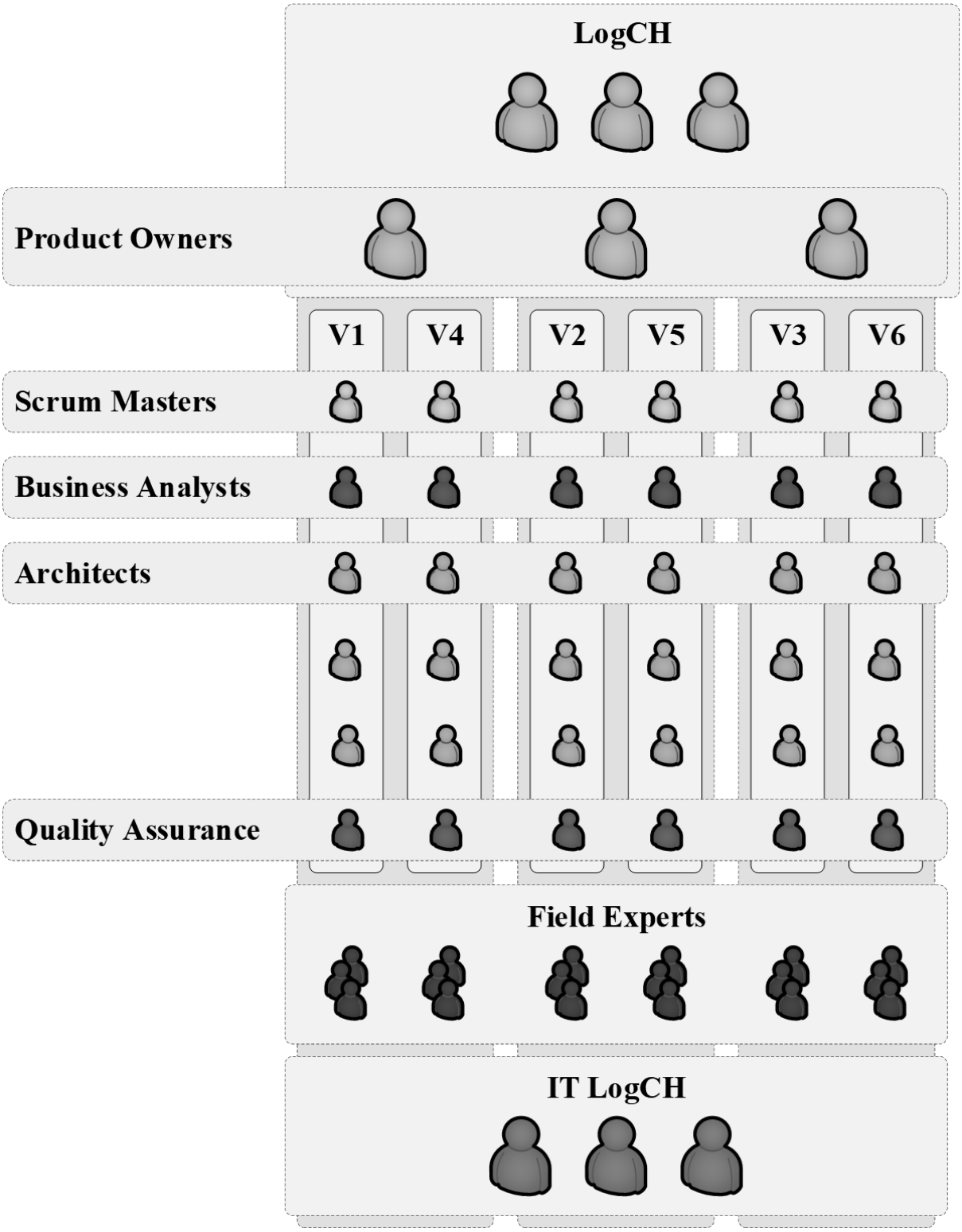

Figure 20: Involved Organizational Actors and Roles

Appendix F to Chapter 4: Shared Office Space

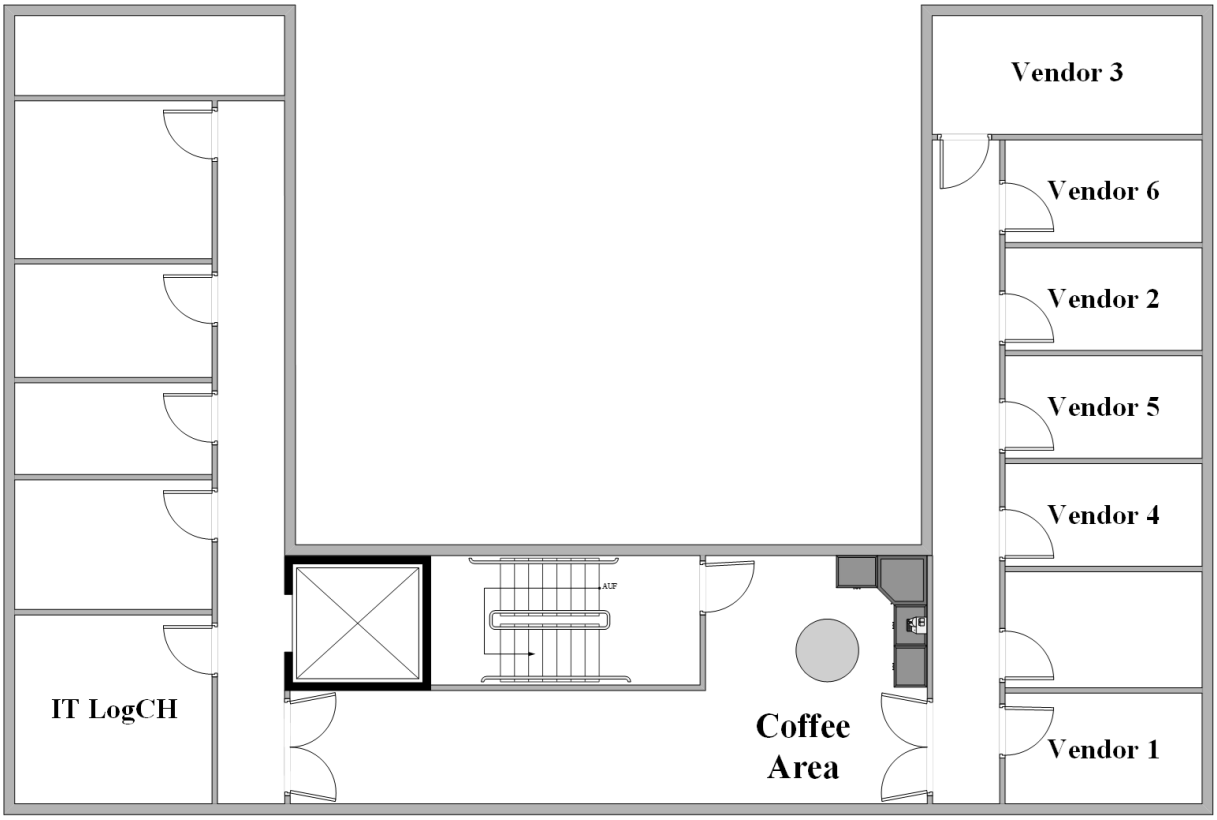

Figure 21: Provided Shared Office Space

Statement of Autonomous and Independent Work

„Ich erkläre hiermit, dass ich diese Arbeit selbstständig verfasst und keine anderen als die angegebenen Quellen benutzt habe. Alle Koautorenschaften sowie alle Stellen, die wörtlich oder sinngemäss aus Quellen entnommen wurden, habe ich als solche gekennzeichnet. Mir ist bekannt, dass andernfalls der Senat gemäss Artikel 36 Absatz 1 Buchstabe o des Gesetzes vom 5. September 1996 über die Universität zum Entzug des aufgrund dieser Arbeit verliehenen Titels berechtigt ist.“

Bern, 15.4.2019 Thomas Hurni