GENERATIVE MECHANISMS FOR DIGITAL PLATFORM ECOSYSTEM EVOLUTION

PhD Series 4-2019

Kalina S. Staykova

GENERATIVE MECHANISMS FOR DIGITAL PLATFORM ECOSYSTEM EVOLUTION

Doctoral School of Business and Management

PhD Series 4.2019

CBS COPENHAGEN BUSINESS SCHOOL
HANDELSHØJSKOLEN

GENERATIVE MECHANISMS FOR DIGITAL PLATFORM ECOSYSTEM EVOLUTION

Kalina S. Staykova

Primary Supervisor: Prof. Jan Damsgaard
Secondary Supervisor: Prof. Chee-Wee Tan

Doctoral School of Business and Management
Copenhagen Business School

Kalina S. Staykova
Generative Mechanisms for Digital Platform Ecosystem Evolution

The Doctoral School of Business and Management is an active national
and international research environment at CBS for research degree students who
deal with economics and management at business, industry and country level in a
theoretical and empirical manner.

Acknowledgements

Just a few years ago, I would have never imagined that I will be currently sitting at my desk at the Department of Digitalization at Copenhagen Business School composing the acknowledgement section of my PhD Dissertation. Writing these lines inevitably brings me back in time as I reflect on how this journey began and where it has led me. Three years ago, when I embarked on this journey, the path ahead seemed uncertain, unpredictable and full with both obstacles and opportunities. I had no clear plan in mind; instead, armed with endless curiosity, enthusiasm and determination to make the most of it, I ventured straight ahead into the PhD process. Embracing the uncertainty and learning to trust the guidance of the people, who accompanied me along, I have now reached the end of this bittersweet journey, which was as demanding as it was rewarding.

As this had hardly been a solo journey, I would like to thank to all the people who walked down this path together with me. First, I would like to express my special gratitude to my primary supervisor, Prof. Jan Damsgaard, who set me onto this journey of learning and exploring and guided me through it with thoughtfulness, dedication and understanding. Jan, without your constant encouragement, steady guidance, constructive dialogue and immense support, I would have never completed this PhD dissertation. I am grateful that you have never tried to curb by curiosity and that you have generously introduced me to your vast network of both scholars and practitioners. I also want to thank Prof. Chee-Wee Tan for accepting to be my secondary supervisor and for always providing me with constructive feedback, which have significantly helped me improve the quality of my work.

I very grateful that my journey towards academic excellence took me to the Center for Process Innovation (CEPRIN) at Georgia State University in Atlanta, Georgia, USA, where I met and collaborated with extraordinary scholars, who generously shared with me their knowledge and time. I would especially like to express my deep gratitude to Prof. Lars Mathiassen, who invited me to visit CEPRIN and to collaborate with him. Lars, your insightful comments, profound mastery in conducting outstanding research and immense generosity with your knowledge and time have been true inspiration to me. Working with you has been a great learning experience, for which I will be always grateful. I also want to thank my other co-authors, Prof. Arun Rai from CEPRIN at Georgia State University and Prof. Jonny Holmström from Umeå University, who have provided me with valuable and insightful feedback on numerous occasions and have always supported my work.

This research would not have been possible without the support of my company supervisors, Mark Wraa-Hansen and Bo Christiansen, who trusted me and embarked on this journey with me three years

ago. Mark and Bo, thank you for opening the doors to MobilePay and for accepting me as part of the team. I also wish to thank my colleagues at MobilePay, who were always willing to share with me their insights and thoughts and were constantly showing curiosity in my academic work. I would like to express special gratitude towards Tonny Thierry Andersen and Jesper Nielsen who initiated this collaboration and who have always been encouraging closer cooperation between academia and practice. I am also thankful to the Innovation Fund Denmark for approving and supporting financially this project.

I would also like to extend my gratitude towards my colleagues at the Department of Digitalization at Copenhagen Business School, who have been part of my day-to-day life for the past three years. I would certainly could have never managed to go through the PhD process without the emotional support of my fellow PhD colleagues, who were always ready to listen and provide advice. I am also thankful to the faculty at DIGI, who were always willing to share their experience and expertise, and to the Secretariat at DIGI, who were always ready to help. I have also received great support from the PhD administration at Copenhagen Business School, who made the PhD process a smooth journey for me.

I would also like to thank the members of my PhD Assessment Committee, Prof. Ioanna Constantiou (Copenhagen Business School), Prof. Ola Henfridsson (Warwick Business School) and Prof. Daniel Veit (University of Augsburg). I am both humbled and honored that such established scholars, whose work has always been a great inspiration to me, have showed interest in my research and approved of my dissertation. I also wish to express my gratitude towards the opponents of both my Work-in-Progress seminars at Copenhagen Business School, whose insightful comments and suggestions helped me strengthen further this research.

A very special thanks go to my family and friends for encouraging me to pursue my interests and for offering me support, advice and distraction when I needed them. I am grateful to my parents and my brother for their unconditional love and for their endless patience. Especially, I would like to dedicate this PhD dissertation to my maternal grandfather, who taught me one of the most important lessons in my life. His unshakable optimism, compassion and perseverance have always amazed me and have always served as my guiding principles in life. Without aspiring to them, I would have never been able to complete this process.

Reflecting in the end of this PhD journey, despite all the difficulties, pressing deadlines and heavy workload, I do not regret undertaking it. It has been a thrilling learning experience, which has helped

me grow as a researcher and as a person. Moreover, were to embark on it again, I would have still chosen to undertake it alongside the same people. Now that I am closing this chapter of my life, I can only wish that the bonds formed during the past three years will remain and strengthen in the years to come, wherever my path may take me to.

English Abstract

Despite their growing economic importance and rapid proliferation across various industries, successful digital platform ecosystems remain difficult to build and sustain over time. Facing challenges stemming from the turbulent and uncertain environment, in which they operate, and from the accumulated over time internal inefficiencies, digital platform ecosystems need to evolve and adapt rapidly. Despite the importance of understanding how and why this evolutionary process occurs, research on this topic has remained elusive. Building upon the notion of generative mechanisms, this PhD dissertation seeks to unravel the various mechanisms, which contingently shape the evolution of digital platform ecosystems. To this end, this research investigates the evolutionary process from three theoretical perspectives – Punctuated Equilibrium, Dialectical and Teleological, and by adopting multi-method approach. As a result, the PhD dissertation puts forward three process theories, each characterized by distinctive generative mechanisms, which collectively provide in-depth insights how digital platform ecosystems evolve over time in response to internal and external challenges.

Dansk Abstrakt

På trods af kraftig vækst i både markedsandele og antal er succesfulde digitale platforme fortsat svære at udvikle, og det er svært at vedligeholde deres succes. Platforme udfordres af både interne og eksterne faktorer og ophobning af interne uhensigtsmæssigheder og må derfor videreudvikles og tilpasses hurtigt. Hvordan og hvorfor denne udviklingsproces foregår har hidtil været underbelyst i den videnskabelige litteratur. Ud fra idéen om generative mekanismer (generative mechanisms) tager denne ph.d.-afhandling fat på at udrede de forskellige forhold, der betinger den evolutionære proces for digitale platforme. Processen undersøges fra tre teoretiske perspektiver: Evolutionær Afbrudt Ligevægt (Punctuated Equilibrium), Dialektik og Teleologik. Afhandlingen anvender en multimetodisk tilgang. Udbyttet af undersøgelserne er tre procesteorier, der hver især karakteriseres ved særlige generative mekanismer, hvilket til sammen bidrager med dybere indsigt i hvordan, digitale platforme udvikler sig over tid.

Table of Contents

List of Tables

Table 1: Overview of the Conceptualization of Digital Platform Ecosystem	Page 18
Table 2: Overview of Perspectives on Digital Platform Ecosystem Evolution	Page 28
Table 3: Key Constructs of Generative Mechanisms	Page 34
Table 4: Overview of MobilePay Data Sources	Page 54
Table 5: Example of Data Analysis from Paper I	Page 55
Table 6: Example of Identification of Transformative Generative Mechanisms	Page 56
Table 7: Conceptualization of Digital Platform Ecosystem Evolution	Page 59
Table 8: The Dominance and Impact of Generative Mechanisms	Page 61
Table 9: Inherent Contradictions within Digital Platform Ecosystem	Page 63
Table 10. Reach and Range Framework for Strategic Challenges	Page 65
Table 11. Overview of Research Papers	Page 68

List of Figures

I Introduction

This opening chapter introduces the main phenomenon of investigation in this PhD dissertation and demonstrates its importance to researchers and practitioners alike. It further presents the goals of this research and outlines the structure of the PhD dissertation.

1. Motivation and Initial Research Focus

Digital platform ecosystems, which function as complex socio-technical systems that facilitate interactions between various actors through developing and managing an IT architecture and appropriate governance regime, have emerged as some of the most prominent economic phenomena in the past couple of years (de Reuver et al., 2017; Hagiu and Wright 2011, 2013; Parker et al., 2016; Tiwana, 2014). For example, some of the most successful companies, in terms of number of users, brand value and profitability, operate as digital platform ecosystems (e.g., Airbnb, Alibaba, eBay, Uber, WeChat, and more). Just consider that fourteen out of the thirty most valuable brands for 2018, as pronounced by Forbes, function as digital platform ecosystems. The list comprises diverse companies such as Amazon, Samsung, Visa, Intel, and Facebook, connecting different types of actors, offering wide range of products and services, relying on different revenue streams and spreading across various industries. The credit card company Visa, for example, traditionally facilitates the interactions between cardholders and merchants (Evans and Schmalensee, 2016); while, Facebook, which started as one-sided platform (enabling the interactions between private users), has formed a robust ecosystem of actors around its platform (users, advertisers and third-party developers).

Despite the observed heterogeneity, researchers point out that all these diverse companies share a number of similarities. In particular, they orchestrate the interactions occurring among vibrant ecosystem of actors (van Alstyne et al., 2016) by providing underlying IT architecture (Baldwin and Woodward, 2009; Yoo et al., 2012) and by imposing emergent governance regime (Boudreau and Hagiu, 2009). Thus, digital platform ecosystems consist of diverse combinations of actors, architecture and governance, which also alter throughout the course of the ecosystem evolution (see e.g., Evans, 2009, Hagiu, 2006, Parker et al., 2016).

Digital platform ecosystems differ from existing businesses such as resellers and suppliers (Hagiu and Wright, 2011; 2013; Parker et al., 2016). Collectively referred to as pipelines (see Parker et al., 2016), these traditional companies are losing their competitive advantages as digital platform ecosystems are transforming established business areas (e.g., music, finance, transportation, publishing) and, as a result, redefining competition (Tiwana, 2014). Researchers argue that digital platform ecosystems manage to defeat pipelines due to their inherent digital properties (see below) and due to their ability to coordinate the exchange of third-party resources (rather than owning them) in an efficient way (van Alstyne et al., 2016). In addition, digital platform ecosystems also utilize the innovation potential of a large number of external innovators rather than relying

solely on their own innovation efforts (Gawer and Cusumano, 2014, Hagiu and Wright, 2011; Parker et al., 2016; Tiwana, 2014).

As many traditional companies venture into creating digital platform ecosystems in an attempt to adapt to their changing environment (Hagiu and Wright, 2013, Parker et al., 2016; Zhu and Furr, 2016), the distinction between traditional product-oriented companies and platform ecosystems has blurred. In particular, as some companies provide a wide range of offerings, they often operate under a hybrid model (Hagiu, 2006; Hagiu and Wright, 2011). For example, Amazon functions as a reseller when it offers products directly to consumers and as a digital platform ecosystem when it offers to its users products by other sellers (Hagiu, 2014). Thus, most companies adopt business models situated in-between full-scale platform ecosystems and traditional retail businesses (Hagiu and Wright, 2011). Contrary to the popular belief that every business should orchestrate an ecosystem of actors around a digital platform, researchers caution against adopting the platform model without fully understanding the requirements it takes to build a successful digital platform ecosystem (Hagiu and Wright, 2013; Parker et al., 2016). Depending on the companies' competitive advantages, it may pay off to operate as a reseller rather than venturing into building a digital platform ecosystem (e.g., the online retailer Zappos envisioned to operate as platform ecosystem, but later re-organized its business and become a reseller) (for more, see Hagiu and Wright, 2011).

Surprisingly, although platforms and their ecosystems have become more notable in the last decade, they, in fact, have existed for centuries (e.g., town markets in the Middle Ages) (de Reuver et al., 2017; Hagiu, 2014; Tiwana, 2014; van Alstyne et al., 2016). The rapid proliferation of novel digital technologies (e.g., cloud computing, smartphones, Internet of Things, Near Field Communication (NFC), and more), which became the "invisible engines" (see Evans et al., 2006) at the center of digital platform ecosystems, have significantly changed the nature of platforms and their ecosystems. In particular, digital technologies, collectively defined as "combinations of information, computing, communication, and connectivity technologies" (Bharadwaj et al., 2013, p. 471) allow for easy communication across devices, services, and networks, supported by increasing and inexpensive computational power and growing capacity to store large amount of data (Bakos, 1998; Bharadwaj et al., 2013; Caillaud and Jullien, 2001; Yoo et al., 2012).

The ongoing adoption of digital technologies has led to the convergence of standalone technology devices and to the emergence of new services and business models, blurring the boundaries between industries (Hagiu, 2006; Tilson et al., 2010). Just consider how the smartphone incorporated latest technology developments and engulfed a number of standalone devices, such as music players, car navigation systems, computers, cameras, payment cards, and more, which subsequently enabled the creation of a myriad of new services offered as software applications (e.g., iTunes, online map services, Instagram) (Hagiu, 2006; Kazan et al., 2018).

As a result, digital platform ecosystems can integrate previously dispersed services and thus reduce the costs associated with their production, distribution and exchange (Bakos, 1998; Hagiu, 2006; Hagiu and Wright,

2011). In addition, they can increase the efficiency of matching and transacting in terms of speed and quality, thus improving the performance of digital platform ecosystems in comparison to non-digital ones (e.g., compare online marketplace vs physical shopping mall) (Bakos, 1998; Caillaud and Jullien, 2001; Hagiu and Wright, 2011; Parker et al., 2016; Yoo et al., 2012).

As the underlying digital technologies are edible, reprogrammable, communicable, and extensible (Yoo et al., 2010; Kallinikos et al., 2013), digital platforms[1] are relatively easy to build, with high, but fixed initial development costs, which as digital platform ecosystems scale can spread across a growing user base (Eisenmannn, 2002; Kohler, 2018; Rysman, 2009; van Alstyne et al., 2016). Due to the use of digital technologies, platforms possess modular and layered IT architecture (Yoo et al., 2012), which, due the availability of boundary resources such as Application Programming Interfaces (APIs) and Software Development Kits (SDKs), allow for interconnectivity towards other digital platform ecosystems (Eisenmann et al., 2009) and towards third-party complementors (Tiwana et al., 2010). In particular, using boundary resources, external complementors can access core platform services to generate and distribute more innovative services (Tilson et al., 2010; Yoo et al., 2012).

Digital infrastructures (such as the Internet, open standards, consumer devices, and more) provide the foundation upon which digital platforms operate by delivering "the necessary computing and networking resources" (Constantinides et al., 2018, p. 382) to support their functioning (Lyytinen and Yoo, 2002; Tilson et al., 2010; Yoo et al., 2010). In particular, digital infrastructures function as "shared, open (and unbounded), heterogeneous and evolving socio-technical system (which we call installed base) consisting of a set of IT capabilities and their user, operations and design communities" (Hansenth and Lyytinen, 2010, p. 4). Thus, researchers view digital platforms in close relation to digital infrastructures (de Reuver et al., 2017) and further, point out that, in comparison, digital platforms and their ecosystems possess different control levels (e.g., different levels of centralization) than digital infrastructures, which constitute the main difference between the two phenomena (de Reuver et al., 2017; Hanseth and Lyytinen, 2010).

While the relationship between digital platform ecosystems and digital infrastructures is outside the scope of this PhD dissertation, it is important to take into account the interdependencies between them, which for long time were unaccounted for (Tilson et al., 2010). In particular, researchers have observed new forms of interplay between digital platform ecosystems and digital infrastructures. For example, due to the communicability and extensibility of digital platforms, there is a widespread connectivity among digital platform ecosystems (e.g., Facebook being used as user verification tool across many third-party platforms), which, as a result, entangle as to form a wider digital infrastructure (de Reuver et al., 2017). The difference between digital platform ecosystems and digital infrastructures also blurs, with researchers finding evidence for "infrastructuring" of

---

[1] For the purposes of this research, digital platforms refer to the underlying architecture around which an ecosystem of actors emerges. Thus, digital platforms are at the center of digital platform ecosystems (Tiwana, 2014).

the digital platform and "platformization" of digital infrastructure, which have various implications for their design and governance (de Reuver et al., 2017; Constantinides et al., 2018).

Due to their digitalization, digital platform ecosystems have become an important subject in the Information Systems (IS) field (along with digital infrastructures) (Constandinides et al., 2018; de Reuver et al., 2017; Tilson et al., 2010; Tiwana et al., 2010). De Reuver et al. (2017), for example, point out that due to their pervasiveness, digital platform ecosystems alter the nature of important IS phenomena, such as user relations, the architecture of IS artefacts and the relations among multiple organizations. Although the increased interest in this socio-technical phenomenon has resulted in a growing number of publications and a number of special issues, researchers still pinpoint that key questions around digital platform ecosystems remain unanswered (for overview, see e.g., Constantinides et al., 2018; de Reuver et al., 2017).

2. Problem Statement

Observing the shift towards platform thinking and the fast erosion of the competitive advantages within traditional industries, many companies, both incumbents and start-ups, try to launch digital platforms and create robust ecosystems around them (either from scratch or by turning products into platforms). More often than not, however, their attempts fail (Hagiu, 2014; Hagiu and Rothman, 2016). Indeed, as Hagiu (2014) points out, digital platform ecosystems that manage to become sustainable over long term are rather rare. Lack of optimal initial platform design (Hagiu, 2006), inappropriate adoption strategies (Evans, 2009) and emphasis on profitability rather than growth (Hagiu and Rothman, 2016; van Alstyne et al., 2016) are some of the main reasons, causing platform ecosystems to fail. However, even though a digital platform ecosystem can successfully ignite and move beyond the initial launch phase, its sustainability can come under threat due to its inability to evolve and adapt to the rapid and unexpected changes, which the platform ecosystem encounters throughout its evolutionary path (see e.g., Ozer and Anderson, 2015, Tiwana et al., 2010; Tiwana, 2014).

A myriad of internal and external challenges can pose threat to the successful existence of a digital platform ecosystem (e.g. Gawer, 2015). In particular, various internal obstacles challenge the optimal functioning of a digital platform ecosystem and constitute a source of uncertainty. For example, after launch, platform owners face demand uncertainty, as there is no guarantee that various actors will join the ecosystem (Evans, 2009). Subsequently, internally accumulated inefficiencies resulting from initial design choices, conflicting interests or uncertain business model (see, Gawer, 2009; 2015; Muezellec et al., 2015) can inhibit the successful performance of a digital platform ecosystem. In addition, unexpected changes in the preferences of various ecosystem actors can also lead to modifications within the digital platform ecosystem (e.g., unmet demands can prompt certain actors to leave the ecosystem) (Gawer and Cusumano, 2002; Ruutu et al., 2017; Wareham et al., 2014). Facing uncertainty concerning the use of boundary resources by third-party complementors, platform owners can also postpone deciding on a concrete long-term evolutionary path, thus increasing the overall level of uncertainty within the ecosystem (Dattee et al., 2017).

Simultaneously, as digital platform ecosystems operate in an uncertain environment (e.g., competitive uncertainty, regulatory uncertainty, technology uncertainty), they face a number of external obstacles (see, e.g., Boudreau and Hagiu, 2009, Gawer and Cusumano 2014, Ojala and Lyytinen, 2017; Ozer and Anderson 2015, Tan et al., 2015). Digital platform ecosystems, for example, have to fend off new rivals (Smedlund and Faghankhani 2015), adapt to shifts in the behaviour of existing competitors (Eisenmann et al. 2011; Gawer and Cusumano, 2007; Ozer and Anderson 2015) and accommodate regulatory changes (Hagiu and Rothman, 2016). Furthermore, while the adoption of new digital technologies made it easy to build and scale digital platforms due to relatively low operational and distribution costs (see above), it also lowered barriers to entry, with competitors easily imitating the services offered by the first mover. This has prompted digital platform ecosystems to evolve rapidly ("compressed evolution"; see Tiwana, 2014) in an attempt to outcompete their contenders and to avoid stalemate, which may render them irrelevant to existing ecosystem actors.

When faced with both internal and external challenges, the ability of digital platform ecosystems to evolve over time is of vital importance for ensuring their long-term sustainability (see Gawer 2015, Han and Cho 2015, Ojala and Lyytinen, 2017; Smedlund and Faghankhani 2015¸ Tan et al. 2015). To address properly these challenges, stemming from both the turbulent nature of the environment and from the presence of internal inefficiencies, a digital platform ecosystem needs to maintain, develop and invest further in its ability to evolve in order to detect on time the upcoming changes and to adapt to them in a swift and accurate manner.

Despite the importance of understanding how and why digital platform ecosystems evolve, this topic, however, has remained elusive in the platform literature (for more details, see Chapter III). For example, as platform ecosystems operate in volatile external environment (Dattee et al., 2017; Ojala and Lyytinen, 2018), it is important to understand how the evolving context affects the evolution of a digital platform ecosystem (Tiwana, 2014). Current research, however, has largely disregarded the context in which digital platform ecosystems operate (de Reuver et al., 2017) and the various internal and external events, which trigger the ecosystem to evolve (Gawer, 2015). While a few studies have investigated how several events can trigger the evolutionary process (see, Dattee et al., 2017; Eaton et al., 2015; Gawer, 2009; Ojala and Lyytinen, 2018; Tan et al., 2015; Tiwana et al., 2010), they fail to explain the mechanisms through which these events lead to changes in the evolutionary trajectory.

Understanding the mechanisms, which contingently drive the evolution of digital platform ecosystems, however, is of paramount importance for two reasons. First, as the evolutionary path of digital platform ecosystems is difficult to predict (Dattee et al., 2017; Ojala and Lyytinen, 2018), platform owner(s) cannot rely on descriptive models (which dominate the current research) to guide the development of their ecosystems. Instead, they need to obtain a better grasp of the nature of the various internal and external triggers, which, as they appear, can challenge and alter unexpectedly the evolutionary trajectory of a digital platform ecosystem. Second, understanding how various triggering events lead to certain evolutionary outcomes can help platform

owners to respond better to the emerging opportunities and threats, thus increasing the potential of a digital platform ecosystem to sustain over time.

3. Research Goals

While gaining a better understanding of the evolutionary process of digital platform ecosystems is of increasing importance for ensuring their sustainability, this topic remains underresearched. To address this shortcoming, the purpose of this PhD dissertation is to offer in-depth insights into how, when faced with multiple challenges and opportunities, digital platform ecosystems evolve in order to survive and thrive. Thus, the core research question (RQ) of this dissertation is:

How does a digital platform ecosystem evolve in response to external and internal challenges and opportunities?

In order to investigate further the core RQ, I put forward two sub-research questions (SRQs):

SRQ1: How do generative mechanisms contingently prompt a digital platform ecosystem to evolve over time?

By answering this SRQ, I aim to identify the mechanisms, which drive the ecosystem evolution, and to outline the process through which they appear and affect the evolutionary trajectory. In particular, I build upon the notion of generative mechanisms as suitable lens to study how digital platform ecosystems evolve over time (see Chapter IV).

SRQ2: How can a platform owner manage the evolution of a digital platform ecosystem?

The evolution of a digital platform ecosystem is seldom a self-driving and self-sustained process; instead, it requires deliberate and timely management (Eaton et al., 2015; Tiwana, 2014). Thus, platform owners should manage diligently the evolutionary process by identifying and addressing opportunities and threats in due time. Subsequently, to answer this SRQ, I look into the strategies a platform owner can adopt in order to manage efficiently the evolution of the ecosystem over time.

Addressing the above posed RQ and SRQs, I, together with my co-authors, develop three process theories, each of which characterized by specific generative mechanisms, and investigating the digital platform ecosystem evolution from different theoretical perspectives. Adopting a critical realism stance (see Chapter V), in particular, I try to identify the generative mechanisms, which contingently drive the evolutionary process of digital platform ecosystems as complex socio-technical phenomena (see also Henfridsson and Bygstad, 2013). Subsequently, I combine the separate process theories in one model (Figure 16), which explains comprehensively how and why digital platform ecosystems evolve over time (see Chapter VII).

4. Outline of the PhD Dissertation

This PhD dissertation constitutes a collection of a wrapper (Chapter I-Chapter X) and six standalone research papers. The purpose of the wrapper is two-fold. On one hand, in the wrapper, I summarize the conducted research in the separate studies, and, on the other hand, I combine the findings from each of them to propose a model, which advances our understanding about why and how digital platform ecosystems evolve over time.

The wrapper (or cover) consists of a number of interconnected chapters. In Chapter I, I introduce the main phenomenon of this research (digital platform ecosystem evolution) and outline its importance and relevance for both academics and practitioners. I further present the main RQ and the subsequent SRQs, which guide the overall direction of this research. In Chapter II, I define the investigated phenomenon, while in Chapter III, I summarize the existing research on digital platform ecosystem evolution and outline research gaps.

Subsequently, in Chapter IV, I conceptualize the notion of generative mechanisms and outline how I plan to apply it to study digital platform ecosystem evolution from multiple perspectives. In Chapter V, I outline the methodological approach to this research and provide details about the collected data and about the techniques applied for analysing the data. Next, in Chapter VI, I present the findings from the six separate studies conducted to answer the RQ and the SRQs and propose a multi-motor explanation of digital platform ecosystem evolution in Chapter VII. Finally, in Chapter VIII, I outline the contributions, which this research delivers to both academics and practitioners, the limitations and promising avenues for future research.

II Conceptualization of Digital Platform Ecosystems

The purpose of this chapter is to introduce the main phenomenon of investigation, namely digital platform ecosystems. After reviewing carefully the existing conceptualizations in the platform literature, I propose an encompassing definition of digital platform ecosystems and outline their main characteristics.

1. Digital Platform Ecosystems

In their work on platform leadership, anchored in the engineering stream of the platform literature (see Gawer, 2014; also Appendix), Gawer and Cusumano (2002) first accounted for an ecosystem of external complementors, coordinated by a platform owner, which emerges around a digital platform. In later studies, other scholars adopted this conceptualization of platform ecosystems (Gawer and Henderson, 2007; Parker and Van Alstyne, 2008). At the same time, in parallel, researchers from the economic stream of the platform literature (see Gawer, 2014; see also Appendix) investigated multi-sided platforms as facilitating the interactions occurring between various groups of actors (Hagiu and Wright, 2011)[2]. Thus, while the engineering stream of platform research emphasizes on the architecture and technical capabilities of a digital platform around which an ecosystem of third-party developers forms, the economic stream focuses on

---

[2] An overview of the economic and engineering streams within the platform literature is provided in the Appendix.

investigating the nature of interactions occurring through the digital platform (Gawer, 2014; see also Appendix).

Although the findings stemming from the two research streams do not contradict each other, the dispersed knowledge across various disciplines and outlets challenges our overall understanding of the phenomenon as researchers face the perils to overlook certain aspects by subscribing to just one of the research views. To overcome this shortcoming, researchers have called for merging the economic and technological perspectives within the platform literature (de Reuver et al., 2017; Gawer, 2014; Thomas et al., 2014).

Unifying the two perspectives, Gawer (2014), for example, proposes a third view that defines digital platform ecosystems as dynamic organizational arrangements that regulate the activities of their actors and help extend the innovation potential of the platform. Such conceptualization allows scholars to take into account the characteristics of both streams of research and recognize the complexity of this phenomenon. Similarly, Thomas et al. (2014) propose a synthesis between the economic and engineering streams of platform literature by urging researchers to focus on (digital) platform ecosystems as socio-technical systems with inherent characteristics stemming from both perspectives (e.g., modular architecture from the engineering and market facilitation from the economic). Thus, they view digital platform ecosystems as encompassing concept, which can bridge the fragmented platform research.

Consequently, increased amount of recent studies (e.g., Altham and Tushman, 2017, Dattee et al., 2017; Constantinides et al., 2018; Jacobides et al., 2017; Wessel et al., 2017) have adopted digital platform ecosystems as key phenomenon and have indicated, to a certain degree, for synthesis between the two research streams. Following the recent developments in the platform literature, this PhD dissertation focuses on digital platform ecosystems as encompassing concept, which integrates the characteristics of both engineering and economic streams.

Despite the proliferation of studies focusing on digital platform ecosystems, however, researchers have failed to introduce a common conceptualization, introducing instead a number of fragmented definitions (see Table 1). The majority of the identified studies adopt the initial conceptualization of platform ecosystems as consisting of a digital platform around which a number of external complementors operate (see Altman and Tushman, 2017; Ceccagnoli et al., 2012; Isckia and Lescop, 2013; Tiwana et al., 2010; Scholten and Scholten, 2012; Wareham et al., 2014; West and Wood, 2014; Yonatany, 2013). Recent studies, however, have extended the concept of platform ecosystem as to incorporate various other actors. Apart from the previously identified third-party complementors, the platform ecosystem, for example, also encompasses consumers and producers (not necessarily third-party complementors), reflecting the economic stream of the platform literature (Constantinides et al., 2018; Inoue and Tsujimoto, 2017; van Alstyne et al., 2016; Wessel et al., 2017). In addition, a number of researchers have also conceptualized digital platform ecosystems in relation to the set of

governance rules the platform owner imposes on various actors in connection to their participation in the ecosystem (Ghazawneh and Henfridsson, 2013; Huber et al., 2017; Kapoor and Agarwal, 2017).

While recent research aims at expanding the concept of digital platform ecosystem beyond the initial narrow conceptualization by acknowledging that it encompasses various actors, elaborated IT architecture and governance rules, there is still lack of studies embracing comprehensively the complexity of this concept. In particular, scholars tend to investigate thoroughly only one particular aspect of digital platform ecosystems (e.g., governance; see Huber et al., 2017) or combination of two aspects (e.g., governance and architecture; see Tiwana et al., 2010). In cases, where researchers analyse several aspects (actors, architecture, governance), they tend to adopt limited view on these constructs (e.g., Ghazawneh and Henfridsson (2013) view governance solely in terms of control and actors solely in terms of third-party complementors), thus not reflecting the complexity of the phenomenon.

Table 1. Overview of the Conceptualization of Digital Platform Ecosystem			
Authors	**Term**	**Definition**	**Main focus**
Altman and Tushman (2017)	Platform Ecosystem	"Ecosystems organize and leverage external entities, which are frequently complementors and have interdependencies between them" (p. 7).	Technology, Actors (third-party complementors)
Ceccagnoli et al. (2012)	Platform Ecosystem	"The network of innovation to produce complements that make a platform more valuable" (p. 263)	Technology, Actors (third-party complementors)
Constantinides et al. (2018)	Platform Ecosystem	"A platform ecosystem model that emphasizes core interactions between platform participants, including consumers, producers, and third-party actors" (p. 381)	Actors (consumers, producers, and third-party actors)
Gawer and Cusumano (2002)	Industry Platforms	Industry platforms include platform leaders and external complementors	Technology, Actors (platform leaders, external complementors)
Gawer and Henderson (2007)	Platform Ecosystem	Industrial ecosystem, where platform owner orchestrates the innovation efforts of complementors	Technology, Actors (third-party complementors)
Ghazawneh and Henfridsson (2013)	Platform Ecosystem	Platform ecosystem encompasses actors coordinated around a platform through boundary resources	Technology, Actors (complementors, platform owners), governance (control)
Huber et al. (2017)	Platform Ecosystem	Platform owner orchestrating a number of external complementors through governance regime	Governance, Actors (third-party complementors)
Inoue and Tsujimoto (2017)	Platform Ecosystem	Platform ecosystem encompasses third-party complementors and consumers	Actors (third-party complementors and consumers)
Jacobides et al. (2018)	Ecosystem	"An ecosystem is a set of actors with varying degrees of multi-lateral, non-	Actors, Technology

		generic complementarities that are not fully hierarchically controlled" (p. 16).	
Kapoor and Agarwal (2017)	Platform-based business Ecosystem	"Platform firms orchestrate the functioning of ecosystems by providing platforms and setting the rules for participation by complementor firms" (p. 531)	Technology, Governance (rules for participation), Actors (complementors)
Parker and Van Alstyne (2008)	Platform Ecosystem	"Platform sponsors often embrace modular technologies and encourage partners to supply downstream complements" (p. 2).	Technology, Actors (third-party complementors)
Scholten and Scholten (2012)	Platform Ecosystem	Platform "provides leverage for its multiple complementors within the platform ecosystem" (p. 6)	Technology, Actors (third-party complementors)
Tiwana et al. (2010)	Platform-based ecosystem	"Collection of the platform and the modules specific to that platform" (p. 2)	Technology
Isckia and Lescop (2013)	Platform-based ecosystem	"Platform-based ecosystems are a new way of managing a portfolio of contributions from varied and independent players" (p. 98)	Technology, Actors (third-party complementors)
Thomas et al. (2014)	Platform Ecosystem	"Platform is a set of shared core technologies and technology standards underlying an organizational field that support value co-creation through specialization and complementary offerings" (p. 4)	Technology
Wareham et al. (2014)	Technology platform ecosystem	"Many independent actors who form an ecosystem of heterogeneous complementors around a stable platform core" (p. 3)	Technology, Actors (third-party complementors)
Wessel et al. (2017)	Platform Ecosystem	Platform ecosystem encompasses producers and consumers	Actors (producers and consumers)
West and Wood (2014)	Open Ecosystem	Platform ecosystem consists of platform sponsor and its complementors	Actors (platform sponsor and third-party complementors)
Yonatany (2013)	Platform ecosystem	Platforms "has a business ecosystem: hundreds of thousands of affiliates or third-party developers that provide complementary components and applications" (p. 54)	Actors (third-party complementors)

Addressing this shortcoming, this PhD dissertation adopts a comprehensive definition of digital platform ecosystems, which reflects their complexity. Thus, I define digital platform ecosystems as socio-technical systems facilitating the interactions between various ecosystem actors through an underlying IT architecture and emerging set of governance rules (Hagiu and Wright, 2011; Tiwana, 2014).

2. Characteristics of Digital Platform Ecosystems

The overview of the various definitions of digital platform ecosystems (see Table 1) demonstrates that the lack of conceptual clarity stems from the different emphasis researchers put on the elements of which the ecosystem comprises (see Table 1, last column). Thus, identifying the key constructing elements of a digital platform ecosystem is vital for crafting an overarching definition of this phenomenon (Jacobides et al., 2018). Although the proposed above definition reflects the socio-technical nature of a digital platform ecosystem by identifying actors, architecture and governance as its constructive elements, it does not capture the complexity of these elements, which is one of the major criticisms towards existing definitions.

To address this shortcoming, I unfold further the three main constructive elements of digital platform ecosystems, namely actors, architecture and governance (Figure 1). To identify their sub-constructs, I review and synthetize the relevant platform literature. The following detailed conceptualization of the three constructs is included in Paper II (Analytical Framing) and Paper III.

Actors

Digital platform ecosystems consist of a number of actors, each assuming different roles. Platform users can be demand-side actors that consume services, which are offered by supply-side actors through the platform (Eisenman et al., 2009; Evans, 2012; Hagiu, 2016; Ondrus et al., 2015). As a focal actor, platform owner(s) hold the property rights, guide the development of the digital platform and govern the participation in the ecosystem (Eisenmann et al., 2009; Parker et al., 2016). Platform providers participate in the production (e.g., technology providers) or distribution (e.g., distribution partners) of the digital platform (Eisenmann et al., 2009; Gawer and Cusumano, 2014; Ondrus et al., 2015, Tiwana, 2014). While platform owners often initially act as platform providers, several platform owners and platform providers can co-exist from the onset (Eisenmann et al., 2009; Ondrus et al., 2015; Parker et al., 2016).

Architecture

The underlying IT architecture of a digital platform ecosystem encompasses the platform core, the periphery around it and the boundary resources, which connect the core and the periphery (Baldwin and Woodward, 2009; Gawer, 2014; Gawer and Cusumano, 2014; Tiwana et al., 2010; Tiwana, 2014). The platform core consists of the main functionalities offered by the platform owner (Olleros, 2008; Tiwana et al., 2010; Tiwana, 2014). A number of external service modules, connected to the platform core, offer additional functionalities as part of the periphery (Baldwin and Woodward, 2009; Olleros, 2008; Tiwana, 2014). The platform owner ensures the connectivity between the core and the periphery through the provision of boundary resources, such as APIs and SDKs (Ghazawneh and Henfridsson, 2013; Um and Yoo, 2016).

Governance

The governance regime consists of various rules that regulate access, participation, and value appropriation in a digital platform ecosystem. Access rules define which actors and under what conditions can become part of the ecosystem (Boudreau and Hagiu, 2009). Through the participation rules, the platform owner determines the behavioural patterns of which actors to permit and which to sanction (Boudreau and Hagiu, 2009; Parker et al., 2016). Appropriation rules refer to the agreements between platform owner and other actors about the distribution of the created value within the ecosystem (Ceccagnoli et al., 2012; Jacobides et al., 2018). These rules are usually contained in revenue sharing agreements, ownership agreements (including of intellectual property rights), agreements about division of responsibilities, and more (Evans and Schmalensee, 2016; Hagiu, 2014; Parker et al., 2016; Tiwana, 2014).
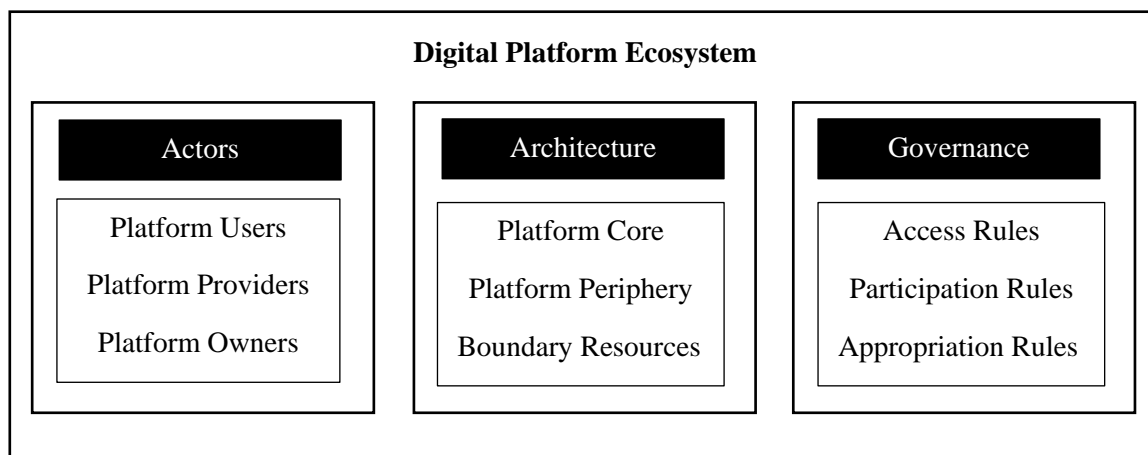
Digital Platform Ecosystem

Actors	Architecture	Governance
Platform Users Platform Providers Platform Owners	Platform Core Platform Periphery Boundary Resources	Access Rules Participation Rules Appropriation Rules

Figure 1. Conceptualization of Digital Platform Ecosystem

III Summary of the Research on Digital Platform Ecosystem Evolution

The evolution of digital platform ecosystems remains elusive topic in the early platform literature (see, Gawer, 2014; also Appendix). For example, although researchers recognize that the architecture of a digital platform is evolvable (Baldwin and Woodward (2009) from the engineering perspective) and that the number of ecosystem actors also grows over time (Evans (2009) from the economic perspective), there is lack of systematic approach towards studying digital platform ecosystem evolution. Instead, most of the studies focus on fixed period(s) of time (de Reuver et al., 2017), thus presenting digital platforms and their ecosystems largely as static (Gawer, 2015), without taking into account their overall evolutionary journey.

1. Summary of Papers with Focus on Digital Platform Ecosystem Evolution

Recent work, however, has begun to acknowledge that digital platform ecosystems are dynamic (e.g., de Reuver et al., 2017; Gawer, 2015; Um and Yoo, 2016). To summarize existing insights, I conduct an extensive literature review, which incorporates both the economic and engineering research streams in the platform

literature. The purpose of this literature review, which builds upon Paper I, is to identify relevant studies, organize them in systematic manner and outline research gaps.

As a result, I identify and review 32 papers, which focus on digital platform ecosystem evolution either explicitly or implicitly. I further analyze the selected studies based on their main research focus and their key findings (see Table 2). Through identification of the repeating themes across the different studies, I systematize the literature on digital platform ecosystem evolution in four different perspectives, namely growth, co-evolution, strategic and life cycle.

Growth Perspective

Early studies investigating explicitly the evolution of digital platform ecosystems focus on both their formation (e.g., launch) and subsequent development by investigating the growth patterns of the distinct groups of actors, taking part in the ecosystem (e.g., Evans, 2009; Evans and Schmalensee, 2010; Cennamo and Santaló, 2015; Hagiu, 2006). Under this growth perspective, the evolutionary journey of a digital platform ecosystem commences with the launch of the digital platform and the acquisition of its initial participants, who can belong to one or more distinct types of actors (Evans, 2009; Evans and Schmalensee, 2010; Hagiu, 2006). To ensure the ignition of the digital platform ecosystem, platform owners need to obtain a critical mass of actors (Evans, 2009).

As platform owners often try to convince two distinct types of actors to join the ecosystem in parallel, digital platform ecosystems can struggle to ignite (Evans, 2009; Hagiu, 2014). To overcome this challenge, platform owners rely on various strategies (e.g., sequential entry, introduction of marquee users, subsidizing demand-side users, and more) (Evans, 2009; Hagiu, 2006). Platform owners can also alter the degree of ecosystem openness by allowing various types of actors to participate (e.g., demand-side and supply-side users, platform providers) in order to foster adoption (Ondrus et al., 2015). By increasing the level of openness, platform owners can strengthen the cross-side network effects between distinct types of actors and, as a result, accelerate the process of acquiring sufficient number of actors (Ruutu et al., 2017).

After a digital platform ecosystem reaches a critical mass of actors and ignites, it enters a phase of self-sustained growth, which can be either rapid or relatively slow (Evans and Pirchio, 2015). Various enablers and constraints, however, can affect the growth patterns. While the presence of strong cross-side network effects enables growth that is sustainable over time (e.g., Evans and Schmalensee, 2010; Casey and Toyli, 2012; Vogelsang, 2010), researchers began to recognize that several constraints (e.g., ill-designed pricing and revenue sharing strategies (Casey and Toyli, 2012, Volelsang, 2010) or inadequate alliance strategy (Casey and Toyli, 2012)) can inhibit sustainable growth patterns.

When a digital platform ecosystem manages to achieve an optimal growth rate, it reaches a market equilibrium (Zhu and Mitzenmacher, 2008). After enjoying a self-sustained growth over time, the ecosystem eventually

reaches a point of saturation, or maturity, where the growth rate of its participants decreases (Cennamo and Santaló, 2015). Further, as digital platform ecosystems can acquire the majority of an existing market or most of it (that is, "winner-takes-all" or "winner-takes-most" market scenarios; see Eisenmann, 2002), this gives rise to monopolistic rents, which the platform owner can capitalize on (Vogelsang, 2010).

Co-Evolution Perspective

While the growth perspective is primarily rooted in the economic stream of the platform literature, the engineering stream of the literature focuses on the ability of the digital platform (as an underlying IT architecture) to evolve over time (see Baldwin and Woodward, 2009). Although early work discusses solely the ability to evolve by encouraging the introduction of boundary resources (or interfaces) enabling the creation of platform periphery, without actually outlining in details this process, it served as a foundation for future studies on digital platform ecosystem evolution.

While recognizing the importance of understanding the IT architecture as underlying part of the digital platform ecosystem, researchers have also acknowledged the interdependencies between architecture and governance, leading to the emergence of the co-evolution perspective (Ghazawneh and Henfridsson, 2013; Tiwana et al., 2010; Tiwana, 2014). In particular, the mutual adjustment of architecture and governance drives (or "accelerates"; see Tiwana, 2014) the evolution of digital platform ecosystems (Ghazawneh and Henfridsson, 2013; Tiwana, 2014). Early conceptual research deconstructs the architecture (decomposition, modularity, design rules) and governance (decision rights, control, and ownership) of digital platform ecosystems to a number of constructs, which all together co-evolve (Tiwana et al., 2010).

Adopting this perspective, scholars further investigate the co-evolution as an attempt to balance between control (governance) and generativity (architecture) (Eaton et al., 2015; Ghazawneh and Henfridsson, 2013). To encourage participation from third-party complementors, platform owners need to develop the generativity of the architecture by introducing new boundary resources (e.g., APIs) through a process of 'resourcing' (Ghazawneh and Henfridsson, 2013). While this improves the overall generativity and facilitates the development of a robust ecosystem around the digital platform, it also leads to increased heterogeneity of actors, which calls for better (often tighter) control regime, established through a process of 'securing' (Ghazawneh and Henfridsson, 2013). The increased level of control over the access and use of boundary resources, however, may face resistance from third-party complementors, who can refuse the new terms imposed by the platform owner (Eaton et al., 2015). Subsequently, this resistance can lead to a process of adjustment, where, under pressure, the platform owner modifies the newly introduced boundary resources (Eaton et al., 2015). Referred to as 'distributed tuning' (Eaton et al., 2015), this process of 'resistance and accommodating', which shapes the evolution of boundary resources, constitutes a particular manifestation of the co-evolution between architecture and governance.

Apart from connecting generativity to governance (in terms of control), researchers also state that the evolution of architecture's generativity through the provision of boundary resources also affects the variety of third-party complements (Tiwana, 2014). In particular, building upon early work in the engineering stream of the platform literature, where digital platform enables the emergence of variety of external complements due to the offering of stable and versatile interfaces (or boundary resources) (see, e.g., Baldwing and Woodward, 2009; Tiwana, 2014), researchers began to analyze closely the evolutionary patterns exhibited by these external complements. This shift has led to the establishment of co-evolution link between generativity (platform core) and variety (platform periphery).

The co-evolution between generativity and variety is a process, which is difficult to predict and guide. While the generativity of the architecture spurs variety of complements, the latter usually evolve on their own with no detailed guidelines from the platform owner (Woodward and Clemons, 2014). Furthermore, while most researchers assume that an increase in the level of generativity (that is increased number of boundary resources, such as APIs and SDKs) would lead to increase in the number of third-party complements (Baldwing and Woodward, 2009; Tiwana, 2014), recent empirical research challenges this assumption (Um and Yoo, 2016).

By investigating the evolutionary patterns of various third-party complements over time, researchers also found evidence that the presence of more complementors, enabled by generativity, do not always lead to more variety. Boudreau (2012), for example, demonstrates that initially present complementors offer more innovative complements in comparison to late comers, who often provide complements similar to the already existing ones. Similarly, Inoue and Tsujimoto (2017) demonstrate that even though there is high variety of complements, this variety can be significantly reduced when a platform owner ventures into new markets. Thus, the variety can decrease in later stages of digital platform ecosystem evolution, and, as a result, diminish the value which demand-side users receive from participating in a particular ecosystem, which, in turn, jeopardizes the sustainability of the digital platform ecosystem (Inoue and Tsujimoto, 2017).

Increased variety of complements, however, is not always advantageous for a platform owner as it can be a source of various tensions between actors within the digital platform ecosystem (including the owner) (Wareham et al., 2014). In particular, third-party complementors often compete with one another (intra-platform competition) to attract demand-side users by upgrading their complements (Tiwana, 2015). In some cases, they also compete with the platform owner by imitating some of the main platform functionalities, or even complements, offered by the owner (Gawer and Cusumano, 2002; Gawer and Henderson, 2007).

Broadening this perspective beyond the co-evolution of architecture and governance, recent studies have pointed out that various other aspects also interplay to drive together the evolution of a digital platform ecosystem. Researchers, for example, have accounted for the co-evolution between architecture and actors (West and Wood, 2014), IS capabilities and strategies (Tan et al., 2015) and between digital platform ecosystem and its environment (Ojala and Lyytinen, 2018; Tan et al., 2016; Tiwana et al., 2010).

While the generativity-variety as a certain manifestation of the early co-evolution research implies for co-evolution between architecture and third-party complementors as certain type of ecosystem actors, researchers also started to explicitly outline such interdependency by including wider set of ecosystem actors. Kim et al. (2013), for example, investigate the evolutionary path of online social networks, which function as digital platform ecosystems, as a configuration of three dimensions (technology, suppliers, and users), thus proposing that architecture and actors co-evolve. Similarly, West and Wood (2014) in their study on the development of the Symbian ecosystem briefly outline the co-evolution between architecture and ecosystem actors. Jha et al. (2016) also found in their research that architecture and a broad range of ecosystem actors (that is, intermediaries, community, institutions, partners, etc.) co-evolve.

Researchers have also acknowledged the co-evolution between two distinct groups of actors (e.g., users and complementors) as each of these groups adapts to the changes in the other (Song et al., 2018). While such interdependency has been recognized by scholars in the growth perspective (e.g., cross-side network effects; see, Casey and Toyli, 2012; Ruutu et al., 2017), Song et al. (2018) outline the impact of governance on the co-evolution between distinct groups of actors through the presence of asymmetric influence mechanism.

Various evolutionary stage models, which trace the simultaneous changes across several elements, also adopt a co-evolution perspective. Tan et al. (2015), for example, propose a three-stage model tracing the evolution of digital platform ecosystem through the co-evolution of Information Systems (IS) capabilities and their corresponding strategies in each evolutionary stage (nascent, formative and mature). In particular, they state that drivers for evolution can be both opportunities and problems, identified through 'market responsiveness IS capability'. After a driver appears, a platform owner needs to find suitable response by relying on IS capabilities that translate "detection of the triggers of MSP development into action" (p. 265). In general, the evolution of digital platform ecosystem develops from formation, where various actors are encouraged to participate, to balancing control and generativity in the later stage, and towards encouraging more openness and providing collective identity (ibid).

Apart from observing solely the co-evolution of actors, architecture and governance, as well as the capabilities and strategies within the digital platform ecosystem, researchers have also pointed out that ecosystems co-evolve together with their environment (Tiwana et al., 2010). Tan et al (2016), for example, propose a three-stage model to trace the co-evolution of competitive environment, IT affordances, and the platform configuration, which evolve from a closed platform to open platform and later community platform. They show that as the competitive environment in which digital platform ecosystems operate changes, platform owners can actualize various IT affordances in order to attract distinct actors (users and third-party complementors alike), thus driving the ecosystem towards more openness. Similarly, Ojala and Lyytinen (2018) argue that actions in response to changing competitive environment lead to changes in the architecture and the corresponding 'control points' (governance), which regulate the access to the architecture. The

introduced changes in the architecture affect the number of affiliated to the platform ecosystem actors and their interactions. Thus, Ojala and Lyytinen (2018) present the evolution of a digital platform ecosystem as influenced by the exchange between its environment, architecture, governance and actors.

Strategic Perspective

A number of scholars investigate the evolution of a digital platform ecosystem from strategic perspective. Researchers initially focused on identifying strategies for achieving critical mass of users (see, Evans, 2009), which are also rooted in the growth perspective. Later, however, the focus shifted towards initial platform design and subsequent development, which usually resulted in proposing two-stage evolutionary models (Hagiu, 2006; Eisenmann et al., 2006; Gawer, 2009).

Hagiu (2006), for example, outlines strategies for design (that is, upon formation) and subsequent development of a digital platform ecosystem. While his work remains largely conceptual although supported by illustrative examples, he concludes that platform ecosystems need to put forward a compelling value proposition and keep maintaining it over time. In particular, he argues that platform owners need to leverage carefully the depth and breadth of the platform ecosystem. Platform depth refers to the addition of more functionalities to satisfy the preferences of existing groups of actors (e.g., users), while platform breadth includes the offering of new functionalities in order to attract additional distinct groups of actors (e.g., merchants).

Similarly, Constantiou et al. (2016) propose a two-stage evolutionary model based on their study of Airbnb. They found that during the first stage after launch, Airbnb followed a zig-zag strategy by introducing various features and functionalities in order to attract users and hosts sequentially. In the second (augmentation) phase, the owner adopted exploration strategy (e.g., introducing new features and functionalities, acquisitions, geographical expansion, community building) in order to enhance the value which participants derived from its services.

In another study, Gawer and Cusumano (2007) outline two strategies for platform entry and subsequent development, namely coring and tipping. While coring refers to creating a standalone value proposition upon the formation of a platform, tipping allows a platform owner to gain prevalence over its competitors through bundling, envelopment and offering unique features. Thus, at later stages of their development, digital platform ecosystems aim at becoming market leaders in order to survive in an intensified competitive environment. To achieve this, Eisenmann et al. (2006) recommend that platform owner should either launch innovative features or expand into rival markets (envelopment). A platform owner, for example, can include similar, loosely related or altogether unrelated complements provided by rivals into its portfolio of offerings (Eisenman et al. 2011).

Life-Cycle Perspective

As some digital platform ecosystems have managed to sustain for more than a decade, researchers began to outline the evolutionary paths of a number of mature platform ecosystems mainly through developing life-cycle models. While these studies provide detailed accounts of the evolutionary journeys of successful digital platform ecosystems, they remain largely descriptive and case-specific.

Lihua et al. (2010), for example, propose an evolutionary life-cycle model for ecosystem development consisting of four stages: birth, expansion, coordination/maturity stage and evolution or death. During the birth stage of the ecosystem, the platform owner focuses on diversifying its offerings and growing number of users. During the next phase of expansion, various external actors join the platform ecosystem, prompting the platform owner to establish and maintain an array of coordination mechanisms to ensure the vitality of its ecosystem in the subsequent maturity stage. The evolution stage is associated with the platform's ability to reshuffle its existing ecosystem by abandoning some its key functionalities in favour to new technologies, features, and actors.

In a similar fashion, Muezellec et al. (2015) propose a life-cycle evolutionary model, consisting of four stages. In contrast to Lihua et al. (2010), however, they organize their research around the business model of the platform ecosystem. During the first embryonic stage, platform owners emphasize on offering innovative features and gradually change their attention towards ensuring user adoption during the following emerging stage. Once sufficient numbers of users join, the platform owner concentrates on catering to these platform participants, usually business customers, who generate revenue. After identifying a viable business model, the ecosystem then moves to the final stage of maturity, where the platform owner caters to all existing actors (that is, private users and business customers alike).

In another study, Han and Cho (2015) trace the evolution of the most popular messaging platform in South Korea, KakaoTalk and present it as consisting of three phases, namely preparation, spread and evolution. The preparation phase encompasses the launch of the digital platform and the expansion of its user base. During the spread phase the platform owner offers unique content, bundles services and does not raise prices in order to achieve market penetration. When a digital platform ecosystem reaches the evolution phase, it has achieved market dominance (ibid).

Table 2. Overview of the Perspectives on Digital Platform Ecosystem Evolution		
Perspective	**Views on Evolution**	**Key Assumptions**
Growth	Evolution through changes in the growth patterns of ecosystem actors	• Critical mass of users to ignite (Evans, 2009; Hagiu, 2006; Ondrus et al., 2015) • Slow or rapid self-sustained growth (Evans and Pirchio, 2014) • Optimal growth rate and maturity (Cennamo and Santalo, 2015)

Co-Evolution	Evolution as simultaneous changes within the digital platform ecosystem and in parallel with its environment	• Co-evolution between platform architecture and platform governance (Tiwana et al., 2010) • Co-evolution between control and generativity (Eaton et al., 2015; Ghazawneh and Henfridsson, 2013) • Co-evolution between generativity and variety (Boudreau, 2012; Inoue and Tsujimoto, 2018; Tiwana, 2015; Um and Yoo., 2016) • Co-evolution between architecture and actors (Jha et al., 2016; Kim et al., 2013; West and Wood, 2014) • Co-evolution between actors (Song et al., 2018) • Co-evolution between IS capabilities and strategies (Tan et al., 2015) • Co-evolution of digital platform ecosystem and its environment (Ojala and Lyytinen, 2018; Tan et al., 2016; Tiwana et al., 2010)
Strategic	Strategies adopted for stirring digital platform ecosystem evolution	• Strategies for ignition (Eisenmann et al., 2006; Evans, 2009; Hagiu, 2006) • Strategies for initial platform design and subsequent development (Constantinou et al., 2016; Gawer and Cusumano, 2008; Hagiu, 2006) • Strategies for competition and market dominance (Eisenmann et al., 2011; Ozer and Anderson, 2015)
Life-Cycle	Evolution as a life-cycle model with a number of stages	• Life-cycle model consisting of four stages: birth, expansion, coordination/maturity stage and evolution or death (Lihua et al., 2016) • Life-cycle model consisting of four stages: embryonic, emerging, identifying business model, maturity (Muezellec et al., 2015) • Life-cycle model consisting of three stages: preparation, spread and evolution (Han and Cho, 2015)

2. Shifting Towards New Topics and Outlining Research Gaps

While early work (Growth perspective) focuses on identifying criteria for ensuring initial success and subsequent growth of a digital platform ecosystem, later research puts emphasis on the process of evolution by stating that various elements of the ecosystem (e.g., architecture and governance) co-evolve over time (Co-evolution Perspective). Simultaneously, researchers have also studied the evolution of digital platform ecosystems from Strategic perspective, but rather than focusing on providing comprehensive overview of the strategic issues arising during the evolutionary process, they have proposed limited in scope evolutionary

models or have examined specific, standalone issues (e.g., envelopment). Scholars have also put forward life-cycle models, thus partitioning the evolutionary path into a number of stages (Life-Cycle Perspective), but these studies remain largely descriptive.

Researchers from all perspectives rely on variety of methods and theoretical lenses to examine the evolution of digital platform ecosystems. System dynamics (Caysey and Toyli, 2012), IS capabilities and affordances (Tan et al., 2015), dialectics (Wareham et al., 2014) are among the theories applied to study the evolutionary process. Researchers largely utilize case studies to conduct their empirical investigation, which include both primary (e.g., Tan et al., 2015) and secondary (e.g., Constantinou et al., 2016) sources of information and various analytical techniques (narrative analysis (e.g., Eaton et al., 2015), open coding (Constantinou et al., 2016), etc.). Some studies also utilize quantitative methods, such as simulations (Ozer and Anderson, 2015), survival analysis (Um and Yoo, 2016), and time-series analysis (Song et al., 2018).

Despite the growing number of studies, which investigate explicitly or inexplicitly the evolution of digital platform ecosystems, scholars have called for more thorough research as several important topics remain understudied (Figure 2). A number of researchers, for example, point out that there is still lack of sufficient knowledge about how digital platform ecosystems form and evolve over time (Casey and Toyli, 2012; Gawer, 2015; Ojala and Lyytinen, 2018; Tan et al., 2015; Tiwana et al., 2010; Um and Yoo, 2016). This somehow paradoxical statement stems from the fact that most of the outlined above studies present the evolution of a digital platform ecosystem in predominantly descriptive manner, which provides accounts of "what happened" rather than how and why.

Researchers further state that there is limited research with regards to the context in which digital platform ecosystems operate (de Reuver et al., 2017) and the situated in it events, which trigger changes in the evolutionary path of an ecosystem (Gawer, 2015). Addressing this gap, researchers have begun to recognize that ecosystems exist in a highly volatile and uncertain environment, which is difficult to predict (Dattee et al., 2017; de Reuver et al., 2017; Ojala and Lyytinen, 2018; Tan et al., 2015; Tan et al., 2016). Dattee et al. (2017), for example, state that most of the existing research presents the evolution of digital platform ecosystems as linear models, thus neglecting the fact that this process occurs in a context of uncertainty. To address this shortcoming, they embark on a study investigating the formation and the subsequent development of a platform ecosystem under uncertainty. In particular, they state that given the uncertainty, platform owners initially tend to postpone deciding which direction to take, instead preferring to wait until ecosystem actors indicate which opportunity they prefer to embrace.

Similarly, researchers have shifted their attention towards identifying internal and external events, which trigger changes in the evolutionary path of a digital platform ecosystem. A number of scholars, for example, have observed that various opportunities and obstacles emerging both internally and externally can trigger the platform ecosystem to evolve (e.g., Hagiu, 2006; Ghazawneh and Henfridsson, 2013; Tan et al., 2015),

without, however, delving into more details. For example, platform ecosystems evolve in response to internal triggers such as fear of losing control over key technology and desire to protect intellectual property rights (Gawer, 2009), changes in the expectations of ecosystem actors (West and Wood, 2014), the emergence of opportunities to collaborate with various partners (Lihua et al., 2016), pursuit of viable business model (Muezellec et al., 2015). External triggers, such as threat from envelopment or imitation (Eisenmann et al., 2011), regulatory requirements (Evans, 2012; Hagiu and Rothman, 2016), and new technology developments (West and Wood, 2014), can also prompt digital platform ecosystems to evolve.

Although scholars have identified a number of triggering events, they have remained dispersed across various studies, with their impact on the ecosystem evolution largely understudied. To drive further this research, Gawer (2015) proposes three major types of triggers, deducted from the organizational boundary literature. In particular, she argues that platform ecosystems evolve in their quest for efficiency, improved innovative capabilities and pursuit of power. Despite its merits, this classification, however, remains largely conceptual, with no empirical data to demonstrate the emergence of these triggers over time and the process through which they lead to changes in the evolutionary path of a digital platform ecosystem.

While various internal and external events can serve as change triggers, prompting the ecosystem to evolve (note that not all events constitute change triggers; for conceptualization see Paper II, Analytical Framing), there is limited knowledge about the mechanisms, which translate the effect of these contextual triggers into specific evolutionary outcomes (Ojala and Lyytinen, 2018). The few studies, which mention mechanisms in one way or another, do not offer detailed conceptualization and do not focus explicitly on studying them. In their study of the role of IS affordances for the development of Alibaba's ecosystem, Tan et al. (2016), for example, present IS affordances as 'sub-sets' of generative mechanisms, but do not develop this view in detail. Other researchers also identify specific mechanisms, such as distributed tuning (Eaton et al., 2015) and asymmetric influence mechanism (Song et al., 2018), but these findings remain largely fragmented. Thus, current research does not explain how various mechanisms set in motion by a number of triggers drive the evolution of a digital platform ecosystem.

While existing studies investigate important issues about the process of digital platform ecosystem evolution (Figure 2) (that is, what evolves (co-evolution perspective) towards what outcome (growth perspective) and through what strategies (the strategic perspective)), they provide rather descriptive overview of this process, with limited explanatory power. To address this shortcoming, scholars have recently drawn their attention towards exploring triggers and mechanisms for digital platform ecosystem evolution, but research remains scant. Thus, to further advance existing research, this PhD dissertation seeks to provide explanation about why and how digital platform ecosystems evolve by investigating how various mechanisms, when triggered by certain events, drive the evolutionary process and what strategies platform owners can adopt to manage it (see above, Introduction, Section 3, Research Goals).
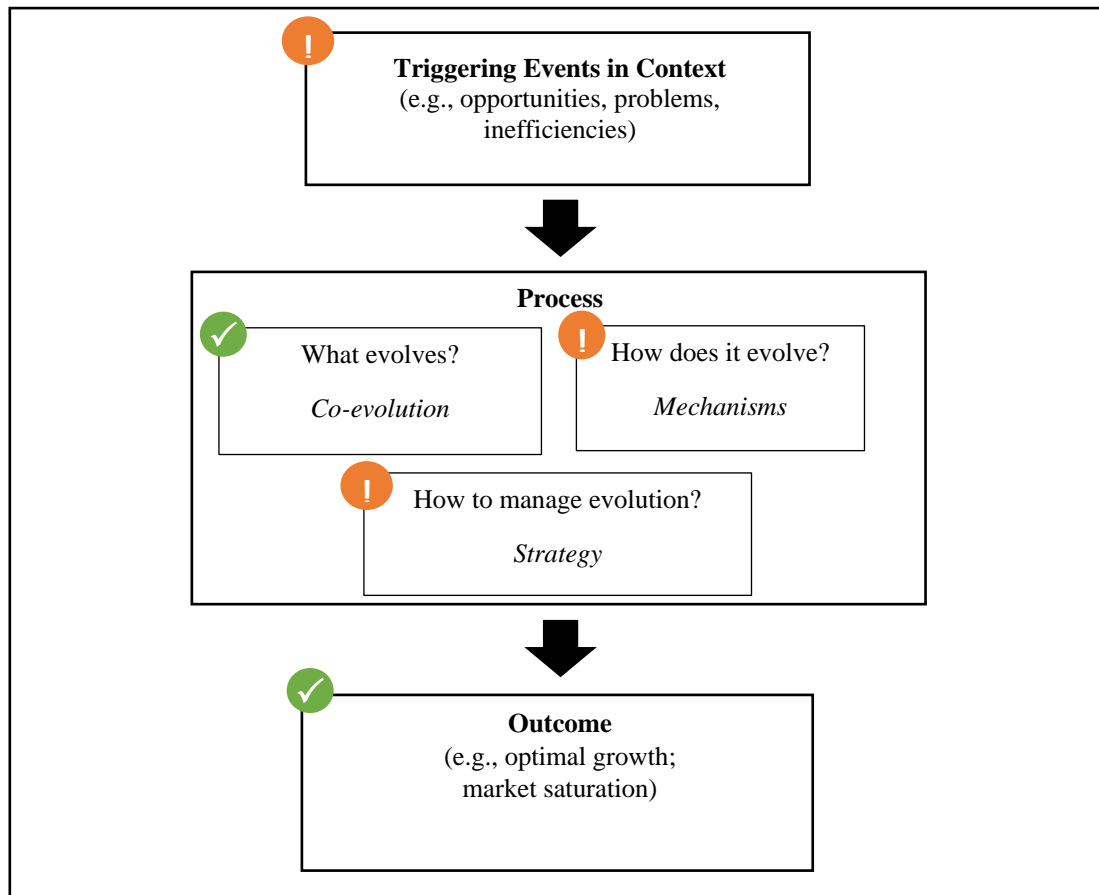
Figure 2. Overview of the Current Research on Digital Platform Ecosystem Evolution[3]

IV Generative Mechanisms as Meta-Theory

To answer the research question why and how digital platform ecosystems evolve over time in response to the various challenges they face, this PhD dissertation adopts the notion of generative mechanisms as meta-theory, which serves to provide an overall guidance for conducting the separate research studies and combining their findings (for the role of meta-theory, see Bostrom et al., 2009). In this chapter, I first introduce the notion of generative mechanisms and present them as "motors of change" (see Van de Ven and Poole, 1995), which drive the digital platform ecosystem evolution. I then outline how generative mechanisms serve as foundation for subsequent research (Figure 3).

1. Overview of Generative Mechanisms

For the purposes of this research, I present generative mechanisms as a form of meta-theory, which helps me outline key concepts and the relationship among them, in order to guide further the development of context specific theories (namely three process theories) (Bostrom et al., 2009; Lewis and Smith, 2014). In particular,

---

[3] An early version of this model appeared in Paper I

a meta-theory "links across theory-domains" (Bostrom et al., 2009, p. 19) to help researchers establish a comprehensive overview of an investigated phenomenon. To this end, I present generative mechanisms as foundation around which I subsequently develop three process theories (see below, Section 4).

A key construct in critical realism (for more, see Chapter V), generative mechanisms provide causal explanations why and how certain events occur (Bhaskar, 1972; Mingers et al., 2013). While researchers have largely relied on statistically derived correlations to study the relations between two observed phenomena (Bygstad et al., 2016; Wyn et al., 2013), scholars have pointed out that to understand fully the causal relationship between them, we need to identify and explain the generative mechanisms, which link them (Bhaskar, 1975; Bygstad et al., 2016; Hedstrom and Swedberg, 1998; Volkoff and Strong, 2013). Due to their ability to account for causality, generative mechanisms allow researchers to 'open up the black box', which often masks the process through which certain outcomes come into being (Archer, 2015; Dalkin et al., 2015).

Generative mechanisms constitute structures (Henfridsson and Bygstad, 2013), with vested in them causal powers (Elster, 2007), stemming from the interplay between the related objects of which the structure consists (Sayer, 1992). Bunge (2004) further presents them as "one of the processes in a concrete system that makes it what it is" (p. 182). Thus, generative mechanisms due to the inherent interplay between their structures, objects and events are "capable of bringing about or preventing some change in all or part of the system" (McGrath, 2013, p. 6).

While generative mechanisms serve as "theoretical cogs and wheels" (Hernes, 1998, p. 74) that help explain how certain observable outcomes occur, due to their context proximity, generative mechanisms do not engage with grand theories (Hedstrom and Swedberg, 1998; McGrath, 2013). Rather, they are suitable for developing middle-range theories (Elster, 2007; McGrath, 2013), which provide generalizable, yet empirically grounded explanations about observed phenomena, thus avoiding offering overly abstract accounts (Hassan and Lowry, 2015).

While researchers draw upon the above definitions when investigating generative mechanisms in their studies, they portray them differently depending on the analyzed phenomenon, the adopted theoretical lens and the applied methods (Wyn et al., 2013). Researchers, for example, investigate mechanisms in various contexts – social mechanisms (Hedstrom and Swedberg, 1998), organizational mechanisms (Pajunen, 2008), socio-technical mechanisms (Bygstad et al., 2016; Henfridsson and Bygstad, 2013; McGrath, 2013; Volkoff and Strong, 2013).

In the Information Systems field, for example, Henfridsson and Bygstad (2013) pinpoint three generative mechanisms (innovation, adoption and scaling), which build upon one another and collectively drive the evolution of digital infrastructures. Through the innovation mechanism, new products and services emerge due to the ability to integrate dispersed resources. As the number of offerings expands, more users join the

infrastructure, a process driven by the adoption mechanism (ibid). Finally, the increased number of users leads to the inclusion of new actors, which allows the digital infrastructure to develop further through a scaling mechanism (Henfridsson and Bygstad, 2013).

Seeking to explain the various coordination efforts associated with the governance of federated IT organizations, Williams and Karahanna (2013) outline two generative mechanisms– a 'consensus making' and a 'unit-aligning'. In particular, they use these mechanisms to explain the process of coordination and the various outcomes observed as result of this process. Unlike the generative mechanisms identified by Henfridsson and Bygstad (2013), which are of socio-technical nature, the consensus-making and unit-aligning mechanisms emphasize the interplay between various actors engaged in coordinating the governance of federated IT organizations.

Similarly, when studying the various degrees of digitalization across three hospital units, Mihalescu et al. (2015) propose three generative mechanisms, namely standardization, alignment, and convergence, to explain the different levels of digitalization in the three units. While the standardization mechanism leads to the recording of all relevant work practices in digital form, the alignment mechanism stirs a process, which allows for more personalized services that can also interconnect through a convergence mechanism (ibid). Although all these mechanisms are set in motion within the specific hospital units, they lead to various degrees of digitalization (that is various outcomes).

2. Operationalization of Generative Mechanisms for Digital Platform Ecosystem Evolution

Regardless of the numerous applications, most scholars provide overlapping conceptualizations of generative mechanisms, which I synthetize in Table 3. Building upon previous work, I further define generative mechanisms for the purposes of studying digital platform ecosystem evolution (Figure 3) (for further conceptualization of generative mechanisms, see Paper II, Analytical Framing).

Initially, generative mechanisms are non-observable and situated in a given context (Dalkin et al., 2015), in which a specific digital platform ecosystem operates until various events, both internal and external, or other mechanisms activate them (Bhaskar, 1975, Bygstad and Munkvold, 2011; McGrath, 2013; Pawson, 2000) (Figure 3). As a digital platform ecosystem constitutes a configuration of actors, architecture and governance (see, Chapter II), at any given point in time, it is characterized by certain dormant properties (e.g., malleability, increased usefulness; see Henfridsson and Bygstad, 2013), rendered to it by the existing configuration. As a result, the existing configuration of the digital platform ecosystem in terms of actors, architecture and governance facilitate or restricts the functioning of the activated generative mechanism (Henfridsson and Bygstad, 2013).

The generative mechanism consists of various activated components (or objects) (actors, organizations, IT systems, and more), which interact to form an interconnected structure with causal powers (Bygstad and

Munkvold, 2011; Pujanen, 2008). The particular composition of an activated generative mechanism depends on which part of the digital platform ecosystem it affects. For example, in the process of introducing new types of ecosystem actors, such as third-party developers, there are multiple socio-technical components involved (e.g., platform owner, platform providers, demand-side users, boundary resources, various rules for access, participation and appropriation). Through the interactions between the activated socio-technical components, a change process occurs leading to certain evolutionary outcomes (e.g., openness towards third-party complementors; see Paper II for details), which we can observe empirically (Bygstad and Munkvold, 2011; Hedström and Swedberg, 1998; Henfridsson and Bygstad, 2013).

Table 3. Key Constructs of Generative Mechanisms	
Context	A particular situation in which latent mechanisms exist and various internal and external events appear (Dalkin et al., 2015; Henfridsson and Bygstad, 2013)
Activation	Various events and other mechanisms can activate a dormant mechanism (Bhaskar, 1979)
Structural components of a mechanism	Mechanisms consist of activated components (actors, systems), which come together to form a network structure (Bygstad and Munkvold, 2011)
Socio-technical interplay of components	A process through which the activated socio-technical components of a mechanism interplay to produce an outcome (Bygstad and Munkvold, 2011; Pujanen, 2008)
Outcome	An observable pattern of events resulting from activated mechanism (Bygstad and Munkvold, 2011)

Generative mechanisms do not exist in isolation. Rather, they build upon one another and jointly drive the evolutionary process (Bygstad and Munkvold, 2011; Hedstrom and Swedberg, 1998; Henfridsson and Bygstad, 2013). Thus, multiple generative mechanisms activated by different triggers and producing various outcomes co-exist and interact throughout the evolution of a digital platform ecosystem (for more, see Paper II, Discussion).
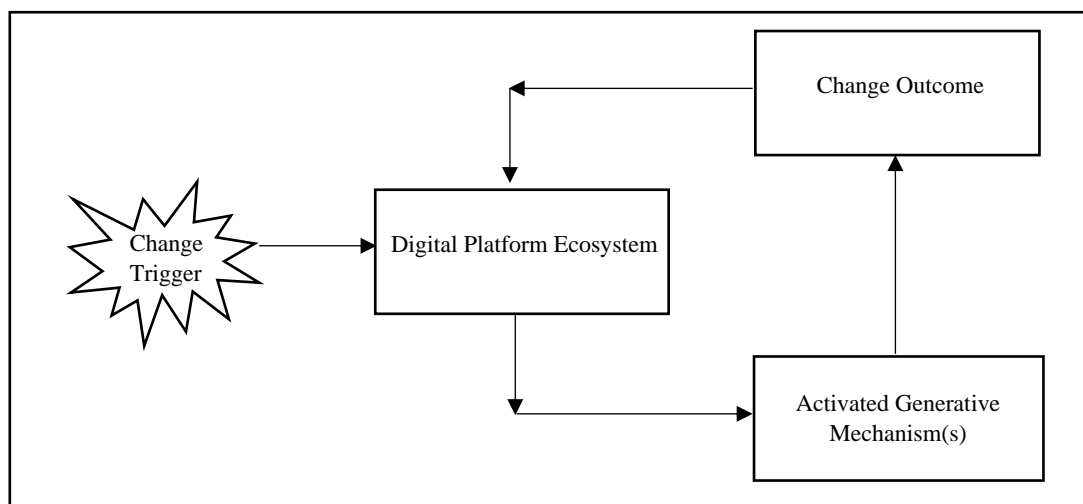
Figure 3. Operation of Generative Mechanisms (Adapted from Henfridsson and Bygstad, 2013)

3. Generative Mechanisms as Motors of Change

Generative mechanisms are the "motors"[4], which produce a string of events, leading to specific changes (Van de Ven and Poole, 1995). As such, they are at the heart of theories, which explain change in various contexts (Archer, 2015; Henfridsson and Bygstad, 2013; Van de Ven and Poole, 1995, Volkoff and Strong, 2013). Observing the multiplicity of theories and their corresponding generative mechanisms within the organizational studies, Van de Ven and Poole (1995) synthetize four ideal types of change process theories - life-cycle, dialectical, teleological, and evolutionary. Each of these change theories emphasize on specific generative mechanism, thus providing different explanations of how changes appear and progress over time.

Life-cycle theory presents the change process as consisting of a number of stages, which trace the development of a phenomenon from its birth to its growth, maturity and eventual decline (Van de Ven and Poole, 1995; Poole and Van de Ven, 2004). A phenomenon evolves from one stage to another by following a determined sequence of events, with each stage influencing the following stage (ibid). The motor driving the change process in life-cycle theory stems either from the inherent characteristics of a phenomenon formed during the initial phase, or from external requirements (Poole and Van de Ven, 2004).

Teleology theory views the change process as a "repetitive sequence of goal formulation, implementation, evaluation, and modification of goals" (Van de Ven and Poole, 1995, p. 516). Thus, the achievement of specific set of goals serves as the generative mechanism driving the change process. As managers respond to specific problem or opportunity as they emerge over time, they set, execute and learn from various goals, without predefined pattern (Poole and Van de Ven, 2004).

Dialectic theory presents the change process as consisting of various tensions, stemming from different goals. According to this theory of change, a specific phenomenon can exist in status quo (thesis), characterized by certain degree of stability, as the conflicting tensions are latent. When triggered, these unreconciled tensions became salient (anti-thesis) and seek to change the status quo. If successful, a transformation of the status-quo (synthesis) occurs. Thus, salient conflict constitutes the generative mechanism driving the change process in this theoretical perspective.

Evolutionary theory, as adopted by Van de Ven and Poole (1995), provides an explanation of the change process on industry level rather than on organizational level. In particular, evolution theory investigates the "cumulative changes in structural forms of populations of organizational entities across communities, industries, or society at large" (ibid, p. 517-518). Thus, Van de Ven and Poole (1995) present a specific view

---

[4] For the purposes of this research, Generative Mechanisms and motors are synonymous.

of evolutionary theory, which mirrors the evolutionary economics' process of variation, selection and retention, where competition serves as generative mechanism driving the change.

Although Van de Ven and Poole (1995) put forward four types of theories, they recognize that the majority of the change theories, in fact, incorporate two or more of the identified generative mechanisms. To portray comprehensively the complexity of the change process, Poole and Van de Ven (2004) urge scholars to combine a number of generative mechanisms from different theoretical perspectives when constructing their own theories. Failure to do so, they argue, often leads to fragmented explanations, which may overlook important aspects of the change process (Poole and Van de Ven, 2004).

In contrast, multi-motor explanation brings together interrelated, yet separate views of the change process approached through different theoretical lenses, which allows for in-depth theory development (Van de Ven and Poole, 1995). Thus, the four basic types of theories and their corresponding generative mechanisms serve as foundational components, which scholars can combine to strengthen the theoretical explanations they put forward when investigating change processes in a particular context (ibid).

4. Framing Multi-Motor Understanding of Digital Platform Ecosystem Evolution

The main goal of this PhD dissertation is to provide comprehensive understanding of how and why digital platform ecosystems evolve over time by outlining the relevant generative mechanisms (see, Introduction, Section 3, Research Goals). To explain this complex process in-depth, I seek to investigate different aspects of the phenomenon in question (digital platform ecosystem evolution) by applying different theoretical perspectives. Subsequently, I adopt the typology of change process theories proposed by Van de Ven and Poole (1995) as an overarching theoretical framework first to inform the design of the separate studies conducted to address the above posed Research Questions, and then to guide the final integration of the findings outlined in each study. The proposed classification is appropriate for the purposes of this research as it facilitates the building of theories, which collectively provide 'multi-motor' explanation of the change process (Van de Ven and Poole, 1995).

Van de Ven and Poole (1995) deduct their typology of four change process theories from the field of organization studies. When transposing it to investigate a socio-technical phenomenon such as digital platform ecosystems, it is appropriate to introduce some modifications to the main assumptions of the framework in order to account for the different nature of the phenomenon. This is not unusual practice as scholars in the IS field often borrow theoretical frameworks and methods from other fields and introduce adjustments if needed (Gregor, 2006). Thus, in the next paragraphs, I clarify some of the assumptions stemming from the four types of theories, namely evolutionary, dialectics, teleology, and life-cycle, and outline how I intend to use them to drive in-depth theorizing (Figure 4).

Van de Ven and Poole (1995) adopt a specific view on evolutionary theory in relation to the variation-selection-retention mechanism, which operates on industry level as it focuses on population of organizations (see above). As such level of analysis presupposes to study the dynamics occurring between several digital platform ecosystems, which falls outside the scope of this research, such view is inapplicable for the purposes of this dissertation. Furthermore, the proposed evolutionary theory identifies competition as a generative mechanism, driving the change process (Van de Ven and Poole, 1995). While competition can be a trigger of digital platform ecosystem evolution (Ojala and Lyytinen, 2018), it is one of the many existing drivers of change as identified by relevant studies in the platform literature (see Chapter III). Thus, the adoption of the evolutionary theory as proposed in the Van de Ven and Poole framework, with emphasis on competition, would lead to omission of a myriad of other external and internal triggers, which collectively drive the evolution of a digital platform ecosystem.

A starting point in the quest for identifying suitable evolutionary theoretical lens is to look at the IS domain for outlining studies which investigate change in socio-technical systems. Lyytinen and Newman (2008), for example, taking into account the punctuated nature of IS change, propose a Punctuated Equilibrium model to study the change process in complex socio-technical systems. Punctuated Equilibrium is an evolutionary theory, which presents the evolutionary process as consisting of stable periods, which are suddenly disrupted by rapid instances of instability (Gersick, 1991). It further emphasises the role of triggering events for producing change (Gersick, 1991; Lyytinen and Newman, 2008) and as such is appropriate for addressing the research gap in the existing literature on digital platform ecosystem evolution (see Chapter III).

Van de Ven and Poole (1995), for example, view Punctuated Equilibrium as a theory, which investigates the change process as determined by the interplay between two separate generative mechanisms, namely evolutionary and teleological. Their analysis, however, builds upon the theory as applied to study organizational evolution (see Tushman and Romanelli, 1985). Consequently, to identify generative mechanisms, I adopt Punctuated Equilibrium theory as theoretical lens drawing upon the work by Lyytinen and Newman (2008), which is suitable to study change in socio-technical systems. Although utilizing Punctuated Equilibrium theory, they, however, do not conceptualize and identify any generative mechanisms. To address this shortcoming, I, together with my co-authors, conceptualize the notion of generative mechanisms (Figure 3) (such conceptualization is missing from the work by Van de Ven and Poole (1995)) and combine it with Punctuated Equilibrium theory (for more details, see Paper II, Analytical Framing).

While the previous study (Paper II) aims at identifying a number of generative mechanisms, which drive the evolution of a digital platform ecosystem, in the next study (Paper III) I adopt a dialectics lens to look at how tensions emerging within the ecosystem drive its evolution. Observing that digital platform ecosystems as socio-technical systems are full of tensions (see, e.g., Jarvenpaa and Lanham, 2013; Wareham et al., 2014), researchers have applied dialectics to investigate various aspects of digital platform ecosystems. Wareham et

al. (2014), for example, list a number of tensions mainly related to the technology aspects of the platform ecosystem, while Eaton et al. (2015) investigate the tensions around the evolution of boundary resources. Their studies, however, offer incomplete conceptualization of the dialectics theory (for more details, see Paper III). To address this shortcoming and to offer an additional theoretical perspective to the investigated phenomenon, in Paper III, I, together with my co-authors, seek to propose a Dialectical theory of digital platform ecosystem evolution.

Teleology theory presents the change process as a number of defined goals, which actors pursue actively (Van de Ven and Poole, 1995). Most researchers recognize the teleological nature of socio-technical systems (e.g., Ralph and Wand, 2008; Richard and Simon, 2006), although Lyytinen and Newman (2008) explicitly state that "systems do not possess teleology" (p. 593). Although not explicitly defined, researchers acknowledge that digital platform ecosystems as socio-technical systems are teleological. For example, Evans (2009) points out that after launch, the goal of the platform owner is to ensure a critical mass of users (see, Chapter III, Growth Perspective). Scholars from the Strategic Perspective also demonstrate the goal-seeking behaviour within digital platform ecosystems (ibid). There is a lack, however, of a comprehensive study, which portrays the evolution of a digital platform ecosystem from a teleological perspective (a notable exception is the study by Tan et al., 2015).

The adoption of teleology perspective to study the evolution of a digital platform ecosystem requires the clarification of a number of considerations. Digital platform ecosystems comprise a myriad of actors (see, Chapter II, Section 2, Characteristics of Digital Platform Ecosystems), who may have complementary or conflicting goals throughout the course of the ecosystem evolution (see above). The majority of the platform literature, however, focuses mainly on the goals of the platform owner as a key ecosystem actor (see, Eaton et al., 2015; Gawer and Henderson, 2007; Cecaggnoli et al., 2012 as exceptions), thus failing to recognize the impact which the goals of other ecosystem actors can have on the evolutionary trajectory of the platform ecosystem. As teleology puts emphasis on setting and achievement of goals as motors of change, a key question is the goals of which actors drive the evolution of digital platform ecosystem (for more, see Chapter VII).

Digital platform ecosystems also operate in a highly turbulent and uncertain environment (Dattee et al., 2017, Parker et al., 2016), which makes setting and pursuing long-term goals problematic. Rather than planned (as per Van de Ven and Poole (1995)), the change in the platform ecosystems seems to be emergent, with platform owners not being able to predict the future evolutionary trajectory as they have to make constant adjustments (Dattee et al., 2017; Ojaha and Lyytinen, 2018). Although Van de Ven and Poole (1995) state that managers can change their goals based on changes in the environment, this is a rather reactive position in relation to previous goal target. Subsequently, I take these considerations in mind when I investigate the evolution of a digital platform ecosystem from a teleological perspective (Paper IV, Paper V, and Paper VI).
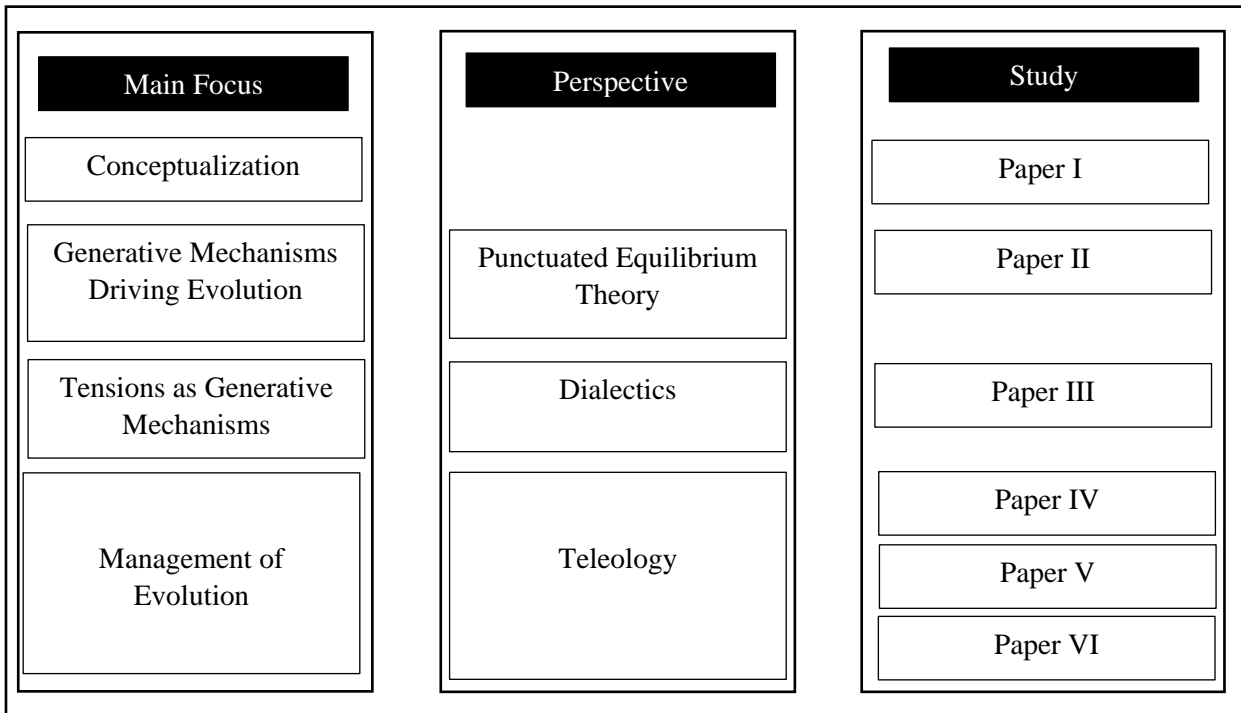
Main Focus	Perspective	Study
Conceptualization		Paper I
Generative Mechanisms Driving Evolution	Punctuated Equilibrium Theory	Paper II
Tensions as Generative Mechanisms	Dialectics	Paper III
Management of Evolution	Teleology	Paper IV
		Paper V
		Paper VI

Figure 4. Overview of the Separate Studies

Life-cycle theory views the change process as a number of stages through which digital platform ecosystem evolves (Van de Ven and Poole, 1995). As demonstrated in the above literature review (Chapter III), existing studies have already presented the evolution of digital platform ecosystems as life-cycle models. Given the presence of a number of studies, I do not find it useful to direct my research efforts on investigating platform ecosystem evolution from a life-cycle perspective. Rather, I utilize the findings from the identified studies (see Chapter III) when discussing and integrating the findings from the five separate studies (Paper II, Paper III, Paper IV, Paper V and Paper VI) in order to put forward a multi-motor understanding of digital platform ecosystem evolution.

V Method

In this chapter, I outline the main principles of engaged scholarship as research approach and critical realism as research paradigm guiding my scientific endeavours. Next, I introduce the research setting and the methods used for conducting the separate studies, part of this PhD dissertation. Then, I present the techniques used for data collection, provide an overview of the gathered data, and demonstrate the techniques used for data analysis.

1. Engaged Scholarship

Conceived in close collaboration with industry, this PhD dissertation is rooted in the practices of Engaged Scholarship research, which aims at reducing the separation between research and practice by advancing theoretical knowledge, while also sharing insights with practitioners and trying to influence their work (Mathiassen and Nielsen, 2008; Ven de Ven, 2007). The aim is to conduct research, which is relevant to both academics and practitioners, while also remaining scientifically rigorous (Van de Ven, 2007).

In particular, I have carried out this project as collaborative basic research, one of the four forms of Engaged Scholarship, where the researcher creates knowledge in order to explain a particular phenomenon while participating actively in the research setting and collaborating closely with relevant stakeholders (Ven de Ven, 2007). After identifying a research problem of mutual interest for me as a PhD fellow and for the case company, MobilePay, through continuous engagement and collaboration with practitioners (see below), I have gained in-depth understanding of the investigated phenomenon and have derived insights, which I have exchanged with practitioners. As a result, they have benefited from obtaining a different perspective of the investigated phenomenon, which has helped them reflect on their journey so far, discover new learning points and prepare better for future challenges (for more details, see Chapter VIII, Implications for Practice).

2. Critical Realism as Research Paradigm

This research adopts critical realism as a research paradigm (Bygstad and Henfridsson, 2013; McGrath, 2013; Mingers et al., 2013; Smith, 2010), which constitutes an alternative to the interpretative and positive paradigms, historically dominating the field of Information Systems (Easton, 2010; Wyn and Williams, 2012). Due to its stronger explanatory apparatus, critical realism can overcome the 'theory-practice inconsistency', which characterizes both positivism and interpretivism (Smith, 2006, p. 191). In particular, it can strengthen the understanding of non-deterministic causality, which is largely unaddressed in the other two dominant perspectives in IS (Smith, 2006).

The main principle of critical realism is that there is a world, which exists independently from our knowledge of it (Mingers et al., 2013). Although rooted in the research paradigm of realism, critical realisms advances our understanding of reality and advocates for the adoption of transcendental realist ontology (Mingers, 2004). As a result, it perceives the world as reality, divided in three distinct levels; real, actual and empirical (see Figure 5) (Bhaskar, 1993). Underlying objects forming structures and their causal powers characterize the real world, but tend to be unobservable (Sayer, 1992). Generative mechanisms operating in the real world produce patterns of events in the actual world, some of which we can experience in the empirical world (Bhaskar, 1993; Mingers, 2004; Smith, 2006). Reality, thus, consists not only of the events we observe, but also of the events that we could not observe and the mechanisms, which produce them.
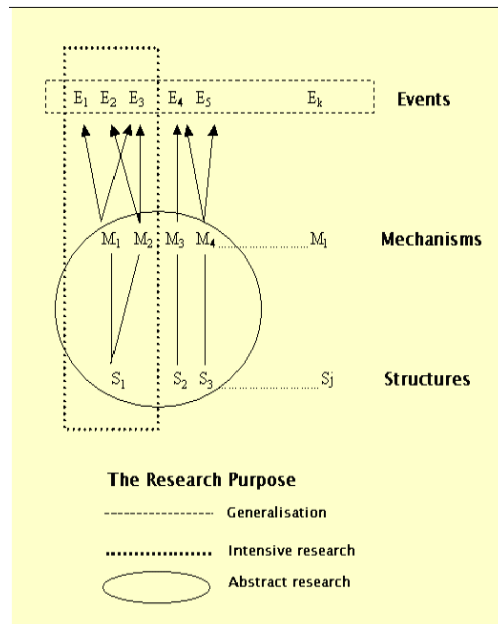
Figure 5. Layered Ontology of Critical Realism (Sayer, 1992)

Understanding causality under the form of a generative mechanism is a central topic in critical realism (Bygstad et al., 2016; Henfridsson and Bygstad, 2013; Sayer, 2000; Smith, 2010). Zachariadis et al. (2013) argue that "observable events that are being causally generated from the complex interactions of mechanisms can give some information on the existence of these unobservable entities" (p. xxx). Critical realists reject the view on causality as a pattern of events based on a number of regularities (see Figure 6) (Sayer, 2000). Rather they advocate for identifying the generative mechanisms, which explain what caused (trigger) a particular phenomenon (outcome) and how the latter came into being (mechanism) (Henfridsson and Bygstad, 2013; Mingers et al., 2013; Sayer, 2000). In particular, the existing structures in the real domain enable certain generative mechanisms, which operate in specific context, to lead to events observable in the empirical domain (Smith, 2006; 2010). Due to the contingent nature of causality, there is no regularity between triggering events, the generative mechanisms and the various outcomes (Sayer, 2002). Instead, different triggers set in motion various generative mechanisms, which can account for different outcomes (Henfridsson and Bygstad, 2013; Sayer, 2000).
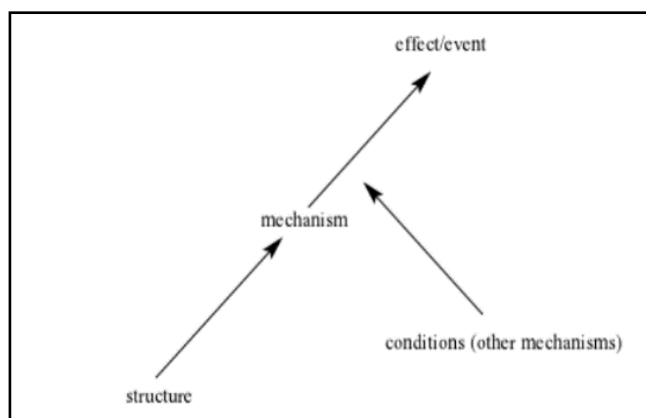
Figure 6. Critical Realism's View on Causality (Sayer, 2000)

Critical realism advocates for "epistemic relativity" (Mingers et al., 2013, p. 797). Thus, critical realists recognize that knowledge is context dependent, socially constructed (Henfridsson and Bygstad, 2013) and incomplete (Smith, 2006). Wyn and Williams (2012) further argue that our knowledge is not isolated, but rather mediated by the values, beliefs and perceptions of the researchers.

Critical realists tell apart between transitive (our knowledge of the world) and intransitive (independent of our knowledge) knowledge (Bhaskar, 1977). Thus, while our knowledge of the reality is transitive, the world itself is intransitive (Smith, 2006). In particular, although researchers observe events in the empirical layer, they, in fact, operate in the actual layers and may be unobservable or different researchers can observe them in different ways (Easton, 2010). Thus, no knowledge is certain and most of the observations are erroneous, as they cannot guarantee complete consistency between reality and theory (Easton, 2010; Sayer, 1992; Wyn and Williams, 2012).

For critical realists, the goal of a theory is to generate as accurate as feasible explanations about the intransitive world rather than putting forward predictions about it (Hunt, 2005; Wyn and Williams, 2012). To ensure that the acquired knowledge about the real world is valid, researchers need to assess it critically by adopting different theoretical perspectives and methods to investigate the same data (Easton, 2010; Sayer, 2000). Thus, researchers often put forward multiple possible explanations of a particular phenomenon (Wyn and Williams, 2012).

As critical realism initially emphasized on ontology and later on epistemology, the guidelines on methodology remained largely absent in early work (Bhaskar, 1975; Sayer, 2000). In later contributions, critical realists recommend that to derive explanations of the observed events and the generative mechanisms producing them, researchers should rely on retroduction (Sayer, 2000), which is a specific form of abductive reasoning. When engaging in retroduction, researchers begin by concentrating on a particular phenomenon they wish to explain and trace back the mechanisms and events, which shape it (Easton, 2010; Sayer, 2000; Volkoff and Strong, 2013). Extending further this view, Mingers et al. (2013) summarize this approach as consisting of several

phases, namely describing the phenomenon, deriving possible generative mechanisms, evaluating the explanatory power of the proposed mechanisms and selecting the correct ones.

Due to the non-deterministic (contingent) causality, critical realism advocates for the adoption of multiple methods (Mingers, 2004; Mingers et al., 2013; Sayer, 2000). Sayer (2000) distinguishes between extensive (largely quantitative) and intensive (qualitative) methods of inquiry, where the former have less explanatory power than the latter (see Easton, 2010). Aiming to overcome the historical separation between quantitative and qualitative research, Zachariadis et al., (2013) further apply the ontological and epistemological principles of critical realism to advocate for mixed-methods research.

Despite these attempts, however, most IS scholars, when engaging in critical realism research, consider case studies as one of the most appropriate methods due to their ability to provide in-depth explanations (Easton, 2010; Mingers, 2004; Wyn and Williams, 2012). Initially, scholars have focused on providing detailed guidance how to conduct case study research from critical realism perspective in order to identify the relevant generative mechanisms (Bygstad and Munkvold, 2011; Easton, 2010; Henfridsson and Bygstad, 2013; Wyn and Williams, 2012). Wyn and Williams (2012), for example, outline five different principles – explication of events, explication of structure and context, retroduction, empirical corroboration, triangulation. Later, researchers also sought to extend these principles by proposing to identify generative mechanisms through affordances (Bygstad et al., 2016; Tan et al., 2015) or grounded theory (Vintzce, 2013).

3. Research Setting

Digital Platform Ecosystems

Digital platform ecosystems are at the centre of inquiry in this PhD dissertation. Due to their unique properties, such as scalability and ability to achieve market dominance, traditional companies and start-ups alike seek to orchestrate digital platform ecosystems. As a result, many digital platform ecosystems have emerged and have spread across a number of industries - from social media (e.g., Facebook, WeChat, YouTube) and online marketplaces (e.g., eBay, Alibaba, Amazon) to accommodation (e.g., Airbnb), music (e.g., iTunes, Spotify), transportation (e. g., Uber) and payments (e.g., ApplePay, Venmo). Due to the novelty of their services and the more efficient ways of operating, digital platform ecosystems tend to disrupt the traditional industries they enter (e.g., Uber and traditional taxi industry), which makes them an interesting topic to investigate. As a starting point, I commenced this research by looking into how digital platform ecosystems across various industries tend to evolve over time in order to identify commonalities and differences, which would inform my subsequent studies (Paper I and Paper III). In particular, as digital platform ecosystems are heterogeneous (see Chapter I), I was initially intrigued to investigate whether they would evolve following similar or different trajectories (Paper I).

Digital Payment Platform Ecosystems

Subsequently, I narrowed down the scope of the research to the payment industry (see Figure 7), which has found itself into a state of flux, facing changing consumer preferences, new competitors, rapid adoption of technologies, and changing regulatory environment. For a number of decades, the payment industry remained stable, characterized by established players (acquirers, issuers, card scheme owners, infrastructure providers) operating around agreed dominant design (card schemes) and having stable revenue streams. In the recent years, however, numerous digital payment platform ecosystems (e.g., ApplePay, SamsungPay, Venmo), offered by non-traditional financial actors, have emerged, prompting incumbents to offer their own compelling digital payment platforms and to orchestrate ecosystems around them (e.g., Pingit by Barclays, MobilePay by Danske Bank, etc.). Thus, after disrupting a number of well-established industries (publishing, music, accommodation and more) (Parker et al., 2016), digital platform ecosystems have also begun to disrupt the traditional financial sector (Evans and Schmalensee, 2016).

Utilizing novel technologies (e.g, NFC, Bluetooth, tokens, etc.), these digital payment platform ecosystems facilitate peer-to-peer and consumer-to-business interactions by coordinating the activities occurring between consumers and merchants (Evans and Schmalensee, 2010; 2016; Kazan et al., 2018; Ondrus et al., 2015, de Reuver et al., 2017). A distinct characteristic of digital payment platform ecosystems is that they orchestrate the activities of a myriad of actors (e.g., technology providers, infrastructure providers, consumers, merchants, and more) (Ondrus et al., 2015). As such, they constitute exemplary cases of digital platform ecosystems and serve as an appropriate context of investigation. Furthermore, as digital payment platform ecosystems operate in a highly turbulent and dynamic environment due to the ongoing digital transformation of the payment industry, they have evolved rapidly (Kazan et al., 2018; Ondrus et al., 2015), resulting in eventful evolutionary trajectories, which are suitable for identifying various triggers and generative mechanisms.

Although digital payment platforms and the ecosystems around them emerged in Asia in early 2000s (Ondrus et al., 2015), the majority of them failed to ignite and stopped operating soon after launch (Ondrus and Lyytinen, 2011). Researchers have observed similar trends in Europe explaining the failed ignition with unrecognized behavioural patterns of consumers, poor technology solutions, and lack of standardization (Ondrus et al., 2009). Thus, initially, due to their relatively short life span, researchers mainly investigated the initial design and ignition strategies of digital payment platforms and their surrounding ecosystems (Evans, 2009; Evans and Schmalensee, 2006), while not delving into studying the evolutionary path of such ecosystems over longer period of time due to lack of successful cases.

The maturity of the technology, combined with the rapid spread of mobile devices, changing consumer preferences (on-demand services) and favourable regulation (Hedman and Hennfridsson, 2015; Kazan et al., 2018) led to the launch of a number of successful digital payment platforms which orchestrated a vibrant ecosystem around them (e.g., Pingit in United Kingdom, iZettle in Sweden, MobilePay in Denmark). As these payment platform ecosystems have managed to overcome the critical early stages and to evolve further by

solving various challenges, investigating their evolutionary journeys can provide rich accounts of why and how they have evolved over time.

MobilePay and the Payment Market in Denmark

Of particular interest for this research is the payment industry in Denmark, as a country characterized by a high level of digitalization (European Payments Council, 2017). Denmark has historically been at the frontier of payment innovation, with Danes adopting relatively fast new payment technology solutions (ibid). For example, after the introduction of the national payment card, the Dankort, in 1984, which connected Dankort cardholders to merchants accepting it, Danes rapidly adopted this new means of payment, abandoning cash. As a result, in the beginning of 2000s, Danes used payments cards more than cash to pay in retails stores (Danish Payments Council, 2016). Similarly, Denmark was among the first countries in the world to introduce online banking in 1999, with three million Danes (out of five million Danish population) adopting it within approximately seven years after the launch of the service (Danish National Bank, 2016).

Not all innovation attempts in the Danish market, however, were successful. Embracing the latest technology innovation, in 1990, Nets, the owner of the Dankort and one of the leading Nordic payment service providers, decided to launch a pre-paid card (Danmønt) utilizing NFC chip (Hjelholt and Damsgaard, 2013). After its introduction, the Danmønt managed to obtain support from all the relevant actors involved and, as a result, vast majority of the Danes adopted it (ibid). The situation, however, changed in 1997 with the rapid spread of mobile phones, leading to one of the main supporters of the Danmønt, a telecom company, to exit the collaboration. Furthermore, the Dankort also competed with the Danmønt, leaving both consumers and merchants dissatisfied with the overlap between the two solutions as the former had to carry two cards and the latter had to install two separate payment terminals at the counter. As a result, Nets terminated the operation of Danmønt in 2005 (Hjelholt and Damsgaard, 2013).

Around 2010, however, the payment landscape in Denmark began to transform once again due to a combination of various technical, regulatory, consumer behavioural and competition changes (see Paper V). With the launch of the iPhone in 2007, new generation of mobile phones with vastly improved capabilities emerged and incorporated services offered previously on multiple physical devices (e.g., camera, music players, navigation devices), with payment cards being the next target (Kazan et al., 2018). The new devices gained rapid adoption with approximately 59 % of the Danes using a smartphone in 2013 (Statista, 2016). At the same time, in 2014, approximately 88 % of the Danish population used Internet, with 79% of the Danes using it to make online transactions in 2015 (Ecommerce News, 2016). The rapid penetration and use of smartphones and the Internet led to consumers requesting on-demand, innovative services.

As an aftermath of the 2008 financial crisis, the regulatory framework in the financial sector in the European Union, of which Denmark is part, was also changing significantly (Hedman and Hennfridsson, 2015; Kazan

et al., 2018). While the regulators introduced stricter requirements for traditional financial institutions, they also encouraged the entry of new actors (e.g., fintech start-ups) with the introduction of the Payment Service Directive (PSD) in 2007, which aimed at granting new entrants non-discriminatory access to the traditionally closed payment infrastructure owned and operated by incumbents (European Commission, 2013). Because of the emerging opportunities, new contenders challenging the dominant positions of established financial institutions announced plans to enter the Danish market. For example, the Swedish-based start-up, iZettle, which provides Point-of Sale solutions to small and medium-sized businesses, entered the Danish market in the end of 2011 (Hedman and Hennfridsson, 2015).

Observing closely these trends, in the summer 2011, the four major Danish telecommunication operators, Telia Denmark, TDC, Telenor and Hi3G (3), announced their plans to work on a common mobile payment solution and entered in negotiations with some of the major banks in Denmark. Soon, however, the negotiations stalled and the banks left the initiative, leading to the telecom operators establishing, in November 2012, a joint company, 4T, which was to develop independently a mobile payment solution.

Despite failing to reach a common agreement with the telecom operators, the Danish banks acknowledged the changing landscape and decided to venture together into the mobile payment area. The talks to launch a joint mobile payment solution, however, stalled, as the banks could not agree on a common vision and technical standard for the new solution. As a result, Danske Bank, the leading bank in Denmark, left the joint initiative in December 2012 and announced that it was going to launch its own mobile payment solution (see also Paper II and Paper V). The rest of the Danish banks continued to cooperate with the goal of launching a common initiative. With many actors competing to introduce first a mobile payment solution, the competitive environment in Denmark intensified.

To outpace competitors, Danske Bank formed a small team, whose task was to create an innovative mobile payment solution as fast as possible, adopting agile methods (see Paper V). In May 2013, Danske Bank launched its own mobile payment application, MobilePay, which initially allowed both Danske bank and non-Danske bank private customers to transfer money to their friends and split the bill in various situations. The digital payment platform, which utilizes the existing card infrastructure operated by Nets, the owner of the Dankort, allows its users to transfer money from their debit cards to the bank accounts of their peers via a mobile phone number.

MobilePay is an exemplary case of digital payment platform ecosystem and as such is suitable for the purposes of this research. In particular, MobilePay functions as a digital platform by providing an underlying IT architecture enabling the direct and regulated interactions between affiliated to its ecosystem actors (e.g., initially private customers and later, commercial customers, third-party complementors, and more; see Paper II). MobilePay also evolved rapidly in response to both internal and external events, and thus its evolutionary path provides a rich account of various developments (in terms of actors, architecture and governance)

occurring from the launch of the digital platform ecosystem (May 2013) until it reached market dominance (September 2017). Furthermore, due to the nature of the PhD dissertation, conceived as a close collaboration with practice, I received unique access to MobilePay, which allowed me to study its evolutionary path from first hand observations (see below, Data Collection).

After its launch, MobilePay quickly reached critical mass of users, with the initial goal of attracting 250,000 private customers (6 % of the Danish market) in one year surpassed in just two months after its introduction (June 2013). The rapid adoption among private customers led to requests from commercial customers, both small and medium-sized businesses (SMEs) and large retail chains, to join the MobilePay ecosystem. Subsequently, MobilePay enabled consumer-to-business transactions in February 2014, initially to SMEs, and later to large supermarkets. In 2015, the digital payment platform also opened to third-party developers, who could incorporate MobilePay as a payment option in their own applications. As a result, the MobilePay ecosystem evolved as to incorporate diverse actors - private customers, various commercial customers such as SMEs, large retailers, third-party developers, NGOs, and municipalities, and platform technology providers who act as distributors (e.g., payment service providers enabling online payments via MobilePay) or technology integrators (e.g., Point-of-Sale (PoS) vendors for in-store payments with large retailers) (see also Paper II). MobilePay also evolved by elaborating its underlying architecture (e.g., introduction of boundary resources, that is APIs and SDKs) and through the emergence of a governance regime (e.g., new rules for access, participation and appropriation), which respectively enable and regulate the interactions among the heterogeneous actors, whom MobilePay connects.

Despite its significant adoption rate, MobilePay continued to face multiple challenges stemming from both internal inefficiencies and frequent changes in the environment in which it was operating (Paper II and Paper V). For example, MobilePay utilized card-based infrastructure, and, as a result, the platform owner incurred operational costs for every transaction as they were subsidized. Although the owner collected revenue from commercial customers, it was not sufficient to establish a viable business model. In addition, the growing complexity of the underlying IT architecture and the tight coupling with existing Danske Bank's IT systems led to the accumulation of technology debt, which increased the instances when MobilePay malfunctioned.

The consolidation of MobilePay's market dominance also came under threat due to the changing competitive environment. Pushing forward with the common bank sector initiative, 81 Danish banks launched a competitive mobile payment solution, Swipp, in late 2013, with the goal of challenging the popularity of MobilePay. Integrated in the mobile banking apps of the respective banks, Swipp allowed its users to execute initially peer-to-peer transactions and later consumer-to-business transactions. Due to the lack of coordination around the Swipp launch, with banks entering the market separately, and the cumbersome registration process, the initial adoption by private customers was limited. Learning from this process, Swipp later launched a separate mobile payment application, with simpler and more easy-to-use design in late 2015. The contender

also continued evolving by enabling in-store and online mobile payments, thus mirroring the evolutionary trajectory of MobilePay. In addition, in February 2014, the four telecommunication operators jointly launched their online payment solution, Paii, which allowed its users to execute both P2P and C2B transactions. Thus, Paii was competing directly with MobilePay and Swipp to reach to both private and commercial customers in Denmark.

Addressing the intensified competitive environment, the platform owner developed MobilePay further by introducing it in various payment contexts (in-store, in-app, online) and among multiple heterogeneous actors (private customers, SMEs, large retailers, online stores, vending machines providers, etc.). As both private and commercial customers of MobilePay, however, could multi-home to competitive solutions (Swipp, Paii, iZettle, PayPal) due to relatively low switching costs and lack of lock-in effects, MobilePay had to continue evolving. As the competition in the payment sector had shifted from executing payments (payments as transactions) to offering services around payments (payments adding value to other services), the platform owner incorporated various value-added services (VAS), such as its own loyalty scheme (Bonus) and third-party loyalty programmes, in 2015-2016.

While MobilePay kept evolving, its main competitors on the Danish market struggled to match its growing user base. After Paii failed to ignite, Swipp acquired the solution in November 2014 in order to appropriate its technological set-up for enabling its own online payments. Despite this acquisition, in 2016, Swipp, had only 900 000 registered private customers and approximately 16 000 commercial customers (Finans, 2016; Skjærlund, 2016). In comparison, in 2016, approximately 3 million Danes used MobilePay to transact with their peers and to pay to approximately 25 000 commercial customers and 3,700 webshops (MobilePay, 2017).

While MobilePay managed to consolidate its position in the Danish market, new global and domestic contenders, both financial and non-financial actors, utilizing novel technologies, emerged. Technology companies such as Apple and Samsung launched their own mobile payment platforms (ApplePay and SamsungPay) and signalled their intention to enter the Nordics in 2016 due to the wide-spread use of smartphones in the region. On domestic level, in 2015, Nets turned the Dankort into a contactless card, thus allowing consumers to pay in-store up to certain amount without having to provide a PIN. In 2016, only one year after its introduction, Danes used the contactless Dankort in 25 percent of all registered card transactions in Denmark (European Payments Council, 2017). The fast adoption of contactless payments among the Danes, however, challenged the use of MobilePay for in-store transactions at large retails chains.

To respond to the new challenges, the platform owner decided to undertake a significant strategic shift by collaborating with other Nordic banks, which would serve as financial and distribution partners. The partner banks would invest in MobilePay in order to get access to its significant user base (app. 90 % of the Danish population used MobilePay in 2017) and would distribute MobilePay's business solutions to their own

commercial customers. If their efforts would lead to an increase in the number of commercial customers using MobilePay, the partner banks would receive part of the generated revenue.

After prolonged negotiation, in September 2016, Nordea, a major Nordic bank and the main supporter of Swipp, joined MobilePay, thus leaving the common bank consortium. After Nordea's exit, the other banks part of Swipp also decided to join MobilePay and, as a result, Swipp closed down in February 2017. Thus, MobilePay remained the leading mobile payment solution on the Danish market, a position, which contenders, however, continued to challenge. In 2017, for example, Nets launched a digitized version of the Dankort (Mobil Dankort) under the form of a digital wallet, which private customers could use to pay in-store when shopping at some of the large retailers.

The inclusion of partner banks in the MobilePay ecosystem required a change in ownership due to competition concerns. Thus, while Danske Bank as the platform owner initially formed an autonomous unit within the bank to develop and operate MobilePay, the new strategic shift required further autonomy. Thus, a separate legal entity, acting as an owner of MobilePay, was formed, with Danske Bank becoming a financial partner. After a year-long preparation, in September 2017, the new legal entity, MobilePay A/S was established, which operates under e-money licence in accordance to EU payment legislation.

Digital platform ecosystems

Digital payment platform ecosystems

MobilePay
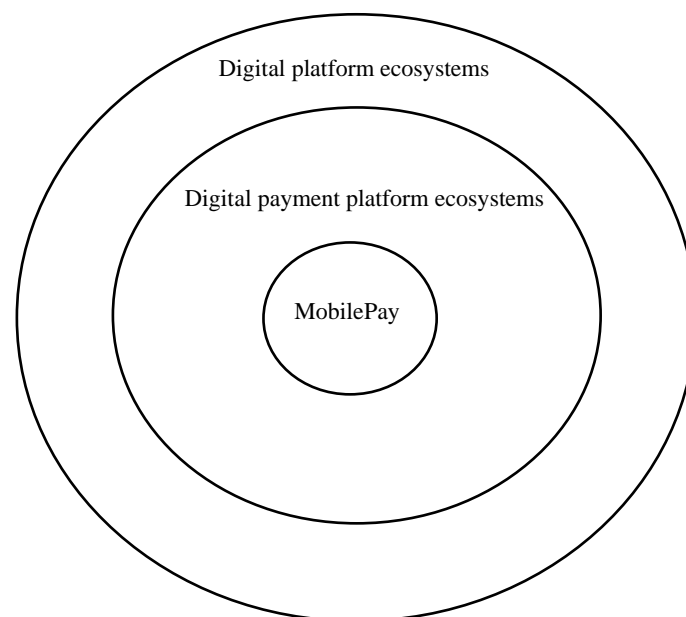
Figure 7. Layered Research Setting

4. Multi-Method Approach

Apart from using different theoretical perspectives, the separate studies also adopt different methods of inquiry. This multi-method approach further strengthens the in-depth theorizing as it aims to investigate the main phenomenon by looking at several cases and by adopting different techniques. In particular, the separate studies

adopt methods such as concept reconstruction (Paper I), longitudinal case study (Paper II, Paper V, and Paper VI), Review and Theory Development approach (Paper III) and multi-case study (Paper IV).

Concept Reconstruction

To conceptualize the main phenomenon of investigation, digital platform ecosystem evolution, Paper I adopts a concept reconstruction approach, proposed by Welch et al. (2016). This method consists of two parts. First, it requires the conduct of literature review (in this case, hermeneutic literature review, see Paper I) whose purpose is to identify and group the various attributes, which collectively construct the investigated concept. Second, the method proceeds with the empirical investigation of the identified attributes, where the goal is to inquire about the accuracy with which they portray the complex nature of digital platform ecosystem evolution (Welch et al., 2016).

Longitudinal Single Case Study

The core RQ and the SRQs are exploratory in nature as they seek to provide an explanation about the emergence and the unfolding of understudied phenomenon. Such inquiries give rise to theories of explaining, which are categorized as Type II Theory in Information Systems (Gregor, 2006). As Gregor (2006, p. 8) points out: "The theory developed, or conjectures, need to be new and interesting, or explain something that was poorly or imperfectly understood beforehand."

Case studies constitute a research approach that can be used to develop this type of theory (Gregor, 2006). In particular, case study research allows for thorough investigation of the context in which complex phenomena operate (Baxter and Jack, 2008), based on collection and detailed analysis of various data sources (Yin, 2003).

The methodology adopted for Paper II, Paper V and Paper VI is a longitudinal single case study, which provides basis for in-depth analysis in order to capture "the knowledge of practitioners and developing theories from it" (Benbasat et al., 1987, p. 370) (see, also Pettigrew, 1990). Furthermore, current research on digital platform ecosystem evolution suffers from lack of longitudinal studies based on primary data (de Reuver et al., 2017). Thus, by adopting this method, this PhD dissertation aims to address an important research gap in the platform literature.

Multi-Case Study

Paper IV adopts a multi-case study approach to investigate the different adoption and expansion strategies used by a platform owner when faced with strategic challenges. By utilizing this method, we derive different strategies from several cases, and subsequently compare and contrast them against one another (Baxter and Jack, 2008; Yin, 2003).

To this end, Paper IV investigates three cases of exemplary digital payment platform ecosystems operating in different markets. Two of the cases are similar, which help to account for similarities between the cases. Validating further the findings, Paper IV also investigates a unique case (Pettigrew, 1990), which is dissimilar to the other two selected cases. To purpose is to check whether the findings can be extended to explain different cases and to further enrich the proposed framework by incorporating new insights.

Review and Theory Development

Paper III adopts a Review and Theory Development approach (Leidner, 2018), which encompasses two separate stages of analysis. While the method requires researchers to conduct a literature review on specific topic, the purpose is to go beyond systemizing the relevant literature and outlining a research gap. Instead, the ultimate goal is to construct a novel theoretical framework, which builds upon existing research, but also adopts an additional theoretical lens (see e.g., Krogh et al., 2012). Thus, Paper III presents a literature review on the various tensions within the digital platform ecosystem and combines the insights from it with Dialectics to derive a Dialectical theory of digital platform ecosystem evolution.

5. Data Collection

This PhD dissertation relies largely on primary data collected in the organizational setting of the investigated digital payment platform ecosystem, MobilePay (Paper II, Paper V, and Paper VI). As Industrial PhD fellow, employed by Danske Bank for the duration of the PhD project (October 2015-September 2018), I entered the unit developing and managing MobilePay in October 2015 as part of the team, responsible for the proposing, conceptualizing and developing novel ideas (the Concepts team), and which determined to a large extent the future evolution of MobilePay. During the first two years of the project, I spent three days per week at MobilePay and were active member of the Concepts team. In September 2017, I embarked on a four-month research visit to the Center for Process Innovation (CEPRIN), part of Georgia State University, USA, where I collaborated with Prof. Lars Mathiassen and Prof. Arun Rai on Paper II and with Prof. Jonny Holmstrom on Paper III.

In October 2015, when I joined the company, MobilePay had operated for two and a half years and had successfully attracted significant number of both private and commercial customers (see above). As I was interested to gain insights into the initial success of MobilePay and to observe the next steps on its path toward maturity, the Concepts team constituted a suitable place to obtain first-hand knowledge. The team initially consisted of five people, each having different competences and being responsible for various projects. During the time I spent with them, some members left the team in pursuit of other employment, while other people joined. As part of an organizational restructuring in September 2017, part of the team members joined a different team, while, I, together with three other colleagues, remained part of a new team (The Venture team).

To collect data about the evolutionary journey of MobilePay, I used participant observation, semi-structured interviews and unofficial conversations with employees, supplemented with secondary data such as archival documents (presentations, memos, meeting notes, analysis, emails, posters, etc.) (Paper II, Paper IV, Paper VI) (Table 4). The preferred approach for data collection was participant observation as "a process enabling researchers to learn about the activities of the people under study in the natural setting through observing and participating in those activities" (Kawulich 2005, p. xxx). Although studies, which rely on participant observations, are rather scant in the IS field, such approach "can enhance our understanding of IS phenomena" (Moore and Yager 2011, p. 127). Participant observation is used when a researcher seeks to acquire profound knowledge about the events and actions, rooted in specific context, that shape a particular phenomenon (Iacono et al., 2009).

For the duration of my employment, the Head of the Concepts team supervised my work and helped me navigate through the organizational structure of both MobilePay and Danske Bank. In particular, I had one-to-one bi-weekly meetings with him discussing ongoing issues around MobilePay and receiving feedback on a number of tasks, in which I have been involved, together with the other members of the team, in my attempts to gain better insights into their work. I also participated in the bi-weekly team meetings, where the team members discussed current affairs, the tasks they were working on and future projects. As the MobilePay unit was relatively small (between 30-40 people), I also had frequent encounters with members of the other teams during weekly status meetings and bi-weekly, later monthly, department meetings, where the Head of MobilePay discussed key issues with all employees, semi-structured interviews, lunch breaks, breakout sessions, and more.

In my role as participant observer, I also contributed selectively to a number of projects, meetings and tasks during my stay at the company. The purpose was to obtain in-depth insights about events as they unfolded and to gain credibility from my colleagues, who would be more willing to share information if they perceived me as an active team member (Pettigrew, 1990; Van de Ven and Hubert, 1990). I engaged in variety of tasks, from initial development of innovation ideas and conducting research on latest developments in the domestic, regional and international payment sectors, to developing competitors' analysis, presentations for legal authorities, and governance policies for working with third-party developers.

As result of my engagement in the company, I managed to collect vast amount of primary data (see Table 4). Throughout the duration of the participant observation (October 2015-September 2017), I kept a research diary, where I noted down on daily basis my observations (for a sample, see Figure 8).

Observations on ideation

In MobilePay, the typical way of working with new ideas is to outline a couple of scenarios and create selection criteria, which are usually not well defined. These selection criteria are left totally to the discretion of the employee, who designs the presentation and are not unified. They vary from project to project. These criteria are lately changed or adapted by the manager, who reviews the criteria. The criteria are largely non-representative. In general, there is lack of established process of how we prioritize ideas and assess them. The assessment is generally left to the discretion, knowledge and opinion of the employee + modified by the manager. I also observed that the speed of innovation in MobilePay is not very fast – for major projects such as loyalty, Kids, marketplace, recurring. Surprisingly, it was fast with WeShare. The question is does the launch of new apps can speed up innovation – it was a new platform (technically as well, as it was supported by Azure), or was it fast as it was not that complicated to do it, or there was a dedicated team to run it (investigate more).

Swipp and NS future

There are ongoing negotiations with Swipp currently. On Wednesday /9.11/, we prepared for announcement that Jyske Bank is joining MobilePay as Nordea did. 20 min before the announcement was made public, it was put on hold, as there was an opportunity to make bigger announcement in a few days. So the announcement was held for 2-3 days. It is largely expected that Swipp as a whole will join us.

New Platform

This is the first week I started looking more into the New Platform. I had a short interview with Joachim about the history and architecture of the new platform. The major reason for the creation of the new

Figure 8. Sample of the Research Diary

As a result, I documented the main events taking place within the company (launch of new features, competitors shift, new partnerships, change in strategic goals, working processes, organizational changes, and more) in the form of narrative spanning across 61 pages. In the research diary, I also captured the discourse around various events (opinions, comments, challenges, and developments) as they unfolded. Furthermore, I took extensive notes during the team meetings, department meetings, status meetings, workshops, and breakout sessions, which I attended. Collectively, these notes amount to 145 pages.

Participant observation as an approach to data collection, however, is not without limitations and thus, researchers advise for its combination with other techniques such as interviews and archival data (see e.g., Kawulich 2005). To complement the data gathered through empirical observations, I further conducted 16 semi-structured interviews with selected MobilePay employees in order to obtain additional insights. I conducted the interviews in English, with the duration of the interviews varying from thirty minutes to an hour and twenty minutes. As the obtained information from the interviews often overlapped with already documented insights (from meeting notes and informal conversations), I decided to engage primarily in observations and informal conversations with colleagues at MobilePay as my main method for collecting data (Leonard-Barton, 1990).

To supplement my data collection, I gathered large amount of archival data (presentations, strategic documents, emails, etc.). In particular, I archived 83 emails, which contained information about important events during the evolutionary journey of MobilePay (e.g., announcement of new product launches, strategic decisions, organizational changes, etc.). I also archived 60 presentations and 55 documents such as press releases, product

guidelines, strategic analysis, and release notes. The collected archived data, together with insights from semi-structured interviews and informal conversations, were the main source of information, which helped me restore the evolutionary path of MobilePay from its launch in May 2013 until I joined the unit in October 2015.

Table 4. Overview of MobilePay Data Sources		
Type of Data	**Data Points**	**Description**
Primary	Research diary	61 pages
	Notes from meetings	145 pages
	Semi-structured interviews	16 (between 30 minutes to 1 hour and 20 minutes)
Secondary	Emails	83
	Presentations	60
	Documents	55

As Paper I and Paper III aim at reviewing relevant literature, the data collection for these papers encompasses identifying and reviewing of a number of studies (for more details, see respective studies). Paper I seeks to identify the various manners in which researchers conceptualized digital platform ecosystem evolution. As part of the adopted concept reconstruction method, I conducted a hermeneutic literature review by iterating between data collection and data analysis (see Boell and Cecez-Kecmanovic 2014). Utilizing extensive keyword strategy, I identified 98 articles across various fields (information systems, organizational studies, product management, innovation studies, etc.), which dealt with digital platform ecosystem evolution either explicitly or implicitly.

Although Paper III also utilizes extensive literature review to advance further our understanding of digital platform ecosystem evolution from dialectical perspective, the data collection process differed. The preferred approach for collecting data was snowballing, where the researcher selects a key article and uses its references to identify additional articles to include in the literature review (Atkinson and Flint, 2001). By looking at the references of a key article in the platform literature (Gawer (2014) on bridging the two streams in the platform literature – economic and engineering), we selected 29 out of the 91 references after reading the abstracts. To identify the final pool of articles, we used two criteria: 1) articles that investigate digital platform ecosystems, 2) articles, which focus on tensions and conflicts.

In order to capture relevant platform research after 2014 (after the publication of Gawer's article), we identified all the articles citing Gawer (2014) in their references by using Scopus. We initially selected 38 articles. After identifying the articles, we went through their references and identified additional relevant articles to add to the final sampling. We then went through their respective references until we could not identify any new relevant articles. In the final sampling, we ended up with 65 articles from various fields of research.

Paper IV utilizes multi-case study informed by both primary and secondary data. To present the strategic challenges MobilePay faced and the strategies it used, we relied on primary data (see above). As we were not able to collect primary data for the other cases, the research utilized a significant amount of secondary data: press releases, annual reports, online news and interviews.

6. Data Analysis

Depending on the concrete method in each study, the separate papers adopt different analytical techniques (for more details, see Papers). In general, this research constitutes an iterative process of data collection, data analysis and data comparison in order to detect the most relevant data for studying the observed phenomenon (Jones and Alony, 2011).

To analyse the gathered data for Paper I, Paper III, Paper IV, Paper V[5], we used an open or axial coding schemes suitable for the selected method. For example, in Paper I, we followed a coding scheme proposed by Welch et al. (2016), who recommend to code the selected articles based on three criteria: use of the concept (platform evolution), identifying its attributes, and capturing the main theoretical assumptions made by the researchers (for more, see Paper I) (see Table 5).

Table 5. Example of Data Analysis from Paper I			
Author	**View on Evolution**	**Attributes**	**Theoretical Assumptions**
Gawer (2015)	Shift of platform boundary	Change in the MSP scope and MSP openness	MSPs' boundary shifts in relation to competition and innovation
Inoue and Tsujimoto (2017)	PE as developing a platform-based ecosystem	Adding third-party complementors	Self-reinforcing loop between users and complementors

Paper II aimed at identifying generative mechanisms triggered by certain events and producing various outcomes. For the data analysis, we adopted the approach proposed by Henfridsson and Bygstad (2013) due to the similarity in the observed phenomena. Based on our theoretical conceptualization, we distinguished between transformative and reinforcing generative mechanisms (see Paper II). To identify the transformative generative mechanisms, we first outlined various significant outcomes in the evolutionary path of MobilePay (corresponding to changes in deep structure, see Table 6) and traced back its triggers and interplay between various socio-technical components in order to identify a mechanism (see Table 6).

---

[5] Paper VI is a research in progress and has no data analysis.

Table 6. Example of Identification of Transformative Generative Mechanisms			
Change in deep structure	**Trigger**	**Interplay between socio-technical elements**	**Mechanism**
Actors: Inclusion of commercial customers Architecture: The platform core expands with a configurable functionalities for C2B payments Governance: Only Danske Bank's commercial customers can freely access and only for in-store trade (no online)	Reaching critical mass of private customers spurs demand for C2B solution (June 2013)	Demand for C2B solution; MobilePay investigates how to technically enable C2B and which merchants to include; Incorporation of novel technologies (Near-Field Communication, Bluetooth, etc.) requires lots of development time; Competitors announce market entry; Decision to develop a business app similar to private app; Creating an admin portal for merchant access; Decision to target only small merchants; Pilot test with small merchants; Commercial Launch of MobilePay Business app	Expansion to include C2B transactions (Architecture-Dominant Mechanism) (February 2014)

After identifying a number of transformative mechanisms across the evolutionary path of MobilePay, we focused on explaining the incremental changes occurring in between two major transformations of the deep structure (e.g., in the period from the launch of the private app in May 2013 to the next transformation, the expansion to incorporate consumer-to-business payments in February 2014; see Paper II). We then identified the triggers of these changes and the reinforcing generative mechanisms, which produce them in a similar manner to Table 6.

VI Summary of the Findings

This PhD dissertation constitutes a collection of six separate papers, addressing the above posed Research Questions (see, Chapter I). In this chapter, I introduce the separate studies, conducted as part of this research. For each paper, I first pinpoint the research question guiding the specific study, present the concrete methodology and outline the main findings.

1. Paper I

Staykova, K. S. and Damsgaard, J. 2017. "Toward an Integrated View of Multi-Sided Platform Evolution". In: Proceedings of the International Conference on Information Systems (ICIS) 2017, Seoul, South Korea.

This exploratory paper seeks to review the existing platform literature in order to understand how researchers portray the evolution of digital platform ecosystems. The initial assumption is that the lack of clear conceptualization of digital platform ecosystems (see de Reuver et al., 2017) spills over to studies on evolution.

Thus, we embarke on a study to unravel the existing conceptualizations of digital platform ecosystem evolution by identifying how scholars view and portray this process.

To conduct our investigation, we adopt a concept reconstruction method (Welch et al., 2016), which consists of reviewing the usage of the digital platform ecosystem evolution as a concept in the existing literature and supplementing this analysis with empirical exploration of the evolutionary process of several digital platform ecosystems. The purpose of the hermeneutic literature review, which encompassed 98 different studies across various fields of research reflecting the different views within the platform literature, is also to deduct a number of attributes, which collectively construct the concept in question (namely, digital platform ecosystem evolution). To check the accuracy with which the identified attributes capture the evolutionary process, we further conduct an empirical investigation by reconstructing the evolutionary path of three exemplary digital platform ecosystems.

Based on the conducted literature review, we confirm our initial assumption that there is a lack of common understanding about what constitutes digital platform ecosystem evolution. Rather, various scholars conceptualize this phenomenon in various manners (we identify twelve different views), which instead of informing our knowledge about the phenomenon, fragment even further our understanding of this complex process. Further, when investigating whether the existing views capture accurately the evolution of the selected digital platform ecosystems, we found that none of the identified views (and its corresponding attributes) could explain the evolutionary process in its entirety as they rather focus on investigating separate, often disconnected topics.

To amend this, we integrate the different views and propose a new conceptualization of digital platform ecosystem evolution as co-evolution of platform constituencies, infrastructure, functionalities and governance regime, which we synthetize from the existing literature (Figure 9)[6]. Thus, we argue that all digital platform ecosystems consist of certain attributes (constructive elements), which co-evolve during the evolution of the ecosystem. We further propose, based on the hermeneutic literature review, that various drivers propel the co-evolution of constituencies, infrastructure, functionalities and governance regime towards certain evolutionary outcomes (Figure 9). Drivers and evolutionary outcomes, however, remain under researched topics within the literature on digital platform ecosystem evolution (for more details, see Paper II).

In subsequent studies, I largely build on this initial conceptualization of digital platform ecosystem evolution. As my research advanced, I have further clarified the nature of the digital platform ecosystem (see Chapter II) and have improved the conceptualization of the evolutionary process (see Paper II; also Chapter VII).

---

[6] An improved version of this conceptualization is presented in Paper II (also in chapter III; Figure 2).
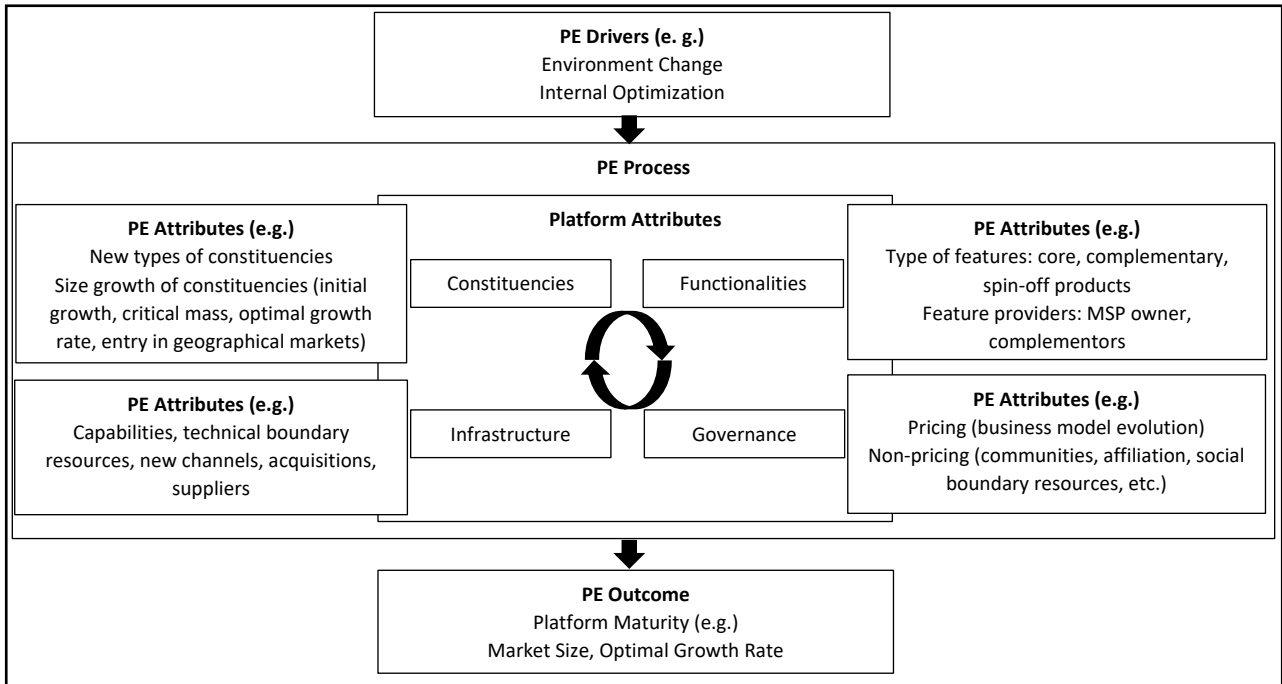
Figure 9. Conceptualization of Digital Platform Ecosystem Evolution

2. Paper II

Staykova, K., S., Mathiassen, L., Rai, A., and Damsgaard, J. (2018). "Generative Mechanisms for Digital Platform Ecosystems Ecosystem: A Punctuated Equilibrium Theory". Paper re-submitted (revise and resubmit) to Research Policy's special issue on Digitization of Innovation and Entrepreneurship.

The purpose of this paper is to advance the existing literature on digital platform ecosystem evolution by addressing an important, yet under researched question, namely how generative mechanisms lead to certain evolutionary outcomes when triggered in response to various internal and external challenges. To this end, the paper combines the notion of generative mechanisms with Punctuated Equilibrium Theory to theorize how and why digital platform ecosystems evolve over time.

Based on extensive literature review, we first group existing studies on evolution in three different perspectives (growth, co-evolution and competition)[7] and outline research gap. Despite the merits of current research, scholars have overlooked two important aspects: the triggers, in response to which a digital platform ecosystem evolves, and the generative mechanisms, which shape the evolutionary process. Thus, this paper investigates the following research question: *How do triggering events and generative mechanisms drive the evolution of digital platform ecosystems?*

---

[7] The categorization of the different perspectives follows loosely the categorization of the literature in Chapter III.

To this end, we combine the notion of generative mechanisms with Punctuated Equilibrium theory to offer a conceptualization of the digital platform ecosystem evolution, which later we use to guide the empirical analysis of the selected case study (see Table 7). Building upon Punctuated Equilibrium Theory, we present the existing configuration of actors, architecture and governance as the deep structure of a digital platform ecosystem, which maintains its composition during periods of stability. Various external and internal events, which appear during the evolution of a digital platform ecosystem, challenge the established configuration, thus prompting it to alter. Not all occurring events, however, constitute change triggers. For an event to qualify as a change trigger, it needs to create a misfit within the digital platform ecosystem or between the ecosystem and its environment, which undermines the overall performance of the ecosystem (see Table 7).

The change triggers can set in motion one or more generative mechanisms, which are rooted in the latent properties of the deep structure and thus relate to one or more of the ecosystem's actors, architecture and governance. When triggered, the generative mechanisms, through the interplay of the activated components (e.g., actors and architecture or architecture and governance) lead to a change outcome, which affects the existing composition of the deep structure. We further distinguish between two types of generative mechanisms, depending on their impact on the digital platform ecosystem. While transformative generative mechanisms lead to radical change in the deep structure of a digital platform ecosystem, reinforcing generative mechanisms introduce incremental adjustments to the existing composition. Subsequently, we conceptualize the evolution of digital platform ecosystems as the ongoing changes (transformative or reinforcing) in relation to its actors, architecture and governance (see Table 7).

Table 7. Conceptualization of Digital Platform Ecosystem Evolution	
Platform Evolution	The ongoing changes in a digital platform ecosystem in relation to its actors, architecture and governance
Deep Structure	A sustained configuration of actors, architecture and governance during a stable period of ecosystem evolution
Change Trigger	An external event that challenges the current configuration of the ecosystem or an internal event that creates a misfit between the configuration of the ecosystem and the environment, thereby challenging the performance of the ecosystem
Generative Mechanism	Latent deep structure properties (related to one or more of a platform ecosystem's actors, architecture and governance) that can be activated to change the ecosystem.
Transforming Mechanism	Mechanism that leads to radical change in the deep structure of a digital platform ecosystem
Reinforcing Mechanism	Mechanism that leads to incremental adjustment of a digital platform ecosystem without affecting its deep structure
Change Outcome	A change in the properties of a digital platform ecosystem (related to one or more of its actors, architecture and governance) in response to a change trigger

Next, we applied the above conceptualization to investigate empirically the evolution of a prominent digital payment platform ecosystem, MobilePay (four years in total). Relying on a longitudinal single case study (see Paper II and Chapter V), we validate the suitability of the proposed theoretical framework and derive a number of insights.

To develop further a Punctuated Equilibrium Theory about digital platform ecosystem evolution, we combine the theoretical framework (Table 7), the insights from our empirical analysis and extant theory. As a result, we argue that digital platform ecosystems evolve through a network of *distributed* and *concurrent* generative mechanisms, which transform and reinforce the deep structure of the ecosystem in response to internal and external events and other mechanisms.

We attribute the triggering of digital platform ecosystem evolution to both internal and external events (consistently with existing platform literature, see Chapter III). While we identify additional triggers to complement the existing ones, we also discover that both internal and external events trigger transformative mechanisms, while mainly internal events set reinforcing mechanisms in motion. We also establish that already activated generative mechanisms can serve as a trigger to subsequent transformative and reinforcing generative mechanisms. Transforming mechanisms can trigger one or more subsequent reinforcing mechanisms, while reinforcing mechanisms can also trigger other reinforcing mechanisms. We also found that reinforcing mechanisms can indirectly trigger transforming mechanisms (for examples, see Paper II, Discussion).

We further illustrate the context dependency of the generative mechanisms by emphasizing on their anchoring in the latent properties of the existing deep structure, which itself is a result of previously activated generative mechanisms, and on their triggering events. When a change trigger appears, it activates certain latent properties of the existing deep structure configuration, which also manifest into a generative mechanism. For example, as MobilePay opened for third-party complementors (transforming mechanism) through the release of boundary resources, the platform became more malleable as a latent property of the ecosystem architecture (Henfridsson and Bygstad, 2013). This malleability subsequently resulted in adoption of the platform by other third-party complementors (reinforcing mechanism).

We also propose a typology of generative mechanisms based on two aspects: their dominance and their impact (see Table 8). The dominance of a generative mechanism signals for their different change focus in terms of actors, architecture and governance. Regardless of their dominance, the change outcomes brought by generative mechanisms can have transforming or reinforcing impact on the existing deep structure of the ecosystem. Based on our empirical analysis, we identify a number of generative mechanisms, which we present in an abstracted form in Table 8.

Table 8. The Dominance and Impact of Generative Mechanisms			
		Impact	
		Transforming	**Reinforcing**
Dominance	**Actor**	• Changing actor types • Shifting owners	• Changing actor populations* • Changing the role of platform owner
	Architecture	• Extending platform core • Including boundary resources • Developing platform periphery • Renewing platform core	• Leveraging existing IT solutions* • Introducing incremental innovation in platform core* • Optimizing functionalities in platform core* • Improving platform connectivity for actors*
	Governance	• Developing governance regime	• Customizing rules for actor types • Improving affiliation process • Tightening and relaxing participation rules* • Adjusting value appropriation rules

Finally, we ponder upon the temporality of generative mechanisms as they appear (and disappear) throughout the evolution of a digital platform ecosystem. In particular, we found that multiple transforming and reinforcing mechanisms operate simultaneously and interact to drive the evolution of the ecosystem. While transformative mechanisms stop operating at some point in time, we found evidence that a number of reinforcing mechanisms (market with * in Table 8) continue to operate throughout the digital platform ecosystem evolution.

Interestingly, and in contradiction to Punctuated Equilibrium Theory, which prescribes clear-cut periods of stability and instability, we observe that the transforming mechanisms could span across considerable periods, thus overlapping with other generative mechanisms. We attribute this difference to the socio-technical nature of generative mechanisms, with various actors and artifacts involved in their activation and operation, to the complexity of change brought by transforming mechanisms, and to the fact that independently of transformative mechanisms, reinforcing mechanisms continue to operate, as digital platform ecosystems evolve not only discontinuously but also cumulatively along multiple dimensions.

3. Paper III

Staykova, K. S., Mathiasen, L., and Holmstrom, J. (2018). "The Dialectics of the Digital Platform Ecosystem Evolution". Paper under development.

In this paper, we investigate digital platform ecosystems evolution by adopting Dialectics as theoretical lens (Figure 10). As multiple tensions occurring, for example, between platform owner and other actors or between

ecosystem growth and the need to maintain its efficiency characterize digital platform ecosystems (see Hagiu, 2014; Eaton et al., 2015; Wareham et al., 2014), we investigate how their appearance and resolution drive the ecosystem evolution. Subsequently, the main research question of this paper is: *How do tensions within the digital platform ecosystem drive its evolution?*
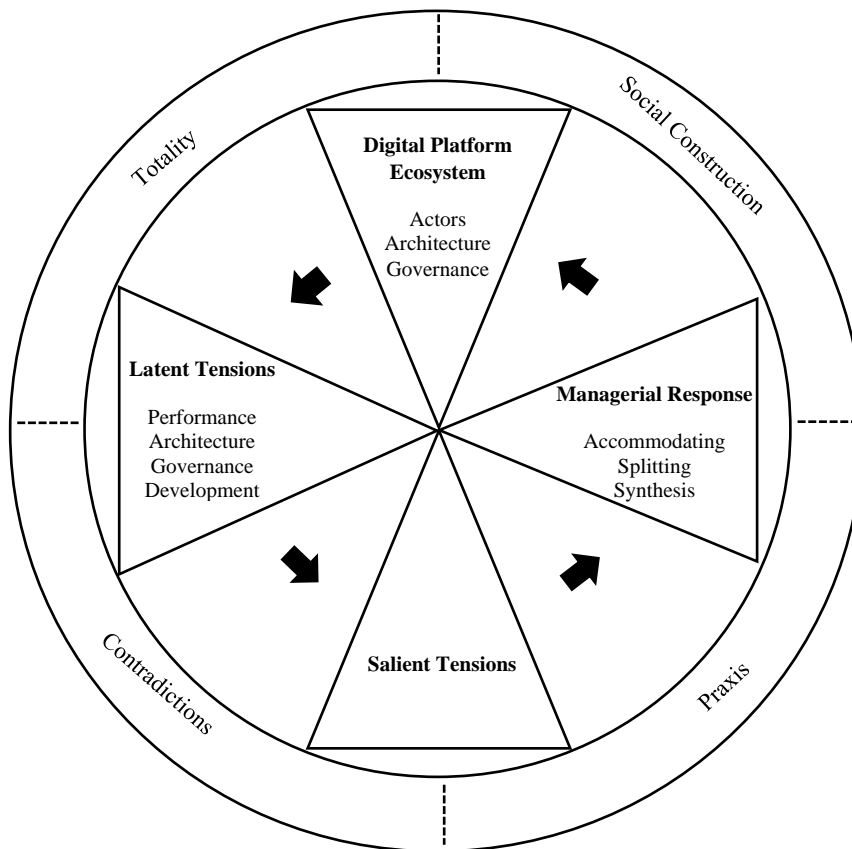
Figure 10. Dialectical Model of Digital Platform Ecosystem Evolution

To this end, we build upon Dialectics theory (Figure 10, outer circle) and combine its key constructs with insights we obtain from reviewing the relevant platform literature (Figure 10, inner circle). As a result, we propose a Dialectical theory of digital platform ecosystem evolution (Figure 10). In particular, we present the digital platform ecosystem as interconnected totality consisting of certain configuration of actors, architecture and governance[8]. We further argue that various inherent contradictions, characterize a particular configuration of ecosystems actors, architecture and governance as part of its latent properties (see Paper III). After reviewing the existing platform literature, we summarize these inherent contradictions in four categories, namely performance, architecture, governance, and development, with each contradiction consisting of identity and two opposites (see Table 9).

---

[8] Consistent with the conceptualization of digital platform ecosystems as deep structure in the Punctuated Equilibrium theory of digital platform ecosystem evolution (Paper II).

Table 9. Inherent Contradictions in Digital Platform Ecosystem Evolution		
Contradiction	**Identity**	**Opposites**
Performance	A digital platform ecosystem must direct resources to ensure appropriate contributions to its participants	Opposite: *Efficiency* forces seek to improve performance through fine tuning of the existing ecosystem configuration Opposite: *Growth* forces seek to improve performance through strengthening network effects from new ecosystem participants
Architecture	A digital platform ecosystem must design and maintain the platform to serve current and future needs of its participants	Opposite: *Reliability* forces seek to improve the capability of the platform architecture to serve the current needs of ecosystem participants Opposite: *Evolvability* forces seek to improve the capability of the platform architecture to serve the future needs of existing and new ecosystem participants
Governance	A digital platform ecosystem must enable the access and support the practices of its participants	Opposite: *Control* forces seek to introduce mechanisms that drive alignment of platform ecosystem participants and their practices Opposite: *Openness* forces seek to introduce mechanisms that drive platform ecosystem renewal through new participants and emerging practices
Development	A digital platform ecosystem must respond to internal and external events that challenge its status quo	Opposite: *Consolidation* forces seek to respond by reinforcing the current trajectory of the digital platform ecosystem Opposite: *Adaptation* forces seek to respond by transforming the current trajectory of the digital platform ecosystem

When triggered by various factors of plurality, change and scarcity (see, Smith and Lewis, 2011), these inherent contradictions transform into salient as various ecosystem actors become largely aware of them. As a result of their activation, the platform owner, as a key ecosystem actor with asymmetrical power (Boudreau and Hagiu, 2009), aims at addressing the tensions often by engaging with other ecosystem actors, who may also react to drive or resolve the tension (praxis) (see e.g., Eaton et al., 2015).

Depending on the nature of the tensions, a platform owner can choose from three different types of responses, namely accommodating, splitting, or synthesis (Van de Ven and Poole, 1995). While accommodating implies that the platform owner tries to manage simultaneously the two opposites of a contradiction, the splitting occurs when the owner separates the two opposites in time and space (Van de Ven and Poole, 1995). When the two opposites cannot co-exist, the platform owner transforms the contradiction through synthesis. Our empirical investigation of the relevant platform literature demonstrates that the platform owner can adopt a combination of these three response strategies when addressing various salient tensions (for more details, see Paper III). Subsequently, the resolution of salient tensions can lead to reconstruction of the existing ecosystem configuration (see Figure 10).

4. Paper IV

Staykova, K. S. and Damsgaard, J. 2016. "Adoption of Mobile Payment Platforms: Managing Reach and Range", Journal of Theoretical and Applied Electronic Commerce Research, 11(3), pp. 65-84.

This paper aims at investigating specific strategies adopted by the platform owner as part of the evolution of a digital platform ecosystem. In combination with Paper V and Paper VI, it provides additional insights into how a platform owner can manage the evolution of a digital platform ecosystem. In particular, this paper asks the following research question: *What strategies do platform owners adopt to drive the adoption and expansion of digital platform ecosystems?*

After reviewing the platform literature, we found that different strategic challenges appear at different stages of the evolutionary process. While initially platform owners are preoccupied with the task of achieving critical mass of participants, new challenges arise as the platform ecosystem evolves, such as ensuring continuous growth and use, establishing viable business model, creating and maintaining generativity, and more. To cope with these challenges, which in this research relate mainly to ecosystem actors, we propose that platform owners should manage carefully the reach and range of their platform ecosystems. To this end, we construct the Reach and Range framework, which can serve as a strategic tool for platform owners to address a number of strategic challenges they face throughout the evolution of their platform ecosystems.
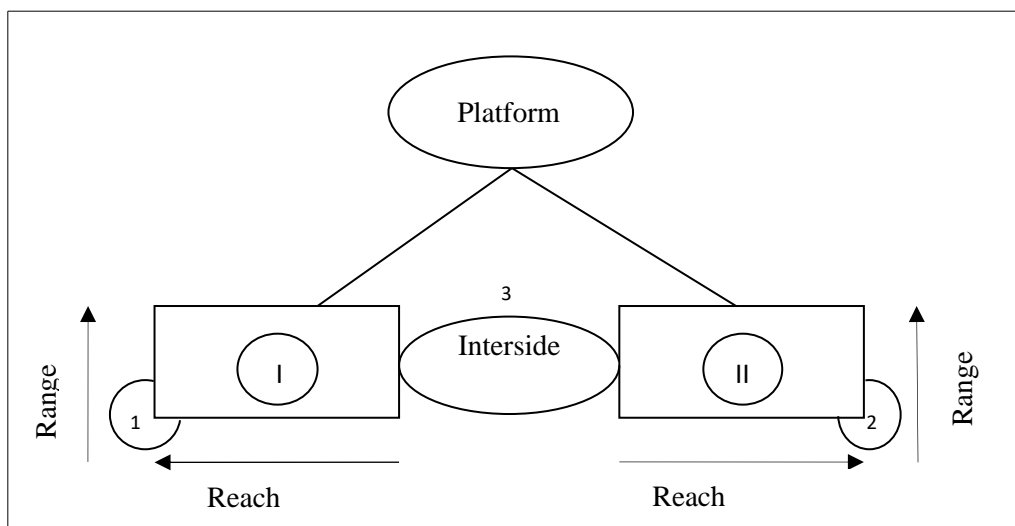
Figure 11. Overview of Reach and Range for Two-Sided Platforms

In particular, we argue that each of the distinct groups of actors is characterized by reach, which refers to number of participants, and range, which refers to the functionalities associated with particular group of actors (Figure 11). As additional distinct groups of actors (e.g., developers) join the ecosystem, the platform owner also needs to manage the interside reach and range occurring between the distinct groups of actors under the influence of cross-side network effects. Thus, managing ecosystem actors requires the careful balance between the reach and range of each distinct group and the interside reach and range between distinct groups of actors.

To identify specific strategies used by platform owners when addressing emerging challenges, we apply the Reach and Range framework to three selected digital payment platform ecosystems. Based on our empirical investigation, we prescribe a number of strategic recommendations that can assist platform owners in their quest to spur adoption and subsequent evolution (see Table 10). In particular, we demonstrate how platform owners can leverage the Reach and Range framework to design specific strategies addressing various challenges as they occur during the evolutionary path of their digital platform ecosystems.

Table 10. Reach and Range Framework for Strategic Challenges					
Platform Type	Strategic Challenge	Reach and Range Framework	Examples		
			MobilePay	*Pingit*	*Swish*
One-Sided	Achieve critical mass of users	Build *Reach*	All banks' customers	All above 16-years old	All participating banks' customers
		Limit *Range*	P2P	P2P	P2P
Two-Sided	Adoption on the second group of participants	Build *Reach*	SMEs Large merchants Webshops	Sole traders Large merchants	SMEs Charities Webshops
		Diversify *Range*	NFC Bluetooth Business Online	*Buy It* button *Pay now with Pingit* button	Swish number for merchants Swish API
	User Stickiness (lock-in effects on the user base)	Strengthen User *Range*	Increased daily payment limit	Twitter Payments	New app design
		Grow User *Reach*	Windows Phone app	Windows Phone app	Windows Phone app
		Enable Interside *Range*	C2B transactions	C2B transactions B2C transactions	C2B transactions
	Recurrence (high volume of cross-side transactions between the	Manage Interside *Range*	Bonus	*Buy It* button	*Pay with Swish* button
		Scale *Reach* on second group of participants	Third-party apps	Insurance companies	Third-party apps

	affiliated sides)				

5. Paper V

Staykova, K. S. and Damsgaard, J. (2018). "Dual-track's strategy for incumbent's transformation: The case of Danske Bank adopting a platform business model", Book Chapter, Accepted for publication in "Digitization Cases".

This case-based research investigates the digital transformation process, which a traditional financial institution undergoes. In particular, Paper V presents a case study of MobilePay as exemplary digital payment platform ecosystem developed and owned by an incumbent financial institution, Danske Bank.

Grounded empirically, this case study provides a detailed account of the MobilePay's evolution, from its launch in May 2013 to its market dominance in September 2017[9]. In particular, it divides the evolutionary trajectory into a number of strategic episodes, each characterized by a challenge (situation faced), the actions taken to address it, the achieved results and the learning points, which platform owners and managers can refer to when managing the evolution of a digital payment platform ecosystem.

The case provides rare glimpse inside the organizational structure of a successful digital payment platform ecosystem. It also outlines the tension occurring between, on one hand, establishing synergies between the incumbent organization and the newly formed platform ecosystem, and, on the other hand, the need to obtain a degree of autonomy. It further offers recommendations how to manage this tension in order for a digital payment platform ecosystem to evolve at optimal speed by leveraging the competencies of the incumbent, while also overcoming inefficient dependencies.

6. Paper VI (solo-authored)

Staykova, K.S. (2018) "Managing Platform Ecosystem Evolution through the Emergence of Micro-strategies and Microstructures". Short Paper accepted to the Thirty Ninth International Conference on Information Systems (ICIS) 2018, San Francisco, USA.

This short paper investigates digital platform ecosystem evolution from strategic perspective. In particular, the purpose of this study is to investigate evolution as purposeful process, resulting from the goal-seeking behaviour of a platform owner, rather than unsupervised process. In addition, I present the evolution of a digital platform ecosystem not as a stable and predictable pattern of events, but rather as meandering through a number of obstacles and new opportunities. Thus, while a platform owner needs to manage the evolutionary process; deliberate, long-term strategies may not be suitable for surviving the uncertain environment in which

---

[9] I present a concise summary of the case in Chapter V, Research Setting.

ecosystems operate. The main research question of this study is: *How do platform owners manage the process of digital platform ecosystem evolution?*

In addition, existing studies present platform owners as collective and faceless actor, without mentioning the organizational structure, which supports their work (e.g., units, division of labor, control systems, etc.). Thus, this research also aims at providing insights into the organizational structure of a digital platform ecosystem by acknowledging the diversity of practitioners and activities in which they engage in order to stir the evolution of the platform ecosystem.

To this end, building upon the strategy-structure interplay in the organization studies (Chandler, 1962), I seek to investigate the strategies and the organizational structures, on which platform owner relies in order to manage the evolutionary path. I further propose the adoption of a micro perspective, which is more suitable for investigating strategizing in dynamic and uncertain environment than traditional macro level perspective (Tsoukas and Chia, 2002). Following a micro perspective, I shift my focus towards studying micro-strategies and microstructures by adopting Strategy-as-Practice lens, on one hand, and micro approach to organizational design, on the other hand.

By combining these two theoretical lenses, I propose a preliminary model for managing the digital platform ecosystem evolution (Figure 12) to guide the empirical analysis. In particular, the model presents the evolution as a series of combinations of micro-strategies and corresponding to them microstructures, which platform owners adopts in connection to emerging threats and opportunities.
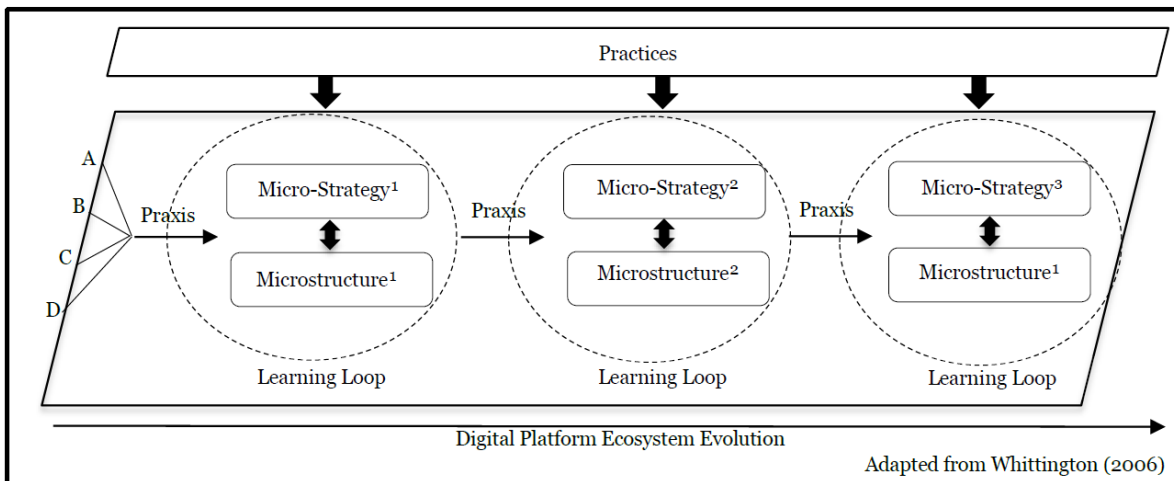
Figure 12. Model for Managing Digital Platform Ecosystem Evolution

Rather than being deliberate and long-term, platform strategy instead comprises of a number of micro-strategies emerging from the micro-activities (praxis) of strategic practitioners (indicated as A, B, C, D), governed by established practices (see Figure 12). Simultaneously, the execution of micro-strategies is supported by the emergence of relevant microstructures, rooted in the praxis of the practitioners.

Utilizing learning loops, practitioners can evaluate whether specific micro-strategies and their corresponding microstructures are suitable for tackling given challenges. Subsequently, practitioners can decide to keep, modify or altogether reject existing micro-strategies and microstructures or to introduce new ones. Thus, the micro-strategies and their corresponding microstructures form a pattern over time, which indicates how digital platform ecosystem evolve from strategic perspective.

As next step, I intend to apply the model to analyze first-hand data, collected during a four-year longitudinal study of a prominent digital payment platform ecosystem. As I spent significant amount observing the work and practices of the employees, I rely on my insights to identify specific micro-strategies and microstructures and to study how they form a specific pattern over time. At this stage, this paper remains research in progress and does not provide in-depth preliminary findings. The initial analysis, however, support the suitability of the proposed model (Figure 12).

7. Overview of the Papers in Relation to Research Question(s)

The separate papers outlined above delve into distinct topics, and investigate the evolution of a digital platform ecosystem from different perspectives and by applying different methods (see Table 11). The findings from the conducted studies collectively inform and advance our understanding of the evolutionary process of this complex socio-technical phenomenon (for more, see Chapter VII).

Table 11. Overview of Papers					
Paper Title	**Main focus**	**Perspective**	**Method**	**Findings**	**Authors**
Toward an Integrated View of Multi-Sided Platform Evolution Paper I	Existing conceptualizations of digital platform ecosystem evolution	Conceptual	Concept Reconstruction	Multiple views on evolution Integrated model of digital platform ecosystem evolution	Staykova, K.S. Damsgaard, J.
Generative Mechanisms for Digital Platform Ecosystems Evolution: A Punctuated Equilibrium Model Paper II	Generative mechanism for digital platform ecosystems evolution	Punctuated Equilibrium	Longitudinal Case Study	A Punctured Equilibrium model for digital platform ecosystem evolution Transforming and reinforcing generative mechanisms	Staykova, K.S. Mathiassen, L. Rai, A. Damsgaard, J.
The Dialectics of the Digital Platform	Tensions driving the digital	Dialectics	Theory and Review	A dialectical model for digital platform	Staykova, K.S. Holmstrom, J. Mathiassen, L

Ecosystem Evolution

Paper III | platform ecosystems evolution | | | ecosystems evolution | |
| Adoption of Mobile Payment Platforms: Managing Reach and Range

Paper IV | Strategies for adoption and expansion | Teleology | Multiple Case Studies | Reach and Range framework for addressing various strategic challenges | Staykova, K.S. Damsgaard, J |
| Dual-track's strategy for incumbent's transformation : The case of Danske Bank adopting a platform business model

Paper V | Incumbent launching and evolving a digital payment platform ecosystem | Teleology | Longitutidanl Case Study | Practical Recommendations for managing digital platform ecosystem evolution | Staykova, K.S. Damsgaard, J |
| Managing Platform Ecosystem Evolution through the Emergence of Micro-strategies and Microstructures

Paper VI | Managing digital platform ecosystems evolution | Teleology | Longtitudinal Case Study | A model for managing digital platform ecosystem evolution | Staykova, K.S. (solo-authored) |

The six distinct studies refer to the specific sub-research questions (for more, see Chapter I) and collectively provide insights to the overall research question (Figure 13). While Paper I aims at understanding existing conceptualizations within the platform literature, Paper II and Paper III look at identifying generative mechanisms which drive the evolution of digital platform ecosystems. Paper II, for example, seeks to empirically identify various generative mechanisms and outline how they drive a Punctuated Equilibrium model for digital platform ecosystem evolution, while Paper III looks into tensions as generative mechanisms and outlines how they drive the evolutionary process. Addressing RQ2, Paper IV, Paper V and Paper VI investigate the evolution of a digital platform ecosystem from teleological perspective by analysing how platform owner can manage the evolutionary process.
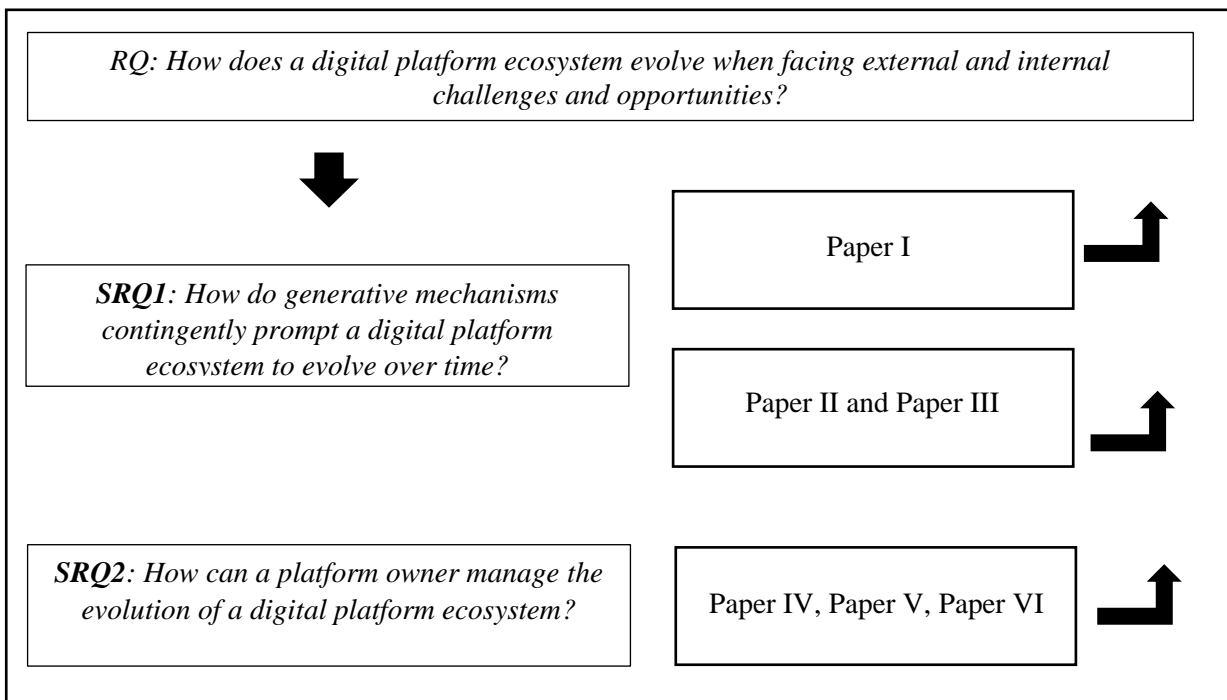
Figure 13. Research Papers in Relation to Research Questions

VII Towards Multi-Motor Explanation of Digital Platform Ecosystem Evolution

In this chapter, I revisit the main phenomenon investigated in this PhD dissertation and reflect upon its characteristics based on the findings from the conducted studies. In particular, I combine the different process theories (Punctuated Equilibrium (Paper II), Dialectical (Paper III) and Teleological (Paper IV, Paper V and Paper VI) deducted from the separate studies and put forward a multi-motor explanation of digital platform ecosystem evolution (Figure 16).

The conducted review of the platform literature (see Chapter III) revealed that, while there is a burgeoning research on digital platform ecosystem evolution, our understanding about how and why this complex process occurs remains limited (main RQ) as existing studies provide multiple, uncoordinated conceptualizations of this phenomenon and fragmented, dispersed insights, without integrating them. In particular, there is lack of knowledge about the generative mechanisms, which produce certain evolutionary outcomes (SRQ1) or about the different strategies, platform owners can adhere to when managing the complex and uncertain evolutionary process (SRQ2). To address these important yet overlooked topics, this PhD dissertation relies on six separate studies, the findings from which collectively provide multi-faceted understanding of digital platform ecosystem evolution.

1. Conceptualization of Digital Platform Ecosystem Evolution

As a starting point of this research, I concentrated my initial efforts on clarifying the main phenomenon of this study, namely digital platform ecosystem evolution. This requires defining the two key concepts at the center

of this investigation – digital platform ecosystems and evolution of digital platform ecosystems, which current research does not conceptualize consistently.

Throughout the separate studies, we define digital platform ecosystems as complex socio-technical systems enabling the interactions between various distinct types of actors through an underlying IT architecture and a set of governance rules. We view this as encompassing definition, which recognizes the multi-faceted nature of digital platform ecosystems. We explain the presence of multiple definitions of this phenomenon in the existing literature (see Chapter II) with the heterogeneity of digital platform ecosystems, which operate in various contexts (de Reuver et al., 2017), and with the different perspectives (that is economic and engineering; see Gawer, 2014; also Appendix) applied for studying them. Thus, by proposing this inclusive conceptualization, we address calls to integrate the different perspectives across the platform literature (see Gawer, 2014; Thomas et al., 2014).

Subsequently, the multiplicity of views concerning digital platform ecosystems spills over to the existing conceptualizations of their evolutionary process (see Paper I). To address this lack of common definition, we propose a novel conceptualization of digital platform ecosystem evolution. In particular, we define evolution as the changes occurring in the constructive elements of a digital platform ecosystem, namely actors, architecture and governance as they co-evolve to address various external and internal triggers (see Paper I and Paper II). This definition reflects the multi-faceted nature of digital platform ecosystems, while acknowledging the complexity of their evolutionary process.

2. Generative Mechanisms for Digital Platform Ecosystem Evolution

To answer SRQ1, we conduct five separate studies to identify various generative mechanisms, which shape the digital platform ecosystem evolution. Subsequently, we build three different theories, which explain the evolutionary process from different theoretical perspectives and based on different methodological approaches. As each of these theories relies on specific type of generative mechanisms, or 'motors' (see Van de Ven and Poole, 1995), we identify a number of generative mechanisms, which collectively explain why and how digital platform ecosystems evolve over time. In this section, I outline the identified generative mechanisms and discuss their characteristics and modus operandi.

In our conceptualization, generative mechanisms operate in a specific context, and when activated by triggers, they produce certain change outcomes (see Chapter IV for conceptualization). Thus, they contingently drive the evolution of a digital platform ecosystem. In addition, generative mechanisms are rooted in the digital platform ecosystem, presented as a specific configuration of actors, architecture and governance, whose latent properties (e.g. malleability, congestion of actors, incurred technology debt, etc.) determine the dominance and nature of the generative mechanism when activated (see Chapter IV). Subsequently, the activation of a generative mechanism leads to changes in the existing configuration of the digital platform ecosystem. To

derive the theories of digital platform ecosystem evolution (Punctuated Equilibrium, Dialectical and Teleological), I, together with my co-authors, build upon this initial conceptualization of generative mechanisms (see also Figure 3).

Punctuated Equilibrium Theory of Digital Platform Ecosystem Evolution

By proposing a Punctuated Equilibrium theory of digital platform ecosystem evolution (Paper II), we argue that digital platform ecosystems evolve through a network of *distributed* and *concurrent* generative mechanisms, which transform and reinforce the deep structure of the ecosystem (that is, its existing configuration of actors, architecture and governance) in response to internal and external triggers and other mechanisms (Paper II). As such, multiple generative mechanisms operate simultaneously and interact across the ecosystem's actors, architecture and governance to drive its evolution.

We further propose a typology of generative mechanisms, which categorizes them based on their dominance and their impact. In particular, the transforming generative mechanisms (such as change in actor types, developing platform periphery, see Table 8) account for radical changes in the existing configuration of actors, architecture and governance, while reinforcing generative mechanisms sustain the existing configuration by introducing incremental changes. Apart from their impact, we further distinguish between their dominance, indicating which element of the digital platform ecosystem (actors, architecture or governance) they mainly affect. For example, change in actor types is an actor-dominant mechanism with transforming impact, while introducing incremental innovation in platform core is an architecture-dominant mechanism with reinforcing impact on the existing deep structure of the ecosystem (see Table 8). For full overview of the empirically identified generative mechanisms, see Chapter VI, Table 8.

Dialectical Theory of Digital Platform Ecosystem Evolution

The existing configuration of actors, architecture and governance, which is a result of initial choice or of the impact of previously activated generative mechanisms (see Chapter VI or Paper II), contains certain latent properties. These latent properties can enable further the evolution of the digital platform ecosystem (e.g., malleability, increased platform attractiveness due to growing user base) or they can constrain its ability to evolve (e.g. accumulated technology debt and unresolved governance issues) (for more details, see Paper II). While the former are opportunities to grasp, the latter are problems, which the platform owner needs to address in due time.

Looking closely into the latent properties of the existing deep structure, which can constrain its further evolution, we present some of them as inherent contradictions, which remain latent until they are triggered (Paper III). These inherent contradictions came into being as result of the regulated interactions between actors on one hand, and actors and architecture, on the other hand, within a certain configuration of the deep structure. As they can escalate over time into intensified conflicts, which can jeoperdize the sustainability of the

ecosystem if not addressed properly, we view them as part of the constraining latent properties of the existing ecosystem configuration.

In Paper III, based on extensive literature review, we identify four types of inherent contradictions, namely performance, architecture, governance and development, each characterized by two opposites, which compete with each other (see Table 9). While these contradictions are present as properties of the existing configuration of the digital platform ecosystem, they are latent until activated by triggers, operating in specific context. These triggers stem from the presence of various competing goals (plurality), change in the environment or within the ecosystem (change) or limited number of resources (scarcity) (for more, see Smith and Lewis, 2011). The activated inherent contradictions manifest into salient tensions within the digital platform ecosystem and draw the attention of the platform owner and other ecosystem actors. Depending on their intensity, the platform owner adopts various strategies to manage them. The resolution of the salient tension then has an impact (reinforcing or transforming) on the existing configuration of actors, architecture and governance of the ecosystem.

We argue that the emerging tensions and the way they unfold over time until they are resolved (or contained) through the action of various ecosystem actors (praxis) and the adoption of managerial responses constitute the generative mechanisms, which drive the evolution from dialectical perspective. This view is similar to Van de Ven and Poole (1995), who state that conflicts can serve as generative mechanisms driving change.

Further, this conceptualization of generative mechanisms is consistent with the one applied in the Punctuated Equilibrium theory of digital platform ecosystem evolution (see Paper II). In the Dialectical theory, we argue that specific generative mechanisms are rooted in the latent properties of the digital platform ecosystem and influenced by certain triggers, which activate them (similarly to the conceptualization in Paper II). The generative mechanisms in the Dialectical theory also have dominance as they relate to the constructive elements of the digital platform ecosystem (namely actors[10], architecture and governance) and an impact on the existing deep structure of the ecosystem depending on the adopted managerial responses.

In contrast to the Punctuated Equilibrium Theory of digital platform ecosystem evolution, the Dialectical theory underlines the role of the managerial responses in the operation of generative mechanisms. In particular, we view the role of the platform owner as mediating the tensions and their impact on the digital platform ecosystem evolution. Thus, depending on the adopted managerial response, the resolution of the salient tensions can reinforce or transform the existing configuration of actors, architecture and governance.

Teleological Theory of Digital Platform Ecosystem Evolution

---

[10] Performance relates to actors; for details see Paper III.

As the Dialectical Theory of digital platform ecosystem evolution reveals the importance of the platform owner(s) for the operation of generative mechanisms, I turn to investigate the evolutionary process from strategic perspective. The resulting Teleological theory of digital platform ecosystem evolution (Figure 14), based on Paper IV, Paper V and Paper VI, follows the initial conceptualization of generative mechanisms and further aims at understanding the role of platform owner for managing the evolutionary process. In particular, I focus on explaining how the goals set by platform owners and their execution drive the evolution of a digital platform ecosystem (see also Van de Ven and Poole, 1995).

Recognizing that digital platform ecosystems operate in volatile and uncertain environment (Dattee et al., 2017), which makes it difficult to predict their evolutionary path (Ojala and Lyytinen, 2018), I argue that instead of relying on long-term goals and deliberate strategies to achieve them, platform owners rather focus on short-term goals and micro-strategies addressing pressing issues as they appear (Paper VI). By adopting a micro approach, this Teleological theory, when completed and supplemented with additional empirical evidence, also aims at moving away from presenting the platform owner as a collective and faceless actor. Instead, it sheds light into the actions of various strategic practitioners, collectively referred to as platform owner in the literature, who design micro-strategies and participate in the microstructures supporting them.

When various strategic issues capture the attention of platform owners, triggered by internal and external events (see Paper IV and Paper V), owners respond by formulating specific short-term goals (Van de Ven and Poole, 1995), which require the design of micro-strategies and corresponding microstructures to support their execution (Figure 14). Thus, the cycle of setting a goal and pursuing its execution, triggered by specific external or internal events, constitutes the generative mechanism from teleological perspective (Van de Ven and Poole, 1995). The execution of the formulated goals leads to various outcomes, which impact the existing configuration of the digital platform ecosystem.
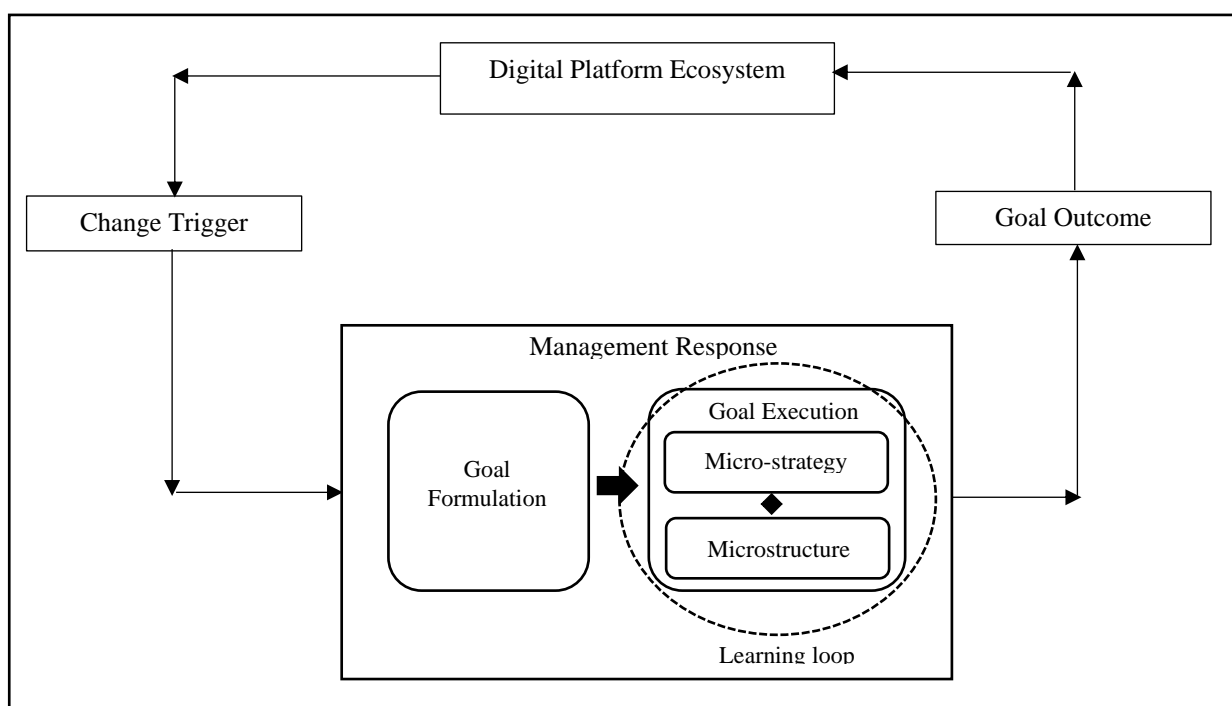
Figure 14. Teleological Theory of Digital Platform Ecosystem Evolution

When next challenge arises, the platform owner can respond by either adopting the same dyad of micro-strategy and microstructure, or a new one. Due to existing learning loops, the platform owner can evaluate whether a specific dyad is suitable for achieving a given goal and to decide whether to retain the dyad when addressing subsequent strategic challenges (Paper VI). For example, the inclusion of new distinct type of actors (e.g., merchants) in the ecosystem, as a result of previous transformative and actor-dominant generative mechanism (that is, change in actors types, see Table 8), serves as a trigger for the activation of an actor-dominant and reinforcing generative mechanism (that is, change in actor population, ibid). While Punctuated Equilibrium theory of digital platform ecosystem states that, the change in actor population (e.g., adoption among merchants) as a generative mechanism reinforces the existing configuration of actors, architecture and governance and operates through various socio-technical interactions among the activated constructive elements of the ecosystem (Table 6), it does not fully demonstrate how this mechanism operates from teleological perspective.

Thus, in contrast to the Punctuated Equilibrium theory of digital platform ecosystem evolution (see Paper II), which focuses on the overall socio-technical interactions within the ecosystem (see Table 6 above), the Teleological theory puts emphasis on the actions of the platform owner when it comes to strategizing, while also, of course, acknowledging the overall interactions within the ecosystem. For example, presenting the above generative mechanism from teleological perspective requires focusing on the platform owner's aspirations to achieve fast adoption among the newly introduced type of actors (that is, more merchants joining the ecosystem) (goal formulation) (see Paper IV and Paper V). To achieve this goal, a platform owner, for example, can design a number of micro-strategies and corresponding microstructures. In particular, to stir initial adoption, platform owner can attract key merchants (that is marquee users), the inclusion of whom signals other merchants for the usefulness of the digital platform ecosystem (see Evans, 2009).

3. Evolution of Digital Platform Ecosystem as Multi-Motor Process

This PhD dissertation focuses on studying the evolution of digital platform ecosystems as complex, multi-faceted and dynamic process. To this end, I, together with my co-authors, study this phenomenon from different theoretical perspectives, with different methods, and in different contexts. As a result, this research aims to propose three process theories, each outlining different generative mechanisms (or motors), which collectively explain how and why digital platform ecosystems evolve over time.

While the Punctuated Equilibrium theory of digital platform ecosystem evolution helps us portray the evolutionary path as constructed based on a network of concurrent and distributed generative mechanisms, which either reinforce or transform the deep structure of the ecosystem, the Dialectical theory presents the evolutionary process as being shaped by the appearance and resolution of tensions as generative mechanisms.

In addition, the Teleological theory views evolution as a cycle of goal setting and execution through micro-strategies and corresponding microstructures (generative mechanisms), set in motion in response to various strategic challenges.

While each theory advances our understanding of the evolutionary process on its own, they investigate separate aspects of the evolution, without providing comprehensive understanding of this phenomenon. Relying on single explanation, however, leads to "oversimplification and selective attention" (Van de Ven and Poole, 1995, p. 526). To avoid potential oversimplification, I combine the findings of these three process theories, at the current stage of their development, and put forward a multi-motor explanation of digital platform ecosystem evolution (Poole and Van de Ven, 2004).

To develop such explanation, I revisit the initial conceptualization of generative mechanisms (see Figure 3) and, following the guidance provided by Van de Ven and Poole (1995), use the findings from the three process theories as building blocks to derive a multi-motor model of digital platform ecosystem evolution (Figure 16). In addition, I also consult studies, which put forward dual-motor explanation of change in various research fields (see Cule and Robey, 2004; Lichtenstein et al., 2006).

I consider a multi-motor explanation of digital platform ecosystem evolution to consist of two things. First, it needs to demonstrate how the identified generative mechanisms (or motors) collectively drive the evolutionary process through their interplay. Such an explanation is prescribed by the existing literature (see Van de Ven and Poole, 1995), where scholars identify various motors (e.g., teleological and dialectical; see Cule and Robey, 2004) and demonstrate the interdependencies between them. As the different theories put emphasis on different aspects (e.g., Punctuated Equilibrium on triggers and on the impact on the existing deep structure, Dialectical on contradictions as constraining latent properties and their resolution through managerial responses, Teleological on goal setting and execution), each of them provides insights about specific aspects of the evolutionary process. Thus, a multi-motor explanation needs to address the inderdependencies between the various generative mechanisms. Second, to construct the multi-motor explanation (Figure 16), I build upon the interplay of generative mechanisms and combine it with other findings from the different process theories to demonstrate how generative mechanisms collectively drive the digital platform ecosystem evolution.

Interplay between Multiple Generative Mechanisms

Based on an empirical investigation in Paper II, we have provided a detailed account of a number of generative mechanisms as they occur during the evolution of a prominent digital platform ecosystem (see above, Table 8). While, in Paper II, we focus mainly on outlining the dominance and impact of generative mechanisms, the subsequent investigation of generative mechanisms from dialectical and teleological perspective reveals certain overlapping.

Existing studies found that generative mechanisms of dialectical and teleological nature characterize Punctuated Equilibrium theory (see Van de Ven and Poole, 1995). Similarly, by taking a closer look at the empirically identified generative mechanisms in Paper II (Table 8), I establish that some of them, depending on their contextualization, are of dialectical and teleological nature. Some of the identified generative mechanisms, for example, stem from inherent contradictions (e.g., renewal of platform core, which corresponds to performance contradiction in Paper III). Further, I found evidence that some of the actor-dominant and transformative generative mechanisms, such as change in actor types, are of teleological nature. For example, the top management within Danske Bank decided to engage with other banks as financial partners, which transformed the existing deep structure of MobilePay ecosystem (see Paper II, Empirical Analysis). Thus, the platform owner played a significant role in initiating the change (goal formulation in the Teleological theory, see Figure 14), which indicates for a generative mechanism of teleological nature (Lichtenstein et al., 2006; Van de Ven and Poole, 1995).

As generative mechanisms are rooted in the latent properties of the deep structure and contextualized further by the triggers, which set them in motion, I argue that whether a generative mechanism is of dialectic or teleological nature depends on its contextualization. Dialectical generative mechanisms, for example, stem from accumulated inherent contradictions, which constitute constraining latent properties of the deep structure (see Paper III). Teleological generative mechanisms, on the other hand, account for the role of the platform owner, as a key actor within the ecosystem, in initiating intentional change (Lichtenstein et al., 2006; Poole and Van de Ven, 2004) in response to internal and external events (e.g., resolving accumulated governance issues; see also Tan et al., 2015).

Investigating further the empirically identified generative mechanisms (Table 8), I, however, have come across certain generative mechanisms, which are neither dialectical, nor teleological in nature. For example, although the development of platform periphery, which we categorize as architecture-dominant and transforming generative mechanism in Paper II, may seem to be initiated by the platform owner through its decision to introduce boundary resources (see Eaton et al., 2015), the subsequent reinforcing mechanism, related to the further development of the periphery, does not exhibit entirely teleological nature. For example, the development of the platform periphery usually follows no pre-established plan as third-party complementors may decide not to join the ecosystem regardless of the presence of boundary resources (West and Woodard, 2014; Um and Yoo, 2016). We have also observed that the platform owner introduced boundary resources ad hoc, in response to demands from various ecosystem actors, rather than following a deliberate plan, which signals for lack of intention. Thus, while the platform owner can initiate the formation of a platform periphery, its subsequent development depends on the actions of third-party developers (see also West and Woodward, 2014). Furthermore, the introduction of boundary resources may lead to dialectical tensions between platform owners and third-party developers (see, Eaton et al., 2015). It follows then that the development of platform

periphery as a generative mechanism may be of dialectical nature as well. In contrast to Eaton et al., (2015), however, we do not observe dialectical tensions or significant teleological drive in the activation and the operation of this particular generative mechanism. Thus, in the case we have empirically observed and analysed, the development of the periphery as a generative mechanism is neither of dialectical nor of teleological nature[11].
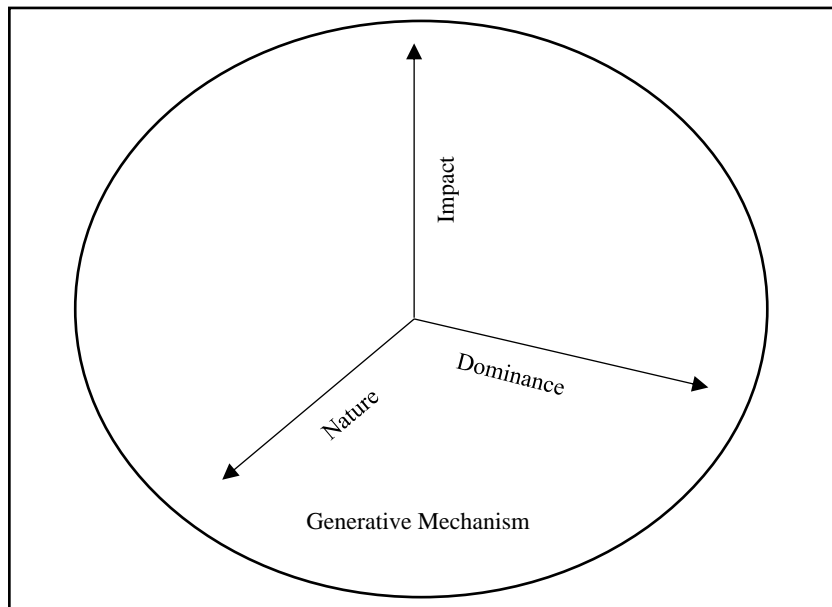
Figure 15. Typology of Generative Mechanisms

Regardless of their nature (dialectical, teleological or other), however, all generative mechanisms have a dominance (that is they are related to actors, architecture and governance of digital platform ecosystem) and impact (reinforcing or transforming) on the existing ecosystem configuration. Thus, by integrating the findings of the three theories, I further extend the proposed typology of generative mechanisms in Paper II, to include nature as another dimension, together with dominance and impact, which characterize generative mechanisms (see Figure 15).

To tackle the interactions between the various generative mechanisms, Van de Ven and Poole (1995) recommend researchers to consider the cross-level relationship between them (nested, entangled and aggregated, see also Poole and Van de Ven, 2004), the forms of relations between them (e.g., direct, indirect or cyclical (ibid)), and the timing of their appearance and disappearance. Poole and Van de Ven (2004) argue

---

[11] It is beyond the scope of this PhD dissertation to define further the nature of the generative mechanisms. It might seem intuitive to refer to them as evolutionary similar to Van de Ven and Poole (1995), however, that implies that these generative mechanisms are related to competition, which is not the case in that particular case.

that the cross-level relationship[12] between the different generative mechanisms can be entangled, nested or aggregated. Nested relationship presupposes that generative mechanisms of high and low level interconnect strongly, while, in contrast, entangled mechanisms are those that influence each other (regardless of their level), but does not require strong interdependency (ibid). On the other hand, aggregated relationship presupposes the emergence of a high-level generative mechanism by aggregating several generative mechanisms of low level (ibid).

As the digital platform ecosystem consists of specific configuration of actors, architecture and governance, which mutually influence each other (see Paper II), I define the relationship between actor-dominant, architecture- dominant and governance-dominant generative mechanisms (see Paper II) as entangled (consistent with the idea of generative mechanisms being distributed). As demonstrated in the Punctuated Equilibrium theory, actor-dominant generative mechanisms with transformative impact (e.g., change in actor types) also alter the ecosystem architecture and governance and may result in architecture-dominant generative mechanism with reinforcing impact (see Paper II, Empirical Analysis). Similarly, actor-dominant, reinforcing mechanisms (e.g., change in actor population) can also indirectly trigger architecture-dominant, transformative generative mechanisms (e.g., renewal of platform core). In addition, the same actor-dominant, reinforcing mechanisms (e.g., change in actor population) can also indirectly affect the activation of a governance-dominant, reinforcing mechanism (e.g., customizing rules for actor types) (see also, Paper II, Empirical Analysis). Thus, while generative mechanisms operate independently, they can interact with other mechanisms (Poole and Van de Ven, 2004).

The generative mechanisms also entangle to reinforce or transform the existing configuration of the deep structure. For example, a number of reinforcing mechanisms continue to operate in parallel with a transformation mechanism (see Paper II). For example, even though the platform owner decides to transform the existing deep structure of the ecosystem by renewing the platform core (architecture-dominant), both private and commercial customers continue to join the ecosystem (that is, change in actor population, which is an actor-dominant, reinforcing mechanism). Thus, while transformation mechanism may impact certain parts of the deep structure (e.g., architecture), other mechanisms continue to operate generating other aspects of it (e.g., actor).

Pondering upon their nature, I also view generative mechanisms of teleological and dialectical nature as entangled given the fact that these mechanisms also have dominance and impact. For example, the inclusion of financial partners as part of the MobilePay ecosystem constitutes a generative mechanism (actor-dominant and transforming) of teleological nature, which also creates a dialectical tension with regards to the ownership

---

[12] I do not view Digital Platform Ecosystems as multi-level phenomenon. Rather, they consists of actors, architecture and governance as separate, entangled constructive elements. Thus, in contrast to Poole and Van de Ven (2004), I do not adopt the idea of cross-level relationship between the generative mechanisms. I, however, view the generative mechanisms as entangled.

of MobilePay (Danske Bank vs other banks). To resolve this tension, Danske Bank transferred its ownership to MobilePay, which became a separate legal entity, a process we identify as an actor-dominant, reinforcing generative mechanism (that is, changing the role of the platform owner; see Table 8).

Various relations between the generative mechanisms exist. The majority of the mechanisms relate directly to one another. For example, the inclusion of new types of actors (transformation mechanism, see Paper II) leads the platform owner to design and execute various adoption strategies (teleological mechanism, see Paper IV), which result in increase in the number of ecosystem actors (reinforcing mechanism, see Paper II). At the same time, this evolutionary outcome seeds inherent contradiction in the ecosystem configuration (e.g., performance), which, when combined with the presence of trigger (e.g. scarcity), may indirectly activate certain tension (conflict) as generative mechanism (e.g., renewal of platform core). The relations between mechanisms can also be cyclical. For example, in the Punctuated Equilibrium theory of digital platform ecosystem evolution, mechanisms with transformative impact precede those with reinforcing impact, which later other transformative mechanisms alter (see Paper II).

Generative mechanisms also operate within certain temporal space (Poole and Van de Ven, 2004; see also Paper II). Transformative mechanisms, for example, disappear once they alter fundamentally the existing configuration of actors, architecture and governance, giving rise to reinforcing mechanisms. Reinforcing mechanisms, on the other hand, can operate in shorter span (e.g., standardization of boundary resources to foster the development of platform periphery, see Paper II) or can re-appear sporadically (e.g., improvement of functionalities) in alternated form (see Paper II, Discussion). Thus, some of the reinforcing mechanisms can continue operating in modified version over longer span. Furthermore, we found evidence that reinforcing and transformative mechanisms may overlap (for explanation, see Paper II, Discussion).

There is no defined order in which transformative or reinforcing mechanisms with various dominance (actor, architecture, governance) appear during the evolutionary path of a digital platform ecosystem. For example, transformative mechanisms occurred with stable frequency during the evolutionary journey (see Paper II, Empirical Analysis). Furthermore, actor-dominant, architecture-dominant and governance-dominant mechanisms also appeared throughout the evolution of the selected case, following no distinct order (both initially and at later stages).

Focusing on their nature, generative mechanisms of dialectical nature seem to appear at later stages of the evolution of the investigated digital payment platform ecosystem. For example, performance as inherent contradiction appeared after a substantial number of actors have joined the ecosystem and their populations had grown (ibid). Similarly, the resolution of accumulated governance issues, which is also dialectical in nature, occur at later stages of MobilePay evolution. It also seems that generative mechanisms of teleological nature appear throughout the evolutionary path of a digital platform ecosystem.

A Multi-Motor Explanation of Digital Platform Ecosystem Evolution

While the separate theories outline the different generative mechanisms in play, they also focus on explaining particular aspects of the evolutionary process. For example, the Punctuated Equilibrium theory provides insights with regards to the dominance and impact of the mechanisms on the existing deep structure. Following the same logic, the Dialectical theory sheds light into the responses, which platform owner can rely on to manage salient tensions. Similarly, the Teleological theory not only tries to explain the evolution as a goal-seeking behaviour, but also provides insights into the strategies and organizational structure undertaken by the platform owner when addressing a specific trigger. Thus, to strengthen further the multi-motor explanation of digital platform ecosystem evolution, I combine the main assumptions from the three theories in a comprehensive model (Figure 16).

At any point in time, digital platform ecosystem consists of a particular configuration of actors, architecture and governance. This specific configuration determines the latent properties of the digital platform ecosystem (e.g., malleability, accumulated technology debt, increased usefulness to actors, and more), which can enable or constrain its ability to evolve and determine the nature and operation of the generative mechanisms.
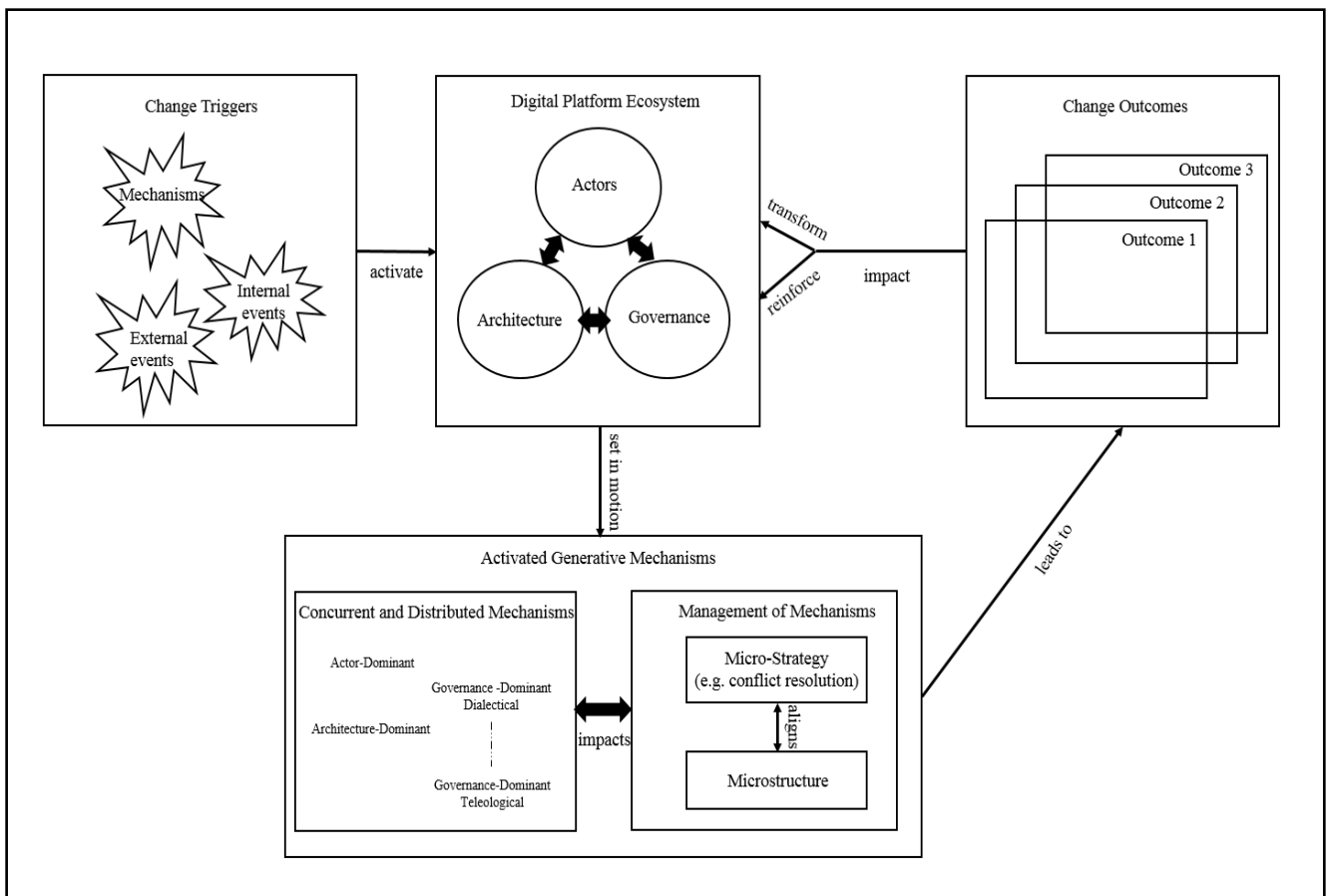
Figure 16. Multi-motor Explanation of Digital Platform Ecosystem Evolution[13]

During its evolutionary path, the digital platform ecosystem accumulates numerous incremental and transformative changes brought by various generative mechanisms (e.g. inclusion of new distinct types of actors; increase in the number of external complementors, etc.) which also alter the latent properties of the ecosystem. Although some changes aim at simplifying the existing configuration in an attempt to improve its functioning (e.g., removing underperforming functions, see Paper II), the complexity of the digital platform ecosystem increases as it matures.

While some of the newly created latent properties act as enablers of digital platform ecosystem evolution (e.g., malleability), other properties act as constrainers (e.g., accumulated technology debt). With the increased complexity, various inherent contradictions, related to the actors, architecture and governance of the ecosystem, appear as part of the constraining latent properties of the existing ecosystem configuration (see Paper III). For example, while the inclusion of new types of actors increases the attractiveness to the ecosystem to other actors and thus improves the overall performance of the ecosystem, it also creates tensions, as the existing architecture may not be able to support the growth of actors, thus challenging the overall performance of the ecosystem.

The existing configuration of actors, architecture and governance remains stable until various disruptive events challenge its current composition (Paper II). These events constitute change triggers, which activate certain generative mechanisms[14]. Throughout the separate studies, we outline a number of external and internal change triggers, which can activate different mechanisms. For example, external events, such as entry of new competitor or technology developments (Paper II), or internal events, such as performance issues (Paper II), conflicting heterogeneous interests (plurality) (Paper III) and the need to address specific strategic challenges (Paper IV and Paper V).

Previously activated generative mechanisms can also trigger subsequent generative mechanisms (Bhaskar, 1975; Poole and Van de Ven, 2004). For example, as the digital platform includes new distinct type of actors and thus transforms the existing configuration of the digital platform ecosystem (actor-dominant and transforming generative mechanism, Paper II), the introduction of new heterogeneous actors increases the possibility of conflicts with exiting actors (new latent property). If their interests diverge significantly, the tension between them become salient, which triggers the activation of new generative mechanism of dialectical nature (Paper III). Similarly, the inclusion of new actors can also lead to performance issues, as the initial composition of the architecture cannot support the increased volume of interactions. This leads to frequent architecture failures (internal events), which activate a transforming generative mechanism (Paper II).

---

[13] The concurrent and distributed generative mechanism in the model are illustrative
[14] Not all events, however, constitute triggers as the platform owner can choose to neglect some of them and not respond.

We could not establish empirically a pattern between certain change triggers and the activation of specific generative mechanisms. Rather various internal and external events and generative mechanisms can set in motion different generative mechanisms (for more details; see Paper II, Discussion, The triggering of generative mechanisms).

As digital platform ecosystems are complex phenomena consisting of various actors, modular IT architecture and complex governance regime, multiple change triggers compete for the attention of the platform owner all the time. As a result, multiple activated generative mechanisms are in play simultaneously affecting various aspects of the digital platform ecosystem (see also Poole and Van de Ven, 2004). Furthermore, the activated mechanisms can differ in terms of their dominance, impact and nature (see Figure 16).

For illustrative purposes, in Figure 16, I have demonstrated the activated generative mechanisms in play during certain period, part of the evolutionary journey of a prominent digital payment platform ecosystem (June 2014 - January 2015) (see also Paper II, Empirical Analysis, Table 5). During that period, the platform owner collaborated with platform technology providers, who wanted to join the growing platform ecosystem - a process, which constituted a transformative and actor-dominant mechanism. While this mechanism was in play (note that this mechanism resulted in transformation of the deep structure in January 2015), a number of reinforcing generative mechanisms with different dominance and of different nature were also present (between June 2014 – January2014), reinforcing previously introduced changes. For example, the platform owner needed to optimize the process through which commercial customers become part of the ecosystem, which is governance-dominant and reinforcing mechanism. Furthermore, it is also of dialectic nature as it stems from the inability of the existing processes to sustain the increased number of commercial customers wanting to join the ecosystem (salient tensions in connection to performance; see Paper III). The platform owner also improved the connectivity for third-party complementors, which is architecture-dominant and reinforcing, but has no dialectical or explicit teleological nature. Another reinforcing mechanism, customization of offerings for commercial customers, which is governance-dominant, was also active during this period. As its operation is a result of the goal-seeking behaviour of the platform owner (that is, improving adoption among commercial customers and securing revenue), this mechanism is of teleological nature.

The reinforcing mechanisms in relation to commercial customers interact with a previously triggered reinforcing mechanism, namely adoption of commercial customers (for more, see Paper II, Empirical Analysis). Thus, as result of their activation and operation, it become easier for commercial customers to join the platform ecosystem. Some of the identified generative mechanisms, however, do not seem to interact directly with each other (e.g., customization of offerings for commercial customers and improved connectivity towards third-party complementors).

As demonstrated in the findings of the Dialectical theory and Teleological theory, activated generative mechanisms often include involvement of the platform owner who manages and resolves salient tensions

(Dialectical) or directs the execution of a particular goal-seeking behaviour (Teleological). I further argue that all of the generative mechanisms (independent of their dominance, impact and nature) (see also Table 8) require active management from the platform owner, regardless of whether they were set in motion as a result of a goal-seeking behaviour. While generative mechanisms operate through the various socio-technical interactions between the activated constructive elements of a digital platform ecosystem, the platform owner plays a significant role, as a particular type of actor, in stirring and shaping these interactions (see Chapter II). Subsequently, throughout the operation of a particular generative mechanism, the platform owner formulates and designs specific micro-strategies and their corresponding microstructures to manage the operation of the mechanism itself (Figure 16). In cases where the activated generative mechanism is of dialectic nature, the platform owner can deploy specific responses, such as splitting, accommodating, synthesis, which I view as micro-strategies.

The generative mechanisms, activated by triggers, characterized by dominance, impact and nature, and shaped by the platform owner, lead to certain evolutionary outcomes (that is, changes in the existing configuration of actors, architecture and governance) (see Figure 16). Depending on the nature of the introduced changes, generative mechanisms can have transformative or reinforcing impact on the existing ecosystem configuration. Thus, digital platform ecosystems evolve over time by continuous re-configuration of its actors, architecture and governance driven by a network of concurrent and distributed generative mechanisms.

VIII Conclusion

In this chapter, I outline the main theoretical contributions of this PhD dissertation and discuss implications for practitioners, which platform owners and managers can take into account during the evolutionary path of their digital platform ecosystems. In addition, I also outline the limitations of this research and propose possible avenues for future exploration, which can address the current shortcomings.

This PhD dissertation focuses on explaining why and how digital platform ecosystems evolve over time. To this end, this research proposes the use of generative mechanisms as meta-theory, which allows for studying this phenomenon from different theoretical perspectives and through different methods. As a result, I, together with my co-authors, seek to propose three process theories (Punctuated Equilibrium, Dialectical and Teleological), which collectively explain the evolution of digital platform ecosystems.

1. Theoretical Contribution

Due to their inherent digital properties, which make them extensible, reprogrammable, edible (Tiwana, 2014) and which reduce the costs for their production, distribution and maintenance (Bakos, 1998, Hagiu and Wright, 2011), digital platform ecosystems can evolve rapidly, in "compressed" manner (Tiwana, 2014). Furthermore by operating in dynamic and uncertain environment (Dattee et al., 2017), digital platform ecosystems also face

various internal and external challenges and opportunities on ongoing basis (Gawer, 2015; Tan et al., 2015). While existing research has advanced our understanding about this important process by addressing it from four different perspectives (see Chapter III), there is lack of sufficient knowledge about the triggers and mechanisms shaping the evolutionary process (de Reuver et al., 2017; Gawer, 2015; Ojala and Lyytinen, 2018).

By investigating this important question, the PhD dissertation contributes to both the platform literature and to the application of generative mechanisms to socio-technical systems (see Henfridsson and Bygstad, 2013). Based on the findings from the six separate studies, this research advances the current platform literature, which comprises of studies dispersed across various fields, in several manners. First, it proposes an encompassing definition of digital platform ecosystems, which reflects their heterogeneity and takes into account the various perspectives through which scholars investigate this phenomenon. By doing so, we address the call by several researchers (de Reuver et al., 2018; Gawer, 2014; Thomas et al., 2014) to merge the existing fragmented perspectives and thus, clarify further the conceptualization of this phenomenon.

Second, it contributes to an important, but currently under researched topic within the platform literature, namely the evolution of digital platform ecosystems. Apart from conceptualizing this process, we also go beyond the existing descriptive, fragmented findings in the platform literature by investigating the generative mechanisms, which drive digital platform ecosystems to evolve over time. In particular, we manage to address the concerns of researchers who state that existing research does not identify the mechanisms explaining why and how platform ecosystems evolve (de Reuver et al., 2018; Ojala and Lyytinen, 2018). In addition, we also answer calls for more research in connection to the triggers of platform ecosystem evolution (see de Reuver et al., 2018; Gawer, 2015).

Answering the main RQ, I, together with my co-authors, argue that digital platform ecosystems evolve through the simultaneous operation of a number of generative mechanisms, characterized by different nature, dominance and impact, and triggered in response to various external and internal events. In addition, we further propose a typology of generative mechanisms (Figure 15) and a list of empirically identified generative mechanisms (Table 8). I further offer a multi-motor explanation of digital platform ecosystem evolution (Figure 16), which explains how the various identified generative mechanisms interplay to drive the digital platform ecosystem evolution (SQR1) and what role the platform owner has in managing the evolutionary process (SQR2).

Addressing SQR1, I, together with my co-authors, offer three theories, each characterized by generative mechanism, which collectively explain the evolution of digital platform ecosystems (Figure 16). In particular, by taking into account the impact of internal and external events on the evolutionary path, we propose a Punctuated Equilibrium theory of digital platform ecosystem evolution, which demonstrates how ecosystems evolve through a distributed and concurrent network of generative mechanisms, transforming or reinforcing the existing ecosystem configuration.

We further investigate how the appearance of tensions and their resolution as a form of generative mechanisms also drives the evolution of the digital platform ecosystem from dialectical perspective. Although digital platform ecosystems are ripe with tensions, few researchers have applied dialectics as a lens to study digital platform ecosystems (see Eaton et al., 2015; Wareham et al., 2014 as exceptions). Thus, by proposing a Dialectical theory of digital platform ecosystem evolution, we aim to extend the current knowledge about the various tensions occurring within the ecosystem and their impact on the ecosystem evolution.

Similarly, by drafting an initial version of Teleological theory of digital platform ecosystem evolution (SRQ2), we look further into the role of the platform owner to formulate and execute strategies in response to internal and external events. In particular, we advocate for the adoption of a micro-perspective towards strategizing and organizational design through the development of micro-strategies and their corresponding microstructures, which platform owners can rely on when faced with various challenges and opportunities. Thus, we further advance research on strategizing within digital platform ecosystems, which is also nascent (Dattee et al., 2017; Ghazawneh and Henfridsson, 2011; de Reuver et al., 2017). In particular, we also portray the platform owner beyond its usual presentation as a faceless actor. Instead, by adopting Strategy-as-Practice perspective, we recognize the role of various strategy practitioners, collectively referred to as platform owner, and the way they organize their activities to support emerging micro-strategies.

Lastly, this PhD dissertation also develops further the conceptualization of generative mechanisms when applied to complex socio-technical systems. While Henfridsson and Bygstad (2013) first adopt generative mechanisms to study the evolution of digital infrastructure as complex socio-technical systems, we further improve their conceptualization by focusing on their contextualization and by proposing a typology of mechanisms based on their dominance, impact on the evolutionary process, and nature (Figure 15).

2. Implications for Practice

Due to the nature of the PhD dissertation, conceived in close collaboration with practice, this research offers a number of implications for practitioners. First, we help platform owners grasp the complexity of the digital platform ecosystem evolution by providing a comprehensive account of the evolutionary process. In addition, we emphasize on its volatile and uncertain nature, which makes it difficult to predict the evolutionary trajectory.

After spending three days per week for about two years at the case company, I witnessed that multiple issues concerning actors, architecture and governance demand the attention of the employees simultaneously. To be able to estimate the impact of various events on the evolutionary journey (transformative or reinforcing), platform owners (and employees) need to understand how these events can trigger various generative mechanisms, which produce certain evolutionary outcomes. Thus, this research draws the attention of the platform owner to the various generative mechanisms, activated by different triggers, which impact the existing

configuration of actors, architecture and governance. The findings of this research also caution platform owners against prioritizing one constructive element over the other (that is, actors, architecture and governance). As actors, architecture and governance entangle, changes in each one of them often affect the other two.

Furthermore, by proposing Teleological theory of digital platform ecosystem evolution, this research demonstrates how platform owner can manage the evolutionary process and thus shape the final evolutionary outcome. In particular, we state that platform owners should rely on micro-strategies and their corresponding microstructures to manage the evolutionary process (Paper VI). We also propose the Reach and Range framework (Paper IV), which platform owners can use when facing various strategic issues as part of their evolutionary journey. We further identify potential tensions, which the platform owner needs to be aware of and propose a number of response strategies for managing the conflicts when they escalate (see Paper III).

In addition, as I followed the principles of engaged scholarship (see Chapter V), I immersed myself in the day-to-day work of the case company (MobilePay). As an active member of the Concepts team, I participated in the delivery of several tasks (see Chapter V) and provided input for a number of other tasks and projects based on my knowledge and expertise. I also shared insights from my research work with relevant stakeholders within the company. As a result of this exchange, the Concepts team developed and launched a new application, WeShare, in June 2016, which allows private customers of MobilePay to create and settle group expenses. The application, which connects tightly to the MobilePay platform core, constitutes an internal complement, offered by the platform owner, as part of the platform periphery.

3. Limitations

This research is not without limitations. While we concentrate on explaining digital platform ecosystem evolution, we mostly focus on one particular context (exception Paper I and Paper III), namely that of digital payment platform ecosystems (see Chapter V, Research Setting). Digital platform ecosystems, however, are heterogeneous and operate in various contexts (see Chapter I, Introduction), which we did not take into account. Furthermore, we rely on one longitudinal single case study, rooted in the digital payment context (Paper II), to identify various generative mechanisms. We, however, try to generalize the findings (see Table 8) and claim that they are applicable to other research settings. We urge other researchers to identify and compare generative mechanisms for digital platform ecosystem evolution across various contexts.

In addition, despite outlining a Teleological theory of digital platform ecosystem evolution, which is currently not completed, we do not provide enough empirical evidence to support it further (Paper VI is research in progress). In particular, while we demonstrate empirically the suitability of the proposed model in Paper VI, at this stage, we do not identify micro-strategies and microstructures in relation to it based on empirical analysis.

4. Future Research

While the findings of this PhD dissertation advance the existing research by addressing important research gaps (see above), it also opens avenues for future research. In particular, researchers can try to apply our conceptualization of generative mechanisms in other contexts in order to compare and contrast our findings. Due to the heterogeneity of the digital platform ecosystems and the contextualization of generative mechanisms, we expect the evolution of various platform ecosystems to consist of different generative mechanisms. We also urge researchers to try to identify additional generative mechanisms, which complement the set of already identified ones.

Furthermore, researchers should also investigate cases where digital platform ecosystems fail to evolve (de Reuver et al., 2017). Explaining such failure may include lack of ability to activate generative mechanisms, or inadequate managerial responses to various strategic issues. By outlining how and why ecosystems fail to evolve in the right direction or at the right speed (Tiwana, 2014), future research can shed light on the nature of activated but unrealized generative mechanisms, which can enrich further our understanding of their role as drivers of digital platform ecosystem evolution.

IX References

Altman, E. J., and Tushman, M. L. 2017. "Platforms, open/user innovation, and ecosystems: A strategic leadership perspective". Harvard Business School Organizational Behavior Unit Working Paper No. 17-076.

Archer, M. S. 2015. "How agency is transformed in the course of social transformation: don't forget the double morphogenesis", in Generative mechanisms transforming the social order, M.S. Archer (ed.), Switzerland: Springer International publishing.

Atkinson, R. and Flint, J. 2001. "Accessing Hidden and Hard-to-reach Populations: Snowball Research Strategies," *Social Research Update*, 33.

Baldwin, C. Y., and Woodard, J. C. 2009. "The Architecture of Platforms: A Unified View". In A. Gawer (ed.) Platforms, Markets and Innovation, pp. 19-44.

Bakos, Y. 1998. "The emerging role of electronic marketplaces on the Internet," *Communications of the ACM*, (41:8), pp. 35-42.

Baxter, P. and Jack, S. 2008. "Qualitative Case Study Methodology: Study Design and Implementation for Novice Researchers," *The Qualitative Report*, (13:4), pp. 544-559.

Benbasat I., Goldstein, D., and Mead, M. 1987. "The Case Research Strategy in Studies of Information Systems," *MIS Quarterly* Vol. 11, pp. 369-386.

Bharadwaj, A., El Sawy, O.A., Pavlou, P.A., and Venkatraman, N. 2013. "Digital business strategy: Toward a next generation of insights," *MIS Quarterly* (37:2), June, pp 471-482.

Bhaskar, R. 1993. Dialectic: The Pulse of Freedom, London:Verso.

Bhaskar, R. 1997 [1975]. A Realist Theory of Science, London: Verso.

Boell, S, K. and Cecez-Kecmanovic, D. 2014 "A Hermeneutic Approach for Conducting Literature Reviews and Literature Searches," Communications of the Association for Information Systems, (34:12).

Bostrom, R., Gupta, S. and Thomas, D. (2009) "A Meta-Theory for Understanding Systems within Socio-Technical Systems," *Journal of Management Information Systems*.

Boudreau, K. J. 2012. "Let a Thousand Flowers Bloom? An Early Look at Large Numbers of Software App Developers and Patterns of Innovation," Organization Science (23:5), pp. 1409–1427

Boudreau, K. 2010. Open Platform Strategies and Innovation: Granting Access vs. Devolving Control. *Management Science*, (56:10).

Boudreau, K. and Hagiu, A. 2009. "Platforms Rules: Multi-sided Platforms as Regulators." In A. Gawer (ed.) Platforms, Markets and Innovation. London: Edward Elgar.

Bunge, M. 2004. "How does it work? The search for explanatory mechanisms." *Philosophy of the Social Sciences*, (34:2), pp. 182-210.

Bygstad, B. and Munkvold, B. E. 2011. "In Search of Mechanisms. Conducting a Critical Realist Data Analysis" In Proceedings: International Conference Information Systems, Shanghai, China.

Bygstad, B., Munkvold, B. E. and Volkoff, O. 2016. "Identifying generative mechanisms through affordances: a framework for critical realist data analysis," *Journal of Information Technology*, (31:1), pp. 83- 96.

Caillaud, B. and Jullien, B. 2001. "Competing Cybermediaries," *European Economic Review*, 45, pp. 797-808.

Casey. T. R., and Töyli, J. 2012. "Dynamics of two-sided platform success and failure: an analysis of public wireless local area access". *Technovation* (32), pp.703–716.

Ceccagnoli, M., Forman, C., Huang, P., Smith, R. H., and Wu, D. J. (2012). Co-creation of Value in a Platform Ecosystem: The Case of Enterprise Software. MIS Quarterly, 36 (1), pp. 263-290.

Cennamo, C., and Santalo, J. 2015. "How to avoid platform traps," *MIT Sloan Management Review*, (51:1), p. 12.

Chandler, A. D. 1962. Strategy and Structure: Chapters in the History of American Enterprise. Boston, MA: MIT Press

Constantinides, P., Henfridsson, O., G. and Parker, G. 2018. "Introduction—Platforms and Infrastructures in the Digital Age," *Information Systems Research*, (29:2), pp. 381-400.

Constantinou, I., Eaton, B., and Tuunainen, V. K. 2016. "*The Evolution of a Sharing Platform into a Sustainable Business*". Proceedings of the 49th Hawaii International Conference on System Sciences (HICSS 2016).

Cule, P., and Robey, D. 2004. "A Dual-Motor, Constructive Process Model of Organizational Transition," *Organizational Studies* (25:2), pp. 229-260.

Dalkin, S., Greenhalgh, J., Jones, D., Cunningham, B., and Lhussier, M. 2015. "What's in a mechanism? Development of a key concept in realist evaluation," *Implementation science*, IS. 10. 49. 10.1186/s13012-015-0237-x.

Danish National Bank. 2016. Danmarks nationalbank annual report. Can be retrieved here: https://www.nationalbanken.dk/en/publications/Documents/2017/03/DN%20Annual%20Report2016.pdf

Danish Payments Council. 2016. "Report on the role of cash in society" Can be retrieved here: http://www.nationalbanken.dk/en/bankingandpayments/danish_payments_council/Documents/Report_on_the_role_of_cash_in_society.pdf

Datee, B., Alexy, O. and Autio, E. 2017. "Maneuvering in Poor Visibility: How Firms Play the Ecosystem Game when Uncertainty is High," *The Academy of Management Journal*, (61:2).

de Reuver, M., Sørensen, C., and Basole, R. C. 2017. "The digital platform: a research agenda*." Journal of Information Technology*. ISSN 0268-3962.

Easton, G. 2010. "Critical Realism in Case Study Research," *Industrial Marketing Management* (39), pp. 118-128.

Eaton, B., Elaluf-Calderwood, S., Sorensen, C., and Yoo, Y. 2015. "Distributed Tuning of Boundary Resources: The Case of Apple's iOS Service System," *MIS Quarterly*, (39: 1) pp. 217-243.

Ecommerce News. 2016. "Ecommerce in Denmark is worth 13.84 billion euros," Can be retrieved here: https://ecommercenews.eu/ecommerce-denmark-worth-13-84-billion-euros/

Eisenmann, T. (ed.) 2002. *Internet Business Models: Text and Cases*. New York: McGraw-Hill/Irwin.

Eisenmann, T., Parker, G., and van Alstyne, M. 2011. "Platform envelopment," *Strategic Management Journal*, (32:12), pp. 1270-1285.

Eisenmann, T., Parker, G., and van Alstyne, M. 2009. "Opening platforms: How, when and why?" In A. Gawer (Ed.), *Platforms, Markets and Innovation*. Cheltenham, UK: Edward Elgar Publishing Limited.

Eisenmann T, Parker G, and van Alstyne M. 2006. Strategies for two-sided markets. Harvard Business Review, (84:10), pp. 92–101.

Elster, J. 2007. Explaining Social Behavior: More Nuts and Bolts for the Social Sciences, Cambridge University Press.

Evans, D. S. 2012. "Governing Bad Behavior By Users of Multi-Sided Platforms", *Berkeley Technology Law Journal*, 27:2.

Evans, D. S. 2009. "How Catalysts Ignite: The Economics of Platform-Based Start-Ups," in *Platform, markets and innovation*, A. Gawer (Ed.), London, UK: Edward Elgar.

Evans, D. S., Hagiu, A. and Schmalensee, R. 2006. *Invisible Engines: How Software Platforms Drive Innovation and Transform Industries*, Cambridge, MA: The MIT Press.

Evans, D, and Pirchio, A. 2015. "An Empirical Examination of Why Mobile Money Schemes Ignite in Some Developing Countries but Flounder in Most," Coase-Sandor Working Paper Series in Law and Economics No. 723.

Evans, D. S. and Schmalensee, R. 2016. *Matchmakers: The New Economics of Multisided Platforms*, Harvard Business Publishing: Boston, Massachusetts, USA.

Evans, D. S., and Schmalensee, R. 2010. "*Failure to Launch: Critical Mass in Platform Businesses,*" Review of Network Economics, (9:4).

European Commission (2013) Proposal for a Directive of the European Parlia-ment and the Council on payment services in the internal market and amend-ing Directives 2002/65/EC, 2013/36/EU and 2009/110/EC and repealing Di-rective 2007/64/E, COM.

European Payments Council. 2017. "The Danish payment landscape (October 2017)". Can be retrieved here: https://www.europeanpaymentscouncil.eu/node/12396

Finans. 2016. Danskerne valgte MobilePay frem for Swipp. Can be found at: https://finans.dk/live/erhverv/ECE9149552/danskerne-valgte-mobilepay-frem-for-swipp/?ctxref=ext

Gawer, A. 2015. "*What Drives Shifts in Platform Boundaries: An Organizational Perspective,*" Conference Paper, DRUID Summer Conference, Copenhagen, Copenhagen Business School, Denmark.

Gawer, A. 2014. "Bridging differing perspectives on technological platforms: Toward an integrative framework," *Research Policy*, (43:7), pp. 1239–1249.

Gawer, A. 2009. "Platform Dynamics and Strategies; from products to services", In Platforms, Markets and Innovation; Gawer, A., Ed.; Edward Elgar Publishing: Northampton, MA, USA; Northampton, MA, USA, 2009, pp. 45-77.

Gawer, A., and Cusumano, M. A. 2014. "Industry platforms and ecosystem innovation," *Journal of Product Innovation Management*, (31:3), pp. 417-433.

Gawer, A., and Cusumano, M. A. 2007. "*A strategy toolkit for platform leader wannabes,*" Conference Paper, DRUID Summer Conference on Appropriability, Proximity, Routines and Innovation, Copenhagen, Copenhagen Business School, Denmark.

Gawer, A. and Cusumano M. A. 2002. *Platform Leadership: How Intel, Microsoft, and Cisco Drive Industry Innovation*, Boston, MA, US: Harvard Business School Press.

Gawer, A. and Henderson, R. 2007. "Platform owner entry and innovation in complementary markets: Evidence from Intel', Journal of Economics and Management Strategy," (16:1), pp. 1-34.

Gersick, C. J. (1991). Revolutionary change theories: A multilevel exploration of the punctuated equilibrium paradigm. Academy of Management Review, 16(1), 10–36

Ghazawneh, A. and Henfridsson, O. 2013. "Balancing platform control and external contribution in third-party development: the boundary resources model," Information Systems Journal, (23:2), pp. 173–192.

Ghazawneh, A., and Henfridsson, O. 2011. "*Micro-strategizing in platform ecosystems: a multiple case study,*" Thirty Second International Conference on Information Systems (ICIS), Shanghai.

Gregor, S. 2006. "The Nature of Theory in Information Systems," *MIS Quarterly*, (30: 3).

Hagiu, A. 2014. "Strategic Decisions for Multi-sided Platforms." *MIT Sloan Management Review*, (55:2).

Hagiu, A. 2006. "Multi-Sided Platforms: From Microfoundations to Design and Expansion Strategies," Working Paper 07-094. Harvard Business School.

Hagiu, A. and Wright, J. 2013. "Do You Really Want to Be an eBay?," *Harvard Business Review*, (91:3), pp. 102–108.

Hagiu, A. and Wright, J. 2011. "Multi-Sided Platforms," Harvard Business School Working Paper 12-024.

Hagiu, A. and Rothman, S. 2016. "Network Effects Aren't Enough," Harvard Business Review, April 2016.

Hanseth, O. and Lyytinen, K. 2010. "Design theory for dynamic complexity in information infrastructures: the case of building internet," Journal of information technology, (25:1), pp. 1- 19.

Han, J. and Cho, O. J. 2015. "Platform business Eco-model evolution: case study on KakaoTalk in Korea". *Journal of Open Innovation: Technology, Market, and Complexity*, (1:6).

Hassan, N., and Lowry, P. B. (2015). Seeking middle-range theories in information systems research. Paper presented at the International Conference on Information Systems, Fort Worth, TX.

Hedström, P., and Swedberg, R. 1998. "Social Mechanisms: An Introductory Essay," In: Social Mechanisms: An Analytical Approach to Social Theory, P. Hedström and R. Swedberg (eds.) Cambridge: Cambridge University Press, pp. 1-31.

Henfridsson, O. and Bygstad, B. (2013). "The generative mechanisms of digital infrastructure evolution", MISQ, 37 (3).

Henningsson, S. and Hedman, J. 2015. "The New Normal : Market Cooperation in the Mobile Payments Ecosystem," Electronic Commerce Research and Applications, (15:5), pp. 305-318.

Hernes, G. 1998. Real virtuality. In P. Hedström&R. Swedberg (Eds.), Social mechanisms: An analytical approach to social theory (pp. 74-101). Cambridge, UK: Cambridge University Press.

Hjelholt, M., and Damsgaard, J. 2013. "Modelling the Genesis and Evolution. The Case of a Prepaid Danish Cashcard," *ITM Communications*, Nr. 2013/1.

Huber T, T. Kude, and Dibbern, J. 2017. "Governance Practices in Platform Ecosystems: Navigating Tensions Between Co-Created Value and Governance Costs". Information Systems Research.

Hunt, S. D. 2005. "For truth and realism in management research," *Journal of Management Inquiry*, (14:2), pp. 127–138.

Iacono, J. Brown, A. and Holtham, C. 2009. "Research Methods – a Case Example of Participant Observation." The Electronic Journal of Business Research Methods, (7:1), pp.39 - 46.

Inoue, Y. and Tsujimoto, M. 2017. "New market development of platform ecosystems: A case study of the Nintendo Wii," *Technological Forecasting and Social Change*, In Press, Available online from January 2017.

Isckia, T., and Lescop, D. 2013. "Platform-based ecosystems: Leveraging Network-Centric Innovation", in *Understanding Business Ecosystems: How firms succeed in the new world of convergence*, S. B. Letaifa, A. Gratacap and T. Isckia (Eds.), Brussels: De Boeck.

Jacobides, M., C. Cennamo, and Gawer, A. 2018. Towards a Theory of Ecosystems. Strategic Management Journal.

Jarvenpaa, S. L., and Lanham, H. J. 2013. "Introduction to Paradoxes and Tensions in Innovation and Implementation of Complex Systems Minitrack". HICSS 2013: 4616.

Jha, K. S., Pinsonneault, A., and Dubé, L. 2016. "The Evolution of an ICT Platform-Enabled Ecosystem for Poverty Alleviation: The Case of eKutir," MIS Quaterly, (40:2), pp. 431-445.

Jones, M., and Alony, I. 2011. "Guiding the use of grounded theory in doctoral studies–an example from the Australian film industry," International Journal of Doctoral Studies, 6, 95-114. Retrieved from http://www.informingscience.us/icarus/journals/ijds

Kallinikos, J., Aaltonen, A., and Marton, A. 2013. "The Ambivalent Ontology of Digital Artifacts". *MIS Quaterly*, (37: 2), pp. 357-370.

Kapoor, R. and Agarwal, S. 2017. "Sustaining Superior Performance in Business Ecosystems: Evidence from Application Software Developers in the iOS and Android Smartphone Ecosystems," Organization Science, (28:3).

Kawulich, B. B. 2005. "Participant observation as a data collection method". *Forum Qualitative Sozialforschung / Forum: Qualitative Social Research*, 6(2).

Kazan, E.; Tan, C.W.; Lim, E.T.K.; Sorensen, C.; Damsgaard, J. 2018. "Disentangling digital platform competition: The case of UK mobile payment platforms," *Journal of Management Information Systems*, 35, 180–219.

Kim, J, Leem, C., Kim, B., and Cheon, Y. 2013. "Evolution of Online Social Networks: A Conceptual Framework," Asian Social Science, (9:4).

Kohler, T. 2018 "How to Scale Crowdsourcing Platforms," *California Management Review*, (60:2), pp. 98 – 121.

Leidner, D. E. 2018. "Review and Theory Symbiosis: An Introspective Retrospective," *Journal of the Association for Information Systems*, (19:6).

Lichenstein, B.B., M. Uhl-Bien, R. Marion, A. Seers, J.D. Orton, Schreiber, S. 2006. "Complexity leadership theory: An interactive perspective on leading in complex adaptive systems," Emergence: Complexity and Organization, (8:4), pp. 2-12.

Lihua, H., Hu, G., and Lu, X. 2010. "E-business Ecosystem and its Evolutionary Path: The Case of the Alibaba Group in China," *Pacific Asia Journal of the Association for Information Systems*, (4:3).

Leonard-Barton, D. 1990. "A dual methodology for case studies: Synergistic use of a longitudinal single site with replicated multiple sites," Organization Science (1:3), pp. 248–66.

Lyytinen, K., and Yoo, Y. 2002. "The next wave of nomadic computing", Inform. Systems Res. (13:4), pp. 377–388.

Lyytinen, K., and Newman, M. 2008. "Explaining information systems change: a punctuated socio-technical change model." *European Journal of Information Systems*, (17:6), pp 589–613.

Mathiassen, L. and Nielsen, P. A. 2008."Engaged Scholarship in IS Research," *Scandinavian Journal of Information Systems*, (20:2), Article 1.

McGrath, K. 2013. "The Potential of Generative Mechanisms for IS Research", In Proceedings: International Conference Information Systems, 2013, Milano, Italy.

Mihailescu, M, Mihailescu, D and Schultze, U. 2015. "The generative mechanisms of healthcare digitalization," In Proceedings: 2015 International Conference on Information Systems, Fort Worth, Texas, USA.

Mingers, J. 2004. "Critical Realism and Information Systems: Brief Responses to Monod and Klein," *Information & Organization* (14:2), pp. 145-153.

Mingers, J., Mutch, A., and Willcocks, L. (2013). Critical realism in information systems research," *MIS Quarterly*, (37:3), pp. 795-802.

MobilePay (2017). MobilePay is heading towards 1000 webshops in the Nordics. Press release. Can be found at: https://www.mobilepay.dk/da-dk/PDF/Pressemeddelelser/Checkout-MobilePay-PressRelease-20170419.pdf

Moore, J. E., and Yager, S.E. 2011. "Understanding and applying participant observation in information systems research," In Proceedings of the 49th SIGMIS annual conference on Computer personnel research, pp. 126-130.

Muzellec, L., Ronteau, S., and Lambkin, M. 2015. "Two-sided Internet Platforms: A Business Model Lifecycle Perspective," *Industrial Marketing Management*, (45:1), pp. 139-150.

Ojala, A., and Lyytinen, K. 2018. "Competition Logics during Digital Platform Evolution," In Proceedings of the 51st Hawaii International Conference on System Sciences (HICSS 2018) (pp. 1026-1035). University of Hawai'i at Manoa.

Olleros, F. X. 2008. "The Lean Core in Digital Platforms," *Technovation*, (28:5), pp. 266-276.

Ondrus, J., Gannamaneni, J., and Lyytinen, K. 2015. "The impact of openness on the market potential of multi-sided platforms: a case study of mobile payment platforms", *Journal of Information Technology*, (30:3), pp 260–275.

Ondrus, J. and Lyytinen, K., 2011. Mobile payments market: towards another clash of the titans. Proceedings of the Tenth International Conference of Mobile Business (ICMB).

Ondrus, J., Lyytinen, K., and Pigneur, Y., 2009. Why mobile payments fail? towards a dynamic and multi-perspective explanation. Proceedings of the 42nd Hawaii International Conference on System Sciences, Waikoloa, Hawaii.

Ozer, G. T., and Anderson, E. G,, Jr. 2015. "*Innovation and Breaching Strategies in Multi-Sided Platform Markets: Insights from a Simulation Study*," International Conference on Information Systems, 2015, Forth Worth, Texas, USA.

Pajunen, K. 2008. "The Nature of Organizational Mechanisms," Organization studies, (29:11), pp. 1449-1468.

Parker, G. and van Alstyne, M. 2008. "*Managing Platform Ecosystems*". International Conference on Information Systems, 2008, Proceedings. 53.

Parker, G., van Alstyne, M. and Choudary, S.P. 2016. Platform Revolution: How Networked Markets Are Transforming the Economy and How to Make Them Work for You. NY: WW Norton Company, Inc.

Pawson R. 2000 "Middle-Range Realism," *Archives Européenes de Sociologie*, Vol. XLI pp. 283-325.

Pettigrew, A. M. 1990. "Longitudinal field research on change: Theory and practice," Organization Science (1:3), pp. 267–92.

Poole, M. S., & Van de Ven, A. 2004. Theories of organizational change and innovation processes. In M. S. Poole & A. H. Van de Ven (Eds.), Handbook of organizational change and innovation. New York: Oxford University Press. Chapter 13, pp. 374 – 397.

Ralph, P. and Wand, Y. 2008. "A teleological process theory of software development," Journal of the Association of Information Systems Theory Development Workshop, International Conference on Information Systems (Paris) - 2008.

Romanelli, E., and Tushman., M. 1994. "Organization Transformation as Punctuated Equilibrium." Academy of Management Journal, 37, pp. 1141-1166.

Ruutu, S., Casey, T., and Kotovirta, V. 2017. "Development and competition of digital service platforms: A system dynamics approach," *Technological Forecasting and Social Change*, 117, pp. 119–130.

Rysman, M. 2009. "The Economics of Two-Sided Markets," Journal of Economic Perspectives, (23:3), pp. 125-143.

Saraswat, P. 1988. "A historical perspective on the philosophical foundations of information systems". Retrieved from Foundations of Information Systemson the World Wide Web: http:// www.cba.uh.edu/~parks/fis/saraswat3.htm.

Sayer, A. 2000. Realism and Social Science, Thousand Oaks, CA: Sage Publications Inc.

Sayer, A. 1992. *Method in Social Science: a Realist approach* (2nd ed.), London, UK: Routledge.

Scholten, S., and Scholten, U. 2012. "Platform-based Innovation Management: Directing External Innovational Efforts in Platform Ecosystems," *Journal of the Knowledge Economy*, (3:2), pp. 164-184.

Skjærlund, S. 2016. Swipp og MobilePay dukker op i flere og flere lokale butikker. Can be found at: https://frdb.dk/erhverv/Swipp-og-MobilePay-dukker-op-i-flere-og-flere-lokale-butikker/artikel/89864

Smedlund, A. and Faghankhani, H. 2015. "Platform Orchestration for Efficiency, Development and Innovation," in Proceedings of 48th Hawaii International Conference on System Sciences (HICSS). Annual Hawaii International Conference on System Sciences. Proceedings., IEEE Computer Society, pp. 1380-1388, Annual Hawaii International Conference on System Sciences, United States, 6-9 January. DOI: 10.1109/HICSS.2015.169.

Smith, M. L. 2010. Testable Theory Development for Small-N Studies: Critical realism and Middle-Range Theory. International Journal of Information Technologies and Systems Approach, 3(1):41-56.

Smith, M. L. 2006. "Overcoming Theory-Practice Inconsistencies: Critical Realism and Information Systems Research," *Information & Organization* (16:3), pp. 191-211.

Smith, W. K., and Lewis, M. W. 2011. "Toward a theory of paradox: A dynamic equilibrium model of organizing," *Academy of Management Review*, (36:2), pp. 381-403.

Statista 2016. Percentage of people who use a smartphone in Denmark from 2012 to 2016. Can be found at: https://www.statista.com/statistics/488341/smartphone-penetration-denmark/

Song, P., L. Xue, A. Rai, and C. Zhang. 2018. "The Ecosystem of Software Platform: A Study of Asymmetric Cross-Side Network Effects and Platform Governance," *MIS Quarterly*, (42:1), pp. 121-142.

Tan, B.; Pan, S. L.; Lu, X., and Huang, L. 2015. "The Role of IS Capabilities in the Development of Multi-Sided Platforms: The Digital Ecosystem Strategy of Alibaba.com", *Journal of the Association for Information Systems*, (16:4).

Tan, F. T. C., Tan, B. and Pan, S. L. 2016. "Developing a Leading Digital Multi-sided Platform: Examining IT Affordances and Competitive Actions in Alibaba.com," *Communications of the Association for Information Systems*, (38:36).

Thomas, L.D.W., E. Autio, and Gann, D. M. 2014. "Architectural Leverage: Putting Platforms in Context", The Academy of Management Perspectives, (28:2), pp. 1–28.

Tilson, D., Lyytinen, K., and Sorensen, C. 2010. "Digital Infrastructures: The Missing IS Research Agenda," *Information Systems Research,* (21:4), pp. 748-759.

Tiwana, A. 2015. "Evolutionary Competition in Platform Ecosystems," *Information Systems Research*, (26:2).

Tiwana, A. 2014. Platform ecosystems, Aligning architecture, governance, and strategy. Amsterdam: Morgan Kaufmann.

Tiwana, A., Konsynski, B. and Bush, A. 2010. "Platform Evolution: Coevolution of Platform Architecture, Governance, and Environmental Dynamics," *Information Systems Research*, (21:4).

Tsoukas, H., and Chia, R. 2002. "On Organizational Becoming: Rethinking Organizational Change." *Organization Science* (13:5), pp. 567-582.

Tushman, M. and Romanelli, E. 1985. "Organizational Evolution: A Metamorphosis Model of Convergence and Reorientation." In B. Staw and L. Cummings, *Research in Organizational Behavior*, 7. Greenwich, CT: JAI Press, pp. 171-222.

Um, S. Y. and Yoo, Y. 2016. "T*he Co-Evolution of Digital Ecosystems*" in Proceedings of International Conference on Information Systems, 2016, Dublin, Ireland.

van Alstyne, M. G. G. Parker, and Choudary, S. P. 2016. "Pipelines, Platforms, and the New Rules of Strategy," Harvard Business Review, April 2016.

van de Ven, A. H. 2007. *Engaged Scholarship: A Guide for Organizational and. Social Research*. New York: Oxford University Press.

van de Ven, A. H., and Huber, G. P. 1990. "Longitudinal field research methods for studying processes of organizational change," Organization Science, (1:3), pp. 213–219.

van de Ven. A., and Poole, M.S. 1995. "Explaining Development and Change in Organizations," *Academy of Management Review*, (20: 3), pp. 510-540.

Vincze, Z. 2013. In search of generative mechanism: the grounded theory approach to process theory building. In: Hassett, M., and Paavilainen-Mäntymäki, E. (Eds.) Handbook of longitudinal research methods in organisation and business studies. Cheltenham:UK.

Vogelsang, M. 2010. "Dynamics of two-sided internet markets," *International Economics and Economic Policy*, (7:1), pp. 129-145.

Volkoff, O. and Strong, D.M. 2013. "Critical realism and affordances: Theorizing IT-associated organizational change processes," *MIS Quarterly*, (37:3), pp. 819-834.

von Krogh, G., Nonaka, I., Rechsteiner, L., 2012. "Leadership in Organizational Knowledge Creation: A Review and Framework," *Journal of Management Studies*, (49:1), pp. 240-277.

Wareham, J., P. B. Fox, and Giner, J. L. C. 2014. "Technology Ecosystem Governance," *Organization Science*, (25:4), pp.1195-1215.

Welsch, C., Rumyantseva, M., and Hewerdine, L. J. 2016. "Using Case Research to Reconstruct Concepts," Organizational Research Methods, (19:1), p. 111-130.

Wessel, M., Thies, F., and Benlian, A. 2017. "Opening the Floodgates: The Implications of Increasing Platform Openness in Crowdfunding". *Journal of Information Technology*. 10.1057/s41265-017-0040-z.

West , J., and Wood, D. 2014. "Evolving an Open Ecosystem: The Rise and Fall of the Symbian Platform", in Ron Adner , Joanne E. Oxley , Brian S. Silverman (ed.) Collaboration and Competition in Business Ecosystems (Advances in Strategic Management, Volume 30) Emerald Group Publishing Limited, pp.27 – 67.

Williams, Clay K. and Karahanna, E. 2013. "Causal Explanation in the Coordinating Process: A Critical Realist Case Study of Federated IT Governance Structures," *MIS Quarterly*, (37: 3) pp.933-964.

Woodard, C.J. and Clemons, E. K. 2014. "Modeling the Evolution of Generativity and the Emergence of Digital Ecosystems", ICIS 2014 Proceedings.

Wynn, D. E., Volkoff, O., Williams, C., and Strong, D. M. 2013. "Critical Realism and Mechanisms: Moving from the Philosophical to the Empirical in the Search for Causal Explanations," Panel.

Wynn, D., and Williams, C.K. 2012. "Principles for Conducting Critical Realist Case Study Research in Information Systems," *MIS Quarterly* (36:3), pp 787-810.

Yin, R. K. 2003. Case study research: Design and methods, 3rd Edition. Thousand Oaks, CA: Sage.

Yonatany, M. 2013. A Model of the Platform-Ecosystem Organizational Form. Journal of Organization Design, (2:2), pp. 54-58.

Yoo, Y., Boland, R. J., Lyytinen, K., and Majchrzak, A. 2012. "Organizing for Innovation in the Digitized World," *Organization Science*, (23:5), pp. 1398–1408.

Yoo, Y., Henfridsson, O., and Lyytinen, K. 2010. "The New Organizing Logics of Digital Innovation: An Agenda for Information Systems Research," *Information Systems Research*, (4), pp. 724-735.

Zachariadis, M., Scott, S., and Barrett, M. 2013. "Methodological Implications of Critical Realism for Mixed-Methods Research," MIS Quarterly (37:3), pp. 855-879.

Zhu, F. and Mitzenmacher, M. 2008. "The Evolution of Two-Sided Markets: A Dynamic Model," Harvard Computer Science Group, Technical Report TR-02-10.

Zhu, F. and Furr, N. 2016. "Products to platforms: Making the leap," *Harvard Business Review*, Vol. 94, pp. 73-78. Boston: Harvard Business Review.

X Appendix

Overview of the Platform Literature

Researchers have studied digital platforms and their ecosystems from two different theoretical perspectives, namely economic and engineering (Gawer, 2014; Thomas et al., 2014). Both the economic and engineering research streams emerged in the early 2000s and have developed over the years in parallel. While the economic stream has its roots in network economics (Rochet and Tirole, 2003), the engineering stream stems from product innovation research (Gawer and Cusumano, 2002). Almost two decades after the initial publications, platform research remains dispersed across various fields - from economics, innovation, and organization studies to strategic management and information systems (Wan et al., 2017). The isolated and fragmented development of the research streams has led to different definitions, with emphasis on different characteristics and the investigation of different topics (see, de Reuver et al., 2017).

1.　　Economic Perspective

From economic view, researchers investigate platforms as two-sided (or multi-sided) markets (see, e.g., Bakos, 1998; Caillaud and Jullien, 2001; Evans 2009; Hagiu 2006, 2014; Rochet and Tirole 2003). While two-sided markets have existed for centuries (Evans and Schamalensee, 2010; Hagiu, 2006), in late 1990s researchers from three different fields (payments, information economy and media studies) began to note down the characteristics of this important economic phenomenon (Roson, 2005). The emergence of information economy facilitated by new information technologies led to the rise of electronic marketplaces, where various actors interact to transfer goods and services (Bakos, 1998; Caillaud and Jullien, 2001).

Definition

Building upon early work on markets with network effects (e.g, Shapiro and Varian, 1999), in late 1990s, a number of researchers focused on this new form of intermediation (also referred to as informational or cyber intermediation; see Caillaud and Jullien, 2001), which utilizes technology to "process, select and use information on a population of agents" (ibid, p. 799). In particular, these electronic intermediaries are built around "software platforms" (Evans et al., 2006), who support the functioning of a two-sided (or multi-sided) market. In parallel to this work, researchers investigating the anti-trust regulation of payment cards (see, e.g., Rochet and Tirole, 2003; Wright, 2004) also drew attention to two-sided markets as they concluded that

payment cards, as a form of two-sided markets, exhibit different characteristics, which make traditional anti-trust regulation inapplicable to them (Roson, 2005). Apart from electronic marketplaces or exchanges, researchers also identify other forms of two-sided markets, both physical and digital, such as video games, payment cards, operating systems, social media, newspapers, shopping malls, crowdfunding, and more (Evans et al., 2006; Hagiu, 2006; Rochet and Tirole, 2003; Rysman, 2000), thus extending the scope of the two-sided market literature.

Early research defines two-sided markets in terms of their ability to mediate (or match) the interactions between various types of participants (Bakos, 1998; Caillaud and Jullien, 2001; Kaplan and Sahwney, 2000; Rochet and Tirole, 2004; Roson, 2005). Such broad definition presupposes that all markets characterized by network effects are also two-sided markets. Observing this, Rochet and Tirole (2003) argue that not all markets with network externalities are two-sided and as a result try to narrow the scope of the two-sided market theory. Building upon the literature on network externalities and on multi-product pricing, Rochet and Tirole (2004) offer a definition, which does not look solely at the presence and nature of network effects, but also incorporates pricing structure as key characteristic of two-sided markets. Thus, they define two-sided markets in terms of their ability to "affect the volume of transactions by charging more to one side of the market and reducing the price paid by the other side by an equal amount" (Rochet and Tirole, 2004, p. 40). As a result, when a two-sided market exists, there should be an interdependency between pricing and user participation (Roson, 2005; Wright, 2004).

Although pricing structures are important characteristics of two-sided markets (see, Rochet and Tirole, 2004; 2006), they are not central in later definitions of this phenomenon. Dismissing the existing definitions as characterized by "too excessive specificity, over-inclusiveness, or being too vague to be of use" (p. 4), Hagiu and Wright (2011) try to define multi-sided platforms in opposition to existing business models, such as resellers and suppliers. Considering the presence of network effects and pricing as not sufficiently distinct characteristics of multi-sided platforms, they propose direct interaction and affiliation as two key aspects of multi-sided platforms. Thus, Hagiu and Wright (2011) define multi-sided platforms as facilitating the 'direct interactions among the affiliated to the platform various groups of actors'.

The purpose of multi-sided platforms is to enable the matching between the platform participants (e.g., buyers and sellers), to facilitate the transactions between them in terms of logistics, settlement and curation, and to provide the relevant infrastructure, which includes the rules governing the interactions (Bakos, 1998; Hagiu, 2006; Parker et al., 2016).

Topics

The economic stream of the platform literature deals with a wide variety of topics - from platform pricing and competition to platform design and efficiency, launch and growth strategies and regulation.

Platform Pricing

Building upon network economics, researchers initially focused on studying optimal pricing (Caillaud and Jullien, 2001; Rochet and Tirole 2003; Weyl, 2006). Establishing suitable pricing model is essential as pricing affects usage (Roson, 2005) and constitutes an important mechanism for addressing inter-platform competition (Armstrong, 2006; Roson, 2005; Weyl, 2006). Due to the two-sided (or multi-sided) nature, establishing a pricing strategy for platforms prove to be a difficult task as the pricing model needs to take into account the interdependencies between the platform participants (Hagiu, 2014; Roson, 2005). Platform owners, for example, need to determine carefully which group of participants to subsidize and from which to receive revenue (Evans, 2012; Hagiu, 2014; Rochet and Tirole, 2003). Pricing decisions also require choosing which pricing mechanisms (membership and usage fees) to use given the specific context (e.g., Caillaud and Jullien, 2003; Rochet and Tirole, 2004).

Platform Competition

The economic stream of platform literature also focuses on different forms of competition, such as inter-platform competition (between two or more platforms), intra-platform competition (or competition within platform participants) and competition between platform participants and platform owner (see, e.g. Caillaud and Jullien, 2003; Cennamo and Santalo, 2013; Parker and van Alstyne, 2008; Rochet and Tirole, 2003). Unlike traditional firms, competition in platform context is multidimensional as platform owners can compete with any distinct type of participants (e.g. users and merchants) (Rochet and Tirole 2003, 2006; Roson, 2005; Seamans and Zhu, 2017). In addition, platform owners can rely on a number of responses when facing competition – from aggressive and defensive moves, which intensify competition, to fostering collaboration (Gawer and Henderson, 2007).

Launch and Adoption

Researchers from the economic stream also discuss at large the launch of two-sided markets and their subsequent adoption. To successfully evolve, platform owner needs to achieve a critical mass of participants (Evans, 2009; Evans and Schmalensee, 2010). Depending on the initial platform design, platform owners need to attract either one distinct group of participants (one-sided platforms) or two groups (two-sided platforms) from the onset. In the latter case, the platform owner needs to solve the famous chicken-and-egg problem by getting simultaneously on board all relevant platform actors (e.g., Evans, 2009; Rochet and Tirole, 2003), which proves to be a challenging task. In general, platform adoption is a cumbersome process, influenced by a number of factors, such as network effects, and behaviour and preferences of platform participants (Evans and Schmalensee, 2010).

To encourage initial adoption, platform owners can rely on a number of strategies. For example, instead of trying to coordinate simultaneously two distinct groups of actors, owners can adopt a zig-zag strategy (see,

Evans, 2009), with emphasis on sequential entry of the different groups of participants (Hagiu, 2006). Platform owners can also subsidize platform participants, who provide value for other participants by offering free functionalities and even paying them (Hagiu, 2006; Rochet and Tirole, 2004). Providing information or technical support can also constitute a form of subsidy (Parker and van Alstyne, 2008). Platform owners can also initially develop their platforms by providing their own services until the achievement of critical mass and later let external complementors to innovate (Hagiu and Eisenmann, 2007).

Platform Design, Efficiency and Governance

The economic stream of platform literature investigates the design of two-sided platforms, which is vital for determining the platform's optimal efficiency. Platform design, which purpose is to facilitate the coordination of exchange between platform participants (Evans, 2012), reflects choices about the number and type of platform participants and about the functionalities, which they need in order to derive value from using the platform (Hagiu, 2014).

The specific platform design can both promote and inhibit the optimal functioning of a platform either voluntarily or involuntarily (Evans, 2012). Inappropriate conduct from platform actors, for example, creates negative externalities for other participants and for the platform owner alike by reducing the overall platform value (Evans, 2012). Examples of such externalities are congestion, fraud, misrepresentation, information asymmetry, reduced quality of complementors - all of which jeopardize efficient platform interaction (Evans, 2012; Halaburda and Yekehezel, 2013). At the same time, platform owner can also create more benefits for one distinct group of participants over another as result of its design decisions (that is, including functionalities, which are beneficial only for certain types of platform participants; e.g., layout of shopping mall or magazines) (Evans and Schmalensee, 2016).

While public regulators sanction platform owner's misbehaviour, the latter can prevent and punish the harmful behaviour of the platform participants. Thus, owners can act as 'licensing authority' (Rochet and Tirole, 2004) or 'private regulator' (Boudreau and Hagiu, 2009; Evans, 2012) by setting relevant rules and processes. Apart from pricing tools, platform owners rely on a number of other measures (e.g., 'technical, informational, legal', p. 164) for controlling the access to the platform, the scope of the enabled through it interactions, and the conduct of the platform participants (Boudreau and Hagiu, 2009).

Public Regulation

Researchers point out that due to their specific nature, two-sided markets challenge the boundaries of traditional regulation (Evans, 2012; Hagiu and Rothman, 2016). Early work on anti-trust investigation in the context of payment cards (e.g., interchange fees) (see, Evans, 2002; Roson, 2005) and information economy (e.g., anti-trust investigation against Microsoft) (see, Eisenmann et al., 2006) clearly demonstrates that traditional economic models do not apply to two-sided markets (Evans and Scmalensee, 2016; Rochet and

Tirole, 2003). Platform pricing as a sign of potential market power abuse constitutes one of the key considerations of early anti-trust investigations. Due to the interdependence between distinct groups of actors, platform owner identifies subsidy side, where prices are below marginal costs, at zero or sometimes even negative, and revenue side, to where costs are allocated (Evans, 2003; Roson, 2005).

Apart from pricing decisions, regulators also investigate closely other activities of platform owners and participants alike. As result of their market-making abilities (Evans, 2003), platforms can create new opportunities for certain market actors, while at the same time diminishing the welfare of actors outside the platform ecosystem (e.g., Airbnb and Uber) (see, Hagiu, 2006). Certain measures to maintain platform value creation (such as restricting access or enveloping external complements) can also constitute anti-competitive behaviour (e.g., Parker et al., 2016). Collaborating with external contributors in the form of mergers or in the form of partner agreements preventing participants to compete with an ecosystem's partners may also restrict competition (e.g., Eaton et al., 2015; Evans, 2012).

2.   Engineering Perspective

Early researchers belonging to the engineering perspective focus on studying physical product platforms in the 1990s (see, e.g., Robertson and Ulrich, 1998; Spagnoletti et al., 2015; Wheelwright and Clark, 1992). Initially rooted in the field of industrial innovation management and product development, scholars investigated the process of turning a product into a platform through mainly architectural changes and the opportunities, which such transformation enables. Similar to the economic perspective, the introduction of digitization led to a shift in platform thinking with researchers studying technology platform as assemblage between hardware and software (Boudreau, 2010; 2012) or as software (digital) platforms (see, e.g., de Reuver et al., 2017; Ghazawneh and Henfridsson, 2013; Tiwana, 2014).

Definitions

Different definitions exist within the engineering stream of the platform literature (de Reuver et al., 2017; Gawer, 2014). Early researchers apply the term "platform" to product development. The origin of the term "product platform" traces back to Wheelwright and Clark (1992) who emphasize on the malleable nature of new types of physical products that allow for "easy modification into derivatives through the addition, substitution, or removal of features" (p. 73). Building upon this initial definition, Baldwin and Woodward (2009) define platform as "a set of stable components that supports variety and evolvability in a system by constraining the linkages among the other components" (p. 3).

While these definitions focus on architectural components, some researchers recognize the commonalty with other aspects of the platform. Robertson and Ulrich (1998), for example, define product platform as "collection of assets that are shared by a set of products". These assets encompass components, processes, knowledge, and people and their relations (ibid). While Gawer and Cusumano (2002) retain to some extent the architectural

view as they define platforms as "an evolving system made of interdependent pieces that can each be innovated upon" (p. 2–3), they also emphasize on the importance of various social and organizational elements. In particular, they argue that for a platform to become a platform leader, it needs to focus not only on the architecture of the platform but also on building relations with third-party contributors and on making decisions about the scope of the platform and the structure of the internal organization, which supports it.

Apart from product platforms, Gawer (2009) observes the emergence of different types of platforms. While product platforms exist internally within a firm (internal platforms), supply chain platforms allow for partners in the supply chain to create their own products derived from shared systems. Industry platforms help external firms create their own complementaries by leveraging the core platform provided by one focal firm (Gawer, 2009). As Gawer (2009) points out firms in the industry platforms, unlike supply chain platforms, do not necessarily have any buyer-seller relationship or share ownership. The industry platforms form an ecosystem of firms in order to harness the innovation potential of external complementors.

With the growing importance of digitization, researchers also turned their attention to technology platforms. Boudreau (2010), for example, defines technology platform as including "physical components, tools and rules to facilitate development, a collection of technical standards to support interoperability, or any combination of these things" (p. 1851). Similarly, West and Wood (2013), emphasizing on the role of the technical architecture (see also, West 2003), state the platform owners should provide standardized components in order to ensure the "vibrant supply of third party complements (''software'') that makes a product (''hardware'') more valuable" (p. 28).

The continuous and wide-spread digitization, characterized by convergence of technologies (see, e.g., Yoo et al., 2010) however, blurred the boundary between hardware and software platforms. Thus, researchers later on focused on studying solely digital platforms (or software platforms). Tiwana et al. (2010) define software-based (or digital) platforms as "extensible codebase of a software-based system that provides core functionality shared by the modules that interoperate with it and the interfaces through which they interoperate" (p. 676). In a similar manner, Hanseth and Lyytinen (2010) state that platforms "provide thus a (semi)-closed, and highly complex suite of IT capabilities, which, thanks to the original architecting, can be extended" (p. 4).

Later, researchers building upon the work on industry platforms (see, Gawer, 2009) and software platforms, begin to distinguish between digital platforms and digital platform ecosystems (see, e.g., Ceccagnoli et al., 2012; Eaton et al., 2015; Ghazawneh and Henfridsson, 2013; Tiwana et al., 2010; Tiwana, 2014). Digital platform ecosystems, in particular, consist of the digital platform itself designed, offered and controlled by the platform owners and by a myriad of external to it complements designed, offered and controlled by external complementors (see, e.g., Parker and van Alstyne, 2008; Tiwana, 2014; Yoo et al., 2010).

Topics

Researchers from the engineering perspective concentrate on investigating issues related to platform architecture, platform openness and governance, and platform innovation.

Platform Architecture

Platform architecture is key topic in the engineering stream of the platform literature, with platform architecture being at the centre of all platform definitions (see above). Despite their heterogeneity (internal, supply chain and industry platforms; see Gawer, 2009), Baldwin and Woodward (2009) argue that all types of platforms possess similar architecture, characterized by certain degree of modularity. In particular, they define platform architecture as "a set of stable components that supports variety and evolvability in a system by constraining the linkages among the other components" (Baldwin and Woodward, 2009, p. 3). Extending further this definition, they point out that platform architecture consists of a stable core, which enables the emergence of a large number of complements around it, with the latter forming the platform periphery (Baldwin and Woodward, 2009). A specific design hierarchy, influenced by design rules (Baldwin and Clark, 2000) guides the relations between platform core and periphery. Design rules, for example, prescribe the decomposition of the system to a number of interdependent sub-systems (Baldwin and Clark, 2000; Baldwin and Woodward, 2009). An example of such a design rule is the interface characteristics, which set the interplay between given components in the platform core and periphery (Baldwin and Woodward, 2009).

Yoo et al. (2010), however, state that modular platform architecture largely discards the novel properties afforded by the adoption of digital technologies. In particular, they argue that modularity presupposes fixed platform design, which only leads to incremental scope of platform innovation (Yoo et al., 2010). Instead, they argue for a layered modular architecture, which reflects the design of physical products combined with capabilities delivered by digital technologies (Yoo et al., 2010). Thus, layered modular architecture advocates for taking into account four distinct layers: 'devices, networks, services and contents' (ibid). While modular layered architecture is similar to previous modular architecture in terms of loose coupling between platform core and platform periphery, it also significantly differs in terms of its undetermined product scope, multiple design hierarchies, and universal components utilized by a myriad of heterogeneous firms (ibid). Modular layered architecture, which enables generativity, also stays incomplete unlike modular product architecture, which is predominantly static (ibid).

The majority of the research on digital platforms from the engineering perspective, however, builds upon the modular product architecture combined with generativity instead of concentrating on the layered modular architecture (see, e.g., Gawer, 2014; Tiwana et al., 2010; Tilson et al., 2010; Um and Yoo, 2016). Thus, a digital platform allows for an ecosystem of actors to emerge around it. Boundary resources, such as APIs and SDKs, grant access to core platform functionalities and allow for the building of third-party applications by extending the initial use of the platform core (Ghazawneh and Henfridsson, 2013).

Platform Openness and Governance

Another central topic in the engineering stream of platform literature is platform openness and the implications it has for governance. As discussed below, openness, for example, fosters platform generativity, and thus innovation (see, e.g. Boudreau, 2010; 2012). Similar to platform architecture, platform openness as a concept has transformed over time. Initially researchers refer to platform openness as a general term, which is often defined in opposition to platform closeness (see, e.g., Boudreau, 2010). Later, platform openness became a nuanced and encompassing term (Boudreau, 2010; Parker et al., 2016). West (2003), for example, presents platform openness as a 'continuum' and argues that a platform can never be fully open, or fully closed. Building upon this, Boudreau (2010) proposes that platforms remain partially open as the platform owner retains its ownership and control over key platform components even if the platform is open. He further distinguishes between two types of platform openness, namely allowing access to the platform core and providing access to complements in the platform periphery (ibid). Thus, researchers discuss platform openness in terms of degree or continuum (see also, Benlian et al., 2015; Ondrus et al., 2015). Recently, researchers also try to define platform openness in relation to the interpretaton of external complementors about the level of platform openness. Benlian et al. (2015), for example, treat platform openness as a complex construct consisting of third-party developers' perception about, on one hand, transparency of and accessibility to the platform's core resources, and development and distribution of complements, on the other.

Various governance issues arise as result of the platform owner's decision to open the platform for external participation. Often these issues intensify and turn into conflicts due to the inherent power asymmetry between the platform owner and various platform participants (e.g., third-party complementors, marquee users, etc.). Platform owner, for example, retains ownership over the platform and as result determines the rules of access and participation (Boudreau, 2010; Evans, 2012). This can put other platform participants in less favourable position and jeopardize their own interests (see, e.g., Gawer and Henderson, 2007). Such tensions require the platform owner to carefully manage certain trade-offs. One of the major trade-offs, which platform owner faces, is between nurturing diverse platform participation while retaining sufficient levels of control (Boudreau, 2010). This trade-off is framed in several manners – for example, diversity vs control (Bodreaux, 2010), control vs autonomy (Tiwana, 2014), and control vs generativity (Ghazawneh and Henfridsson, 2013).

Openness presupposes that a platform owner relaxes its tight grip over the platform and share control with other platform participants at different levels (see, Boudreau, 2010; Eisenmann et al., 2009), but this also leads to change in the power asymmetry and also affects the returns for the platform owner (Boudreau, 2010). Apart from jeopardizing the interests of the platform owner, decentralized control can also influence the level of external contribution and hence platform adoption (Ghazawneh and Henfridsson, 2013; Tiwana et al., 2010). High level of control can stifle generativity, while lack of any control spurs disproportionate variety and fragmentation (Gawer and Cusumano, 2002; Yoo et al., 2010). Thus, a platform owner needs to achieve "just-

right" level of control (Tiwana et al., 2010, p. 679; see, also Wareham et al., 2014). On the other hand, Tiwana et al. (2010) study control in opposition to autonomy. They argue that while the platform owner should retain certain level of control, it should also grant autonomy to platform participants by sharing decision rights with them about relevant functionalities and their actual implementation. Thus, platform control becomes distributed across a myriad of platform participants (Tilson et al., 2010). Eisenman et al. (2009), for example, recommend a combined governance regime where the platform owner retains decision rights over the core platform technology, while allows other providers to establish relations with the demand-side and supply-side participants.

Platform Innovation

Platforms serves as "stable nexus or foundation" (Boudreau, 2010, p. 1851) around which external complements emerge, thus fostering platform innovation. The formation of such ecosystem is contingent upon the properties of the platform architecture. A number of researchers point out the differences between innovations enabled by modular architecture and architecture that supports generativity (see, e.g., Yoo, 2013; Um and Yoo, 2016). The difference is mainly in the way architecture is constructed. Both modularity and generativity facilitate innovation through recombination of components (Yoo, 2013). Modularity, however, allows for decomposition of an already completed system, while generativity extends an existing system in an unexpected ways, thus making it incomplete (Yoo, 2013; Yoo et al., 2010).

Instead of innovating on its own, however, platform owners rely on the innovation potential of a myriad of external actors (Ghazawneh and Henfridsson, 2013). Thus, innovation is distributed (Selander et al., 2013; Yoo et al., 2010; Yoo et al., 2012) among actors with heterogeneous knowledge such as third-party content creators and complementors, who may form specific online communities (Yoo et al., 2010). Further, external developers are not one group, but rather encompass various types (heterogeneity) – from freelancers and entrepreneurs to enterprise developers (see, e.g., Selander et al., 2013; West and Wood, 2014). The variety of developers, who have their own interests and capabilities, which can diverge (Almirall and Casadesus-Masanell, 2010; Selander et al., 2013), influences differently their level of participation (Benlian et al., 2015).

References

Almiral E., and Casadesus-Masanell, R. 2010. "Open versus closed innovation: a model of discovery and divergence," *Academy of Management Review*, (25:1), pp. 27-47.

Armstrong, M. 2006. "Competition in two-sided markets," *RAND Journal of Economics* (37:3), pp. 668–691.

Baldwin, C. Y., and Clark, K. (2000). *Design Rules, Vol. 1: The Power of Modularity*, Cambridge, MA:MIT Press.

Baldwin, C. Y., and Woodard, J. C. 2009. "The Architecture of Platforms: A Unified View". In A. Gawer (ed.) Platforms, Markets and Innovation, pp. 19-44.

Bakos, Y. 1998. "The emerging role of electronic marketplaces on the Internet," *Communications of the ACM*, (41:8), pp. 35-42.

Benlian, A., Hilkert, D., and Hess, T. 2015. "How open is this platform? The meaning and measurement of platform openness from the complementors' perspective," *Journal of Information Technology*, 30, pp. 209-228.

Boudreau, K. J. 2012. "Let a Thousand Flowers Bloom? An Early Look at Large Numbers of Software App Developers and Patterns of Innovation," Organization Science (23:5), pp. 1409–1427

Boudreau, K. 2010. Open Platform Strategies and Innovation: Granting Access vs. Devolving Control. *Management Science*, (56:10).

Boudreau, K. and Hagiu, A. 2009. "Platforms Rules: Multi-sided Platforms as Regulators." In A. Gawer (ed.) Platforms, Markets and Innovation. London: Edward Elgar.

Caillaud, B., and Jullien, B. 2003. "Chicken & Egg: competition among intermediation service providers", *Rand Journal of Economics*, 34, pp. 309-328.

Caillaud, B., and Jullien, B. 2001. "Competing Cybermediaries," *European Economic Review*, 45, pp. 797-808.

Ceccagnoli, M., Forman, C., Huang, P., Smith, R. H., and Wu, D. J. (2012). Co-creation of Value in a Platform Ecosystem: The Case of Enterprise Software. *MIS Quarterly*, (36:1), pp. 263-290.

Cennamo C., and Santaló, J. 2013. "Platform competition: strategic trade-offs in platform markets," *Strategic Management Journal*, (34:11), pp. 1331-1350.

de Reuver, M., Sørensen, C., and Basole, R. C. 2017. "The digital platform: a research agenda*." Journal of Information Technology*. ISSN 0268-3962.

Eaton, B., Elaluf-Calderwood, S., Sorensen, C., and Yoo, Y. 2015. "Distributed Tuning of Boundary Resources: The Case of Apple's iOS Service System," *MIS Quarterly*, (39: 1) pp. 217-243.

Eisenmann, T. and Hagiu, A. 2007. "Staging Two-Sided Platforms," Harvard Business School, note no. 808-004.

Eisenmann, T., Parker, G., and van Alstyne, M. 2009. "Opening platforms: How, when and why?" In A. Gawer (Ed.), *Platforms, Markets and Innovation*. Cheltenham, UK: Edward Elgar Publishing Limited.

Eisenmann T, Parker G, and van Alstyne M. 2006. Strategies for two-sided markets. Harvard Business Review, (84:10), pp. 92–101.

Evans, D. S. 2012. "Governing Bad Behavior By Users of Multi-Sided Platforms", *Berkeley Technology Law Journal*, 27:2.

Evans, D. S. 2009. "How Catalysts Ignite: The Economics of Platform-Based Start-Ups," in *Platform, markets and innovation*, A. Gawer (Ed.), London, UK: Edward Elgar.

Evans, D. S. 2003. "The Antitrust Economics of Multi-Sided Platform Markets," Yale Journal on Regulation, (2:2).

Evans, D. S., Hagiu, A. and Schmalensee, R. 2006. Invisible Engines: How Software Platforms Drive Innovation and Transform Industries, Cambridge, MA: The MIT Press.

Evans, D. S. and Schmalensee, R. 2016. *Matchmakers: The New Economics of Multisided Platforms*, Harvard Business Publishing: Boston, Massachusetts, USA.

Evans, D. S., and Schmalensee, R. 2010. "*Failure to Launch: Critical Mass in Platform Businesses*," Review of Network Economics, (9:4).

Gawer, A. 2014. "Bridging differing perspectives on technological platforms: Toward an integrative framework," *Research Policy*, (43:7), pp. 1239–1249.

Gawer, A. 2009. "Platform Dynamics and Strategies; from products to services", In Platforms, Markets and Innovation; Gawer, A., Ed.; Edward Elgar Publishing: Northampton, MA, USA; Northampton, MA, USA, 2009, pp. 45-77.

Gawer, A. and Cusumano M. A. 2002. *Platform Leadership: How Intel, Microsoft, and Cisco Drive Industry Innovation*, Boston, MA, US: Harvard Business School Press.

Gawer, A. and Henderson, R. 2007. "Platform owner entry and innovation in complementary markets: Evidence from Intel," Journal of Economics and Management Strategy, (16:1), pp. 1-34.

Ghazawneh, A. and Henfridsson, O. 2013. "Balancing platform control and external contribution in third-party development: the boundary resources model," Information Systems Journal, (23:2), pp. 173–192.

Hagiu, A. 2014. "Strategic Decisions for Multi-sided Platforms." *MIT Sloan Management Review*, (55:2).

Hagiu, A. 2006. "Multi-Sided Platforms: From Microfoundations to Design and Expansion Strategies," Working Paper 07-094. Harvard Business School.

Hagiu, A. and Wright, J. 2011. "Multi-Sided Platforms," Harvard Business School Working Paper 12-024.

Halaburda, H. and Yehezkel, Y. 2013. "Platform Competition under Asymmetric Information," *American Economic Journal: Microeconomics*, Vol. 5, pp. 22-68.

Hagiu, A. and Rothman, S. 2016. "Network Effects Aren't Enough," Harvard Business Review, April 2016.

Hanseth, O. and Lyytinen, K. 2010. "Design theory for dynamic complexity in information infrastructures: the case of building internet," *Journal of information technology*, (25:1), pp. 1- 19.

Kaplan, S., and Sawhney, M. 2000. "E-Hub: The New B2B Marketplaces," Harvard Business Review, (78:3), pp. 97-103.

Ondrus, J., Gannamaneni, J., and Lyytinen, K. 2015. "The impact of openness on the market potential of multi-sided platforms: a case study of mobile payment platforms", *Journal of Information Technology*, (30:3), pp 260–275.

Parker, G. and van Alstyne, M. 2008. "*Managing Platform Ecosystems*". International Conference on Information Systems, 2008, Proceedings. 53.

Parker, G., van Alstyne, M. and Choudary, S.P. 2016. Platform Revolution: How Networked Markets Are Transforming the Economy and How to Make Them Work for You. NY: WW Norton Company, Inc.

Robertson, D. and Ulrich, K. 1998. "Planning for product platforms," *Sloan Management Review*, (39:4), pp. 19–31.

Rochet, J.-C., Tirole, J., 2006. "Two-sided markets: A progress report," RAND *Journal of Economics* 35, pp. 645-667.

Rochet, J.-C., and Tirole, J. 2004, "Two-Sided Markets: An Overview,", Mimeo, IDEI University of Toulouse. A preliminary version was presented at "The Economics of Two-Sided Markets" conference, held at the University of Toulouse, January.

Rochet, J., and Tirole, J. 2003. "Platform Competition in Two-Sided Markets," *Journal of the European Economic Association*, (1:4), pp. 990-1029.

Roson, R. (2005). "Two-Sided Markets: A Tentative Survey," *Review of Network Economics* (4:2), p 142.

Rysman, M., 2000. "Competition between networks: a study of the market for yellow pages," Boston University mimeo.

Seamans, R., and Zhu, F. 2017. "Repositioning and cost-cutting: The impact of competition on platform strategies," *Strategy Science* (2:2), pp. 83–99.

Selander, L., Henfridsson, O., and Svahn, F. 2013. "Capability Search and Redeem Across Digital Ecosystems," *Journal of Information Technology* (28:3), pp. 183–197.

Shapiro, C. and Varian H. R. 1999. *Information Rules: A Strategic Guide to the Network Economy. Cambridge*, MA: Harvard Business School Press.

Thomas, L.D.W., E. Autio, and Gann, D. M. 2014. "Architectural Leverage: Putting Platforms in Context", The Academy of Management Perspectives, (28:2), pp. 1–28.

Tilson, D., Lyytinen, K., and Sorensen, C. 2010. "Digital Infrastructures: The Missing IS Research Agenda," *Information Systems Research,* (21:4), pp. 748-759.

Tiwana, A. 2014. Platform ecosystems, Aligning architecture, governance, and strategy. Amsterdam: Morgan Kaufmann.

Tiwana, A., Konsynski, B. and Bush, A. 2010. "Platform Evolution: Coevolution of Platform Architecture, Governance, and Environmental Dynamics," *Information Systems Research*, (21:4).

Um, S. Y. and Yoo, Y. 2016. "T*he Co-Evolution of Digital Ecosystems*" in Proceedings of International Conference on Information Systems, 2016, Dublin, Ireland.

Wan, X., Cenamor, J., Parker, G., and Van Alstyne, M. 2017. "Unraveling Platform Strategies: A Review from an Organizational Ambidexterity Perspective." Sustainability, (9:5), pp. 734.

Wareham, J., P. B. Fox, and Giner, J. L. C. 2014. "Technology Ecosystem Governance," *Organization Science*, (25:4), pp.1195-1215.

West, J. 2003. "How open is open enough? Melding proprietary and open source platform strategies," *Research Policy*, 32, pp. 1259-1285.

West , J., and Wood, D. 2014. "Evolving an Open Ecosystem: The Rise and Fall of the Symbian Platform", in Ron Adner , Joanne E. Oxley , Brian S. Silverman (ed.) Collaboration and Competition in Business Ecosystems (Advances in Strategic Management, Volume 30) Emerald Group Publishing Limited, pp.27 – 67.

Weyl, E. G. 2006. "The Price Theory of Two-Sided Markets." Can be retrieved at:
http://economics.uchicago.edu/pdf/Weyl_011507.pdf

Wheelwright, S. C. and Clark, K. B. 1992. "Creating project plans to focus product development," *Harvard Business Review*, (70:2), pp. 67–83.

Wright, J. 2004. "One-sided Logic in Two-sided Markets," *Review of Network Economics*, 3(1), pp. 42—63.

Yoo, Y. 2013. "The Tables Have Turned: How Can the Information Systems Field Contribute to Technology and Innovation Management Research?" *Journal of the Association for Information Systems*, (14:5), pp. 227-236.

Yoo, Y., Boland, R. J., Lyytinen, K., and Majchrzak, A. 2012. "Organizing for Innovation in the Digitized World," *Organization Science*, (23:5), pp. 1398–1408.

Yoo, Y., Henfridsson, O., and Lyytinen, K. 2010. "The New Organizing Logics of Digital Innovation: An Agenda for Information Systems Research," *Information Systems Research*, (4), pp. 724-735.

Paper I: "Toward an Integrated View of Multi-Sided Platform Evolution"

Authors: Staykova, K. S. and Damsgaard, J.

Paper in the Proceedings of the International Conference on Information Systems (ICIS) 2017, Seoul, South Korea.

Towards an Integrated View of Multi-Sided Platforms Evolution

Completed Research Paper

Kalina S. Staykova
Copenhagen Business School
Howitzvej 60, 2000 Frederiksberg
kss.digi@cbs.dk

Jan Damsgaard
Copenhagen Business School
Howitzvej 60, 2000 Frederiksberg
jd.digi@cbs.dk

Abstract

How do Multi-Sided Platforms (MSPs) evolve over time? Although MSPs are perceived as highly evolvable socio-technical systems, Platform Evolution remains an elusive topic in the MSP literature with many unanswered questions. In particular, Platform Evolution (PE) as a concept has not been explicitly defined in the MSP literature. Rather, there is multiplicity of views, which contributes to the lack of conceptual clarity. In order to address this shortcoming, we put forward a new, integrated conceptualization of PE as a complex, multi-faceted and dynamic process. Rather than proposing yet another view on PE, we adopt a "concept reconstruction" approach, which allows us to integrate the existing work on PE in a coherent manner, and to propose a comprehensive conceptualization of PE.

Keywords: Multi-Sided Platforms, Platform Evolution, Hermeneutic Literature Review

Introduction

Multi-Sided Platforms (MSPs), which function as complex socio-technical systems that enable interactions between various affiliated constituencies through developing and managing an underlying infrastructure, have emerged as some of the most powerful and valuable business models around (Hagiu and Wright 2011, 2013). Just consider that sixteen out of the twenty-five most valuable brands for 2014, as pronounced by BrandZ Top 100, function as MSPs (Taube 2014). Yet, despite their increased importance, our knowledge of this phenomenon remains scant as the existing literature on MSPs fails to capture its complexity, with many important problems being understudied (Thomas et al. 2014; Sriram et al. 2014).

Platform Evolution (PE), for example, has remained an elusive topic in the MSP research, with only few models and prescriptions guiding the platform throughout its evolution (Gawer 2014). Although early work on MSPs view platforms as being static, a growing number of researchers recognize MSPs as evolving entities (Eck et al. 2015; Gawer 2014; Smedlund and Faghankhani 2015; Tiwana 2014). Understanding the evolutionary path of MSPs, and the changes, which such a journey brings is of importance in order to ensure the long-term success and survival of MSPs *(*see, e.g., Han and Cho 2015; Smedlund and Faghankhani 2015; Tan et al. 2016). Indeed, as Hagiu (2014) points out MSPs that manage to become successful in the long term are rather a rare phenomenon. Although this is partially attributed to failures in the initial design of MSPs and ill-planned ignition strategies (see, Evans 2009), the platform's inability to evolve over time also influences its vitality (Tiwana 2014).

Despite the importance of this topic, researchers have failed to capture the complexity of PE (Gawer and Cusumano 2007). In particular, PE as a concept has never been explicitly defined in the MSP literature. Rather, scholars have investigated the phenomenon under different terms (e.g., platform development (Ruutu et al. 2017; Watanabe et al. 2017), platform expansion (Hagiu 2006), platform evolution (Tiwana 2014), etc.). They have also studied various aspects of PE in fragmented manner, without providing a comprehensive understanding of MSPs' evolutionary paths. Thus, we formulate the following research question (RQ):

How do MSPs evolve over time?

To address this RQ, we propose a new, integrated conceptualization of PE as a complex, multi-faceted and dynamic process. Rather than introducing yet another view and thus, diluting the concept of PE even further, we aim to "reconstruct" it by limiting the present concept stretching (Welch et al. 2016). To do that, we review the existing research in order to identify the various views on PE and further test empirically whether these perspectives can fully capture the evolutionary path of a MSP. Based on our exhaustive literature review and empirical investigation of exemplary MSPs, we put forward a general model, which, in our view, depicts the essence of PE.

This paper proceeds as follows: First, we outline the theoretical foundations of this paper. We, then, present the methodology we use to carry out our study. As a next step, we introduce the results of the conducted exhaustive literature review and the subsequent empirical investigation of the selected case studies. In the final sections of the paper, we discuss our findings, offer some conclusions and suggest promising areas for further research.

Multi-Sided Platforms

The literature on MSPs has studied platforms from two different theoretical perspectives. Under the economic perspective, MSPs are investigated as two-sided markets (Evans 2009; Hagiu 2006, 2014; Rochet and Tirole 2003). Most of the researchers' efforts in this stream are focused on designing pricing strategies (Rochet and

Tirole 2003, Weyl 2006) and investigating strategies for achieving same-side and cross-side network effect, platform envelopment and platform design (Eisenmann et al. 2011, Evans 2009; Hagiu 2006, 2014). Platforms are also studied as technological architectures (Gawer and Cusumano 2007), which can be modular (Baldwin and Woodard 2009) or layered (Yoo et al. 2012). The technological view on MSPs puts emphasis on investigating the platforms' architecture as consisting of core and periphery (Gawer 2014; Staykova and Damsgaard 2015), the recombination of which facilitates platform innovation (Gawer and Cusumano 2007; Tiwana et al. 2010; Yoo et al. 2012). Researchers belonging to either of the two MSP streams have also delved into common topics such as platform-based ecosystems (Ceccagnoli et al. 2011, Cennamo and Santalo 2013, Isckia and Lescop 2013, Tiwana et al. 2010), platform business models (Eisenmann et al. 2011, Evans 2013, Hagiu 2014, Tiwana 2014) and platform governance (Boudreau and Hagiu 2009; Hagiu 2014; Tiwana 2014). Bridging the economic and technological perspectives on MSPs, Gawer (2014) proposes a new conceptualization of MSPs as evolving organizations or meta-organizations that coordinate multiple agents and are characterized by modular architecture. Building upon this, we investigate MSPs as socio-technical entities, which facilitate the interactions between various affiliated constituencies through developing and managing of an underlying infrastructure (Eaton et al. 2015, Hagiu and Wright 2011).

Method

Concepts are foundational elements of theory creation (Welch et al. 2016) and constitute the "basic unit of thinking" (Sartori 1984, p. 74). They are characterized by certain level of abstraction and thus observable only through set of shared attributes or characteristics (Gerring 1999, Posdakoff et al. 2016, Sartori 1984; Welch et al. 2016). To conceptualize Platform Evolution, we adopt pragmatist-interactionist approach to concept reconstruction, proposed by Welch et al. (2016), which incorporates investigation of the usage of the PE concept in the existing literature and empirical exploration of the manner in which MSPs evolve. While the conducted literature review is used for identifying and clustering the attributes (or characteristics) related to PE, the subsequent empirical investigation is to inquire about the suitability and accuracy with which these attributes portray the complex nature of PE. We also utilize some of the prescriptions put forward from Podsakoff et al. (2016) for identification and analysis of the related to the concept attributes. As a final step, we propose a new definition of the PE concept.

Hermeneutic Literature Review

To identify the existing views on PE, we conduct a hermeneutic literature review, which presents an interactive process consisting of two intertwined phases - "search and acquisition circle" and "analysis and interpretation circle" (Boell and Cecez-Kecmanovic 2014, p. 258). Thus, the analysis of the initially selected articles leads to the identification of new search criteria, which expand the scope of the literature review. Unlike other

approaches (e.g., systematic literature review, see, Levy and Ellis 2006), this approach allows for continuous enrichment of our understanding of the investigated phenomenon though the discovery of new insights (Boell and Cecez-Kecmanovic 2014). Thus, we deem the hermeneutic approach more appropriate due to the multiplicity of views in the MSP literature and due to the complex, multi-faced nature of the PE.

Our initial search strategy consisted of identifying all the relevant articles discussing "platform evolution" in the AIS Library. The analysis of the initially selected articles helped us expand our search strategy by including new keywords (e.g., "platform formation", "platform development", "platform growth", platform expansion", etc.). As the literature on MSPs is spread across various disciplines other than Information Systems (see, Section Multi-Sided Platforms), we also expanded our search by including multiple other databases (ACM Library, EBSCO Host, Emerald Insights, Google Scholar, Oxford, Sage Journals, Science Direct, Scopus, Springer, Taylor and Francis, Web of Science, Wiley). Thus, our literature review entered into a hermeneutic cycle where new keywords and search databases were identified based on ongoing analysis of the selected articles. We terminated our search once we could not identify more articles, which contain different information from the ones already gathered. As a result, we identified 98 articles in total, which provide insights into how MSPs evolve over time. To the best of our knowledge, we consider this literature review to be exhaustive.

We adopted an inductive approach to analyze the gathered data, thus we "allow research findings to emerge from the frequent, dominant, or significant themes inherent in raw data, without the restraints imposed by structured methodologies" (Thomas 2006, p. 238). We first analysed the selected articles using a coding scheme based on the prescriptions set by Welch et al. (2016). As the purpose of the literature review is to investigate the manner in which researchers conceptualize a phenomenon, Welch et al. (2016) recommend that the analysis should focus on investigating how the concept is used (see, View on Evolution, Table 1), what its attributes are (see, Attributes, Table 1), and what theoretical assumptions are made (see, Table 1). Although the authors provide a framework to guide analysis, they do not pose constraints on the process of data interpretation.

Author	View on Evolution	Attributes	Theoretical Assumptions
Gawer (2015)	Shift of platform boundary	Change in the MSP scope and MSP openness	MSPs' boundary shifts in relation to competition and innovation
Inoue and Tsujimoto (2017)	PE as developing a platform-based ecosystem	Adding third-party complementors	Self-reinforcing loop between users and complementors

Table 1. Example of Coding Scheme Adapted from Welch et al. (2016)

We, then, group the identified attributes in several themes based on the observed commonalities among them (Podsakoff et al. 2016). The emerged themes and the associated with them attributes capture the variety of

perspectives (or views) on PE among the researchers in the field. We use further the results from the analysis as a basis for the subsequent empirical investigation.

Attributes	Themes
Number of complementors	
Evolution of boundary resources	Evolution of Platform-Based Ecosystem
Growth of user base	
Critical mass of users	Growth Models

Table 2. Example of Organizing Attributes into Themes (adapted from Podsakoff et al., 2016)

Empirical Investigation Through Case Studies

Case Study research aims at providing in-depth understanding of complex phenomena by allowing researchers to analyze them within their context of emergence and existence (Baxter and Jack 2008), based on collection and detailed analysis of rich data sources (Yin 2003). Thus, case study research is suitable method for empirical investigation of concepts (see more, Podsakoff et al. 2016; Welch et al. 2016).

The selection of specific case studies is guided by the findings of the conducted literature review (see more, Welch et al. 2016). Based on our initial analysis, we adopt a "most-likely" case design (Welch et al. 2016) as we do not find evidence for overlapping of PE with other concepts, but rather for lack of concept clarity, which stems from the presence of multiple (not contradicting) views about the essence of PE (see, below). Thus, we initially hypothesize that all of the identified attributes constitute composition elements of the PE concept. The purpose of the "most-likely" case study is to verify to what extent the outlined attributes capture correctly the complex nature of PE.

Although a single in-depth case study is deemed sufficient (see, Welch et al. 2016), we chose to focus on two case studies in order to strengthen the conclusions we draw from our findings. As Welch et al. (2016) argue the cases, underlining the empirical investigation, should be exemplary and "provide the richest opportunity for questioning existing assumptions about how concepts are constituted" (p. 120). Thus, we select YouTube and Twitter as two exemplary cases of MSPs, which have relatively long and diverse evolutionary paths, and which are often viewed as prominent cases of MSPs (see, e.g., Evans and Schmalensee 2016; Hagiu 2006, etc.). Furthermore, we select YouTube and Twitter as their evolutionary paths cover approximately the same time span (YouTube is founded in 2005, while Twitter is founded in 2006) and both operate as social media platforms.

To conduct our investigation, we rely on large set of secondary qualitative data, which we gathered from official blog posts from the two MSPs. We collected 424 blog posts for Twitter and 346 blog posts for YouTube for the period between their launch and the end of 2016. We construct the evolutionary paths of YouTube and

Twitter as a series of events and we code each one of them based on whether they refer to a certain identified attribute or not. During the data analysis process, we also adopt an open coding as we also look for previously unidentified attributes.

The Concept of Platform Evolution in the Existing Literature

Based on the conducted literature review, we identify 12 distinct views, outlining the manner in which MSP evolve over time (see Table 3). For clarity reasons, we present them in two groups: PE as stage models, which view PE as a continuum, and PE as standalone issues, which focus on studying particular aspects of PE. We also present the attributes associated with each of the views summarized in Table 3. When presenting the attributes, we aim at connecting given set of attributes to specific view as they are found in the literature, even though that may lead to a repetition of some attributes. We reduce this repetition at a later stage for conducting the empirical investigation (compare Table 3 and Table 4). We also adopt the labels of the attributes as the original authors first introduced them. Although this may lead to lack of clarity, we think it is necessary to adhere to the initial wordings, as we do not want to overlook involuntarily a given aspect of PE. The purpose of the literature review and the empirical investigation is to identify the attributes and provide evidence for their accuracy, while the final parts of the paper (see, Discussion) concludes whether they are relevant or not and in what form.

Platform Evolution as Stage Models

A significant part of the MSP literature emphasizes on the nature of PE as a gradual, modular process, which consists of several stages (Miguel and Casado 2016). We identify inductively several PE stage models: growth models, maturity models, transformation models, wide-ranging models and reconfiguration models.

Growth Stage Models

Upholding the evolution-as-growth view, researchers such as Evans (2009), Casey and Töyli (2012), Vogelsang (2010), etc., investigate PE as a model, consisting of several interconnected stages. The first phase encompasses the launch of a platform (Evans 2009) (also known as market entry (Vogelsang (2010) or platform formation (Casey and Töyli 2012)), as well as the initial efforts to attract significant number of platform participants. The pre-condition to transitioning to the next phase of rapid growth (or ignition stage (Evans 2009)) is the achievement of critical mass of users (Evans 2009, Evans and Schmalensee 2010). In a similar manner, Ruutu et al. (2017) argue that until a MSP reaches a critical mass of users, its development is fragmented. If a platform survives, it reinforces positive feedback loops between the different constituencies affiliated to the platform during its next development cycle.

While mostly pre-occupied with investigating the initial growth path of a platform until it reaches a critical mass of users, researchers do not elaborate profoundly on the next stages of PE when critical mass of users is ensured. In his early work, Evans (2009) states that a MSP ignites after it reaches a critical mass of users and eventually achieves a long-term equilibrium. Later, Evans and Pirchio (2014) further refine this model by outlining two possible paths for platform growth in the ignition stage – explosive growth or slow growth, which are both dependent on the presence of strong cross-side network effects. For Eisenmann (2006) and Ruutu et al. (2017), the ultimate goal of any MSP is to establish winner-takes-it-all market by capturing the largest market share. Vogelsang (2010) argues that once a critical mass of users is achieved, a platform can exploit the monopolistic rents (e.g, transaction fees) it has earned and establish a viable business model in order to become profitable. A number of researchers also emphasize on the interdependency between MSP growth and MSP profitability (Bhargava 2014, Cuthbertson et al. 2015).

Maturity Stage Models

MSP's evolutionary journey can be presented as a maturity model, where the platform's main purpose is to reach a certain level of maturity. Researchers view maturity in different manners – from optimal user growth (Zhu and Mitzenmacher 2008) and business model maturity (Muzellec et al. 2015) to diversification of MSP services portfolio through the attraction of third-party complementors (Cennamo and Santaló 2015, Tan et al. 2015).

Muzellec et al. (2015), for example, propose a PE stage model consisting of four stages – embryonic stage, emergent stage, growth stage and maturity. The different stages are characterized by change in the platform's focus from creating value primarily for users during the early stages to shifting to serving business customers in later stages of PE. In the maturity stage, MSP caters to both business customers and users in order to maximize the value that is created through their interactions. This value optimization allows for MSP to establish a profitable business model, which is business oriented.

MSP's maturity can also be measured by the level of achieved user growth. While Zhu and Mitzenmacher (2008) view maturity as market equilibrium where a platform is established as a dominant firm based on its ability to achieve optimal growth rate, Cennamo and Santaló (2015) argue that MSP reaches a maturity level when the growth of its user base decreases. At the same time, Cennamo and Santaló (2015), who distinguish between stages of early and late platform maturity, also argue that the user growth rate is driven by availability of high quality external complementors.

To a certain degree, maturity models can be seen as extension (or spin-off) of the above described growth models. Thus, platforms tend to develop constantly until they reach a certain mature stage of their evolution. Not all platforms, however, can reach maturity as there are numerous examples of platforms, which fail at the initial stages of their development (see, Evans 2016; Hagiu 2014).

Transformation Stage Models

PE is seen as a process of transformation, which changes the nature of the MSP through attracting new types of platform participants (e.g., Gawer and Cusumano 2015, Tan et al. 2015, Yang et al. 2015). Tan et al. (2015) propose a PE stage model, which traces the MSP development from "hub and spoke MSP", to network platform, and finally to symbiotic platform (service providers, buyers, sellers) (more like MSPs). This transformation journey is marked by three separate stages – nascent stage, where a platform is characterized as being two-sided, formative stage and a maturity stage, which is characterized with the introduction of new services offered by complementors. Gawer and Cusumano (2013) argue that internal platforms (platform targeting key users) can evolve to supply-chains (number of suppliers) and then gradually to industry platforms, leveraging a huge network of external complementors.

Wide-Ranging Stage Models

Researchers often deduct a platform evolutionary model based on their investigation of particular cases. The proposed models reflect the characteristics of the specific cases and signal for the diversity of evolutionary paths, which a platform owner can undertake. Thus, rather than focusing on investigating one particular element of PE, these models reconstruct PE as a sum of multiple varied attributes. For example, Leong et al. (2013), who investigate the development of the largest Chinese online ticketing firm, argue that MSP evolves through the introduction of various elements - new features (group-buy feature), website re-organization, introduction of a forum, feedback, polling (community-building), building a distribution system.

Zhu et al. (2016) investigate the evolutionary path of a Chinese online shopping mall, which consist of establishing of logistics and distribution system, geographical expansion to multiple cities, and the establishing of a supply chain for offering of finance service. Han and Cho (2015) view the evolution of the most popular messaging app in South Korea, KakaoTalk as consisting of several phases: expanding to new business domains (service diversification), bundling services, becoming distribution platform and engaging in open innovation (building an ecosystem of actors). Wang et al. (2015) study E-Commerce Platforms suggest that PE encompasses continuous launch of products, multi-channel expansion, multi-brand expansion, and geographical expansion. Constantiou et al. (2016) propose a two-stage evolutionary model based on their study of Airbnb's evolution. During the first stage after the platform launch, Airbnb followed a zig-zag strategy by introducing various features and functionalities in order to attract users and host. In the second phase (augmentation phase), the platform engages in active exploration phase (e.g., introducing new feature and functionalities, horizontal acquisitions, geographical expansion, community building) in order to augment its services.

PE is also investigated as a continuous change across (or re-configuration of) multiple platform dimensions related to the platform itself (e.g., Gawer 2014), its ecosystem of external partners (Ghazawneh and Henfridsson 2011), the technology that supports the platform's offerings (e.g., Tan et al. 2016), and the environment, in which a platform operates (e.g., Tiwana et al. 2010). Gawer (2014), for example, view PE as reconfiguration of various platform elements – organizational forms, capabilities, access to innovative actors, types of governance, degree of interface openness. Kim et al. (2013) investigate the evolutionary path of online social networks as a configuration of three dimensions (technology, suppliers, and users) that change throughout the span of PE. Tiwana et al. (2010) see PE as a co-evolution of platform governance (decision rights, control, and ownership), platform architecture (decomposition, modularity, design rules) and environmental dynamics. Wang et al. (2015) also view PE as co-evolution of various elements - firm entrepreneurial action, organizational agility, digital options, and IT competence.

A significant part of the reconfiguration models put emphasis on the reconfiguration (or evolution) of the technology (or IT) which supports the services enabled through the platform (Hanseth and Lyytinen 2010, Sedera et al. 2016, Tan et al. 2016b, Yang et al. 2015). Tan et al. (2016b), for example, argue that during the initial stages of platform development, developing IT capabilities is not in focus, as platform owner needs to solve issues such as user adoption and achievement of viable business models. As the platform's user base grows in size (and as they face scaling issues, see Furstenau and Auschra 2016), the platform needs to optimize its IT capabilities to support that growth. The establishment of ecosystem of external developers also puts restraints onto the IT resources and requires their further optimization to correspond to the business development of the platform. They argue that during the evolutionary path of the platform, IS capabilities are transformed and sometimes replaced (Tan et al. 2015). Tan et al. (2016a) view PE as a three-stage model, where the MSP and the infrastructure, which supports it, co-evolve: : 1) reinforcing digital platforms – reinforcing digital infrastructure, 2) organizing business ecosystems – reciprocating digital infrastructure, 3) establishing networked community – reproducing digital infrastructure.

Platform Evolution as Standalone Issues

A number of researchers also delve into the topic of platform evolution by investigating standalone issues. Thus, they focus on providing in-depth insights into diverse topics from growth of platform constituencies and the establishment and evolution of platform-based ecosystem to platform entry into geographical markets.

Platform Evolution as the Ability to Grow the MSP's Constituencies

Several researchers, adopting predominantly the economic perspective of MSPs, view PE as the ability of the platform owner to grow the size of its constituencies over time (e.g. see, Casey and Töyli 2012, Chu and Manchanda 2016, Garcia- Swartza and Garcia-Vicente 2015, Ting et al. 2014). The difference between this view and the growth stage model is that the former does not view the MSP growth as a stage-based process, but rather as undetermined process that is dependent on several conditions.

Eisenmann (2006) and Kumar et al. (2010), for example, stress out the importance of achieving rapid growth through the execution of user acquisition strategies. The process of platform growth, which is also referred to as platform diffusion (see, Casey and Töyli 2012), however, requires to grow the size of all of the distinct types of participants affiliated to the platform. Thus, for example, Chu and Manchanda (2016) argue that a MSP grows as it manages to attract increased numbers of both buyers and sellers, while Cennamo and Santalo (2013) argue that platforms evolve through the growth of their installed base (users) and the growth of the external complementors. MSP's growth is driven by the presence of strong same-side (within one group of platform participants) and cross-side (between two or more distinct groups of platform participants) network effects, which create positive feedback loops (Chu and Manchanda 2016, Garcia- Swartza and Garcia-Vicente 2015).

The growth of the MSP's constituencies is also investigated in connection to the establishment and further development of platform-based communities around the different distinct types of platform participants (e.g., users, developers, advertisers, etc.). For example, Leong et al. (2013) and Kyprianou (2015) argue that building a platform-based community constitutes an important part of the platform's evolution path. The establishment of these communities is usually associated with the achievement of a certain level of growth of the platform constituencies. Yang et al. (2015), for example, view the establishment of platform-based community as one of the stages of PE, which occurs when a platform reaches a certain level of maturity. The communities around the various platform constituencies serve the purpose of strengthening the value proposition towards the platform participants. In particular, Constantiou et al. (2016) in their investigation of the evolution of Airbnb identify the building of community as one of the manners in which a platform owner augments its services.

Platform Evolution as a Shift in the Platform Boundary

A number of researchers view PE as a shift of the platform boundary (Gawer 2015, Eisenmann et al. 2011, Um and Yoo 2016). From economic perspective, platform boundary encompasses all the functionalities offered by and through the platform (Eisenmann et al. 2011). Thus, a change in platform boundary is associated with the introduction of new functionalities and features. The stream of platform literature, which views MSPs as modular system, considers the interface as marking the platform boundaries (Gawer 2015). From the technological perspective, the shift in the platform boundary means a change in the degree of platform openness, which is realized through the availability of various APIs and SDKs (Gawer 2015). Thus, for

example, Um and Yoo (2016) view platform boundary as not only encompassing the platform, but also its ever-growing ecosystem of external complementors.

Platform Evolution as Introducing New Features and Functionalities

A number of authors associate PE with introduction of new features and functionalities, which enrich the platform offerings and thus, increase its value proposition to both present and future participants (Edelman 2015, Eisenmann et al. 2011, Evans 2013, Cuthbertson et al. 2015, Davis and Murphy 2002, Leong et al. 2013, Miguel and Casado 2016, Ozer and Anderson 2015, Saarikko 2014, Sen et al. 2011, Scholten 2011, Smedlund and Faghankhani 2015, Song and Wildman 2012). The novel features can be offered by the platform owner itself (see, Ozer and Anderson 2015), or by third-party complementors (see, Smedlund and Faghankhani 2015)).

This view of PE implies that the platforms commence with relatively few core functionalities, which constitute the MSP's main value proposition (Bhargava 2014, Olleros 2008, Gawer and Cusumano 2007, Sen et al. 2011, Staykova and Damsgaard 2015). This minimalistic platform core, hosting relatively few functionalities, gradually expands over time to incorporate variety of novel offerings. Ozer and Anderson (2015), for example, discuss the platform's ability to offer new exploratory features, novel complementary functionalities and a bundle of these features. The new features are introduced to support each of the affiliated to the platform constituencies (see, platform depth (Hagiu 2006); platform range (Staykova and Damsgaard 2016)). MSP can also expand by offering spin-off functionalities, or standalone (additional) platforms in addition to the main platform (e.g., UberEats) (Staykova and Damsgaard 2016, Watanabe et al. 2017).

Ozer and Anderson (2015) argue that platforms cannot survive by solely offering innovative features. Rather, through a process of platform envelopment, a platform can bundle functionalities offered by other platforms operating in adjacent markets into its initial value proposition (Eisenman et al. 2011). A platform can envelop complements, weak substitutes and unrelated platforms (Edelman 2015, Eisenmann et al. 2011, Schiborr 2016), or enter into rival markets in order to attract rivals' users (Bar-Gill 2014, Ozer and Anderson 2015). Similarly, Dietl et al. (2009) discuss "tying of a service supplied in a primary market with another service supplied in a secondary market" (p. 9) as a type of defensive move a platform can adopt if it is simultaneously present in more than one market. In connection to this, Smedlund and Faghankhani (2015) discuss MSP's ability to establish interconnectivity to other MSPs.

Platform Evolution as Development of an Ecosystem of External Complementors

A number of researchers view the emergence, establishment and development of an ecosystem of third-party complementors as stage of the MSPs' evolution (see, e.g., Boudreau and Jeppesen 2015, Gawer and Cusumano 2015). In particuliar, Kim (2016) states that "after building a two-sided market, a business is required to

complete its ecosystem to enable itself to continue its platform business in the market". Smedlund and Faghankhani (2015) upheld the same view by arguing that platform's growth patterns change over time as platform evolves from being focused exclusively on creating and executing platform-centered strategies to developing a robust ecosystem of external complementors.

The development of a robust ecosystem is based on the MSP's ability to attract external complementors (e.g., Ceccagnoli et al. 2012, Inoue and Tsujimoto 2017, Manner et al. 2013, Tiwana et al. 2010, Zhu et al. 2016), which is dependent upon the establishment of generative capabilities (Eck et al. 2015, Holmström 2013). An example of such generative capabilities are technical boundary resources such as APIs and SDKs (e.g., Gawer 2015) and social boundary resources, such as intellectual property rights (IPR) and agreements with third-party complementors (Ghazawneh and Henfridsson 2011). Furthermore, Gawer and Cusumano (2015) argue that the development of robust ecosystem is facilitated by the degree of platform openness (which is connected to APIs) and the modular nature of its architecture, which allows numerous third-party developers to join the platform.

Platform Evolution as Platform Ecosystem Evolution

After a platform-based ecosystem (PBE) is established, the platform and its ecosystem continue to co-evolve (Gawer and Cusumano 2015). Similarly, Isckia and Lescop (2015) also view PE as continuous innovation, which can be provided by both the platform owner and external complementors. Thus, a number of researchers focus on studying the evolution of the platform-based ecosystem itself (e.g., Lee and Hwang 2016, which is primarily associated with the dynamics in the number and quality of external complementors (Inoue and Tsujimoto 2017, Lee and Hwang 2016, Cennamo and Santaló 2015). Studies investigate platform-based ecosystems' emergence, growth and contraction over time in response to various events. Scholten and Scholten (2012) argue that a platform-based ecosystem develops through continuous innovation, renewal and service portfolio optimization, while Lee and Hwang (2016) view the formation of PBE as a process of variance (introducing large number of complementors) and selection (reducing the overall number of external complementors by keeping only those preferred by users). Similarly, Cennamo (2017) argues that although platform owner can benefit from attracting and leveraging a huge network of external complementors during the initial stages of platform evolution, this may lead to market saturation prematurely. As a result, the diversity and the number of third-party complementors can significantly diminish at later stages and this can jeopardize the sustainability of the platform over time.

The development of PBE is dependent upon the degree of platform openness, which also changes over time (Parker and van Alstyne 2008). In particular, the evolution (or change) of the degree of platform openness impacts (West 2003) the evolution of the PBE as it influences the number of complementors, affiliated to the platform (Ondrus et al. 2015). West (2003), for example, argues that platforms can start as being relatively

closed (or proprietary) and later, open up to various degrees. As platform openness is achieved mainly through the availability of boundary resources (e.g., APIs, SDKs), Eaton et al. (2015) investigate the development of PBE through the evolution of boundary resources (e.g., APIs). Um and Yoo (2016) further develop this view in a study, which investigates the PBE evolution through the introduction of external and internal APIs and the interconnectivity among them.

The growth of the PBE is also seen as co-evolution between the platform owner and external developers (Scholten and Scholten 2012). Uphelding that view, Lindgren et al. (2015) study the change in the organization identity caused by the transformation of the relationships between the platform owner and the various actors, who take part of the PBE.

Apart from investigating platform ecosystems as consisting of third-party developers, researchers also view the platform ecosystem in broader terms as encompassing various business partners (that is, not only external complementors). Thus, PBE is also associated with the development of an overall ecosystem of multiple stakeholders around the platform.

Tan et al. (2013), for example, study platform development from the perspective of collaboration with various external partners (e.g., customers, partners, stakeholder, etc.). Based on their empirical-based model, they argue that during the early stages of platform development a MSP is focused in building a critical mass of users and engages in low levels of external collaboration. During the next development stage, a platform owner integrates services by partners to help platform constituencies develop their business (e.g, advisory services offered by third-party experts). The level of collaboration with external partners increases when the platform commences to build capabilities by collaborating with various actors (e.g, offering financial services) and by engaging in value-adding collaborations, which expand the initial value proposition of the platform.

Lihua et al. (2010) also propose an evolutionary model for business ecosystem development consisting of four stages: birth, expansion, coordination/maturity stage and evolution or death. During the birth stage of the business ecosystem, the platform focuses on diversifying its offerings to growing number of users. Thus, the ecosystem consists of the platform, its customers, and various players who supports the functioning of the ecosystem. During the next phase of expansion, various external players join the platform business ecosystem. As the number of partners grows, MSP needs to establish and maintain an array of coordination mechanisms to ensure the vitality of its ecosystem. The evolution stage is associated with the platform's ability to reshuffle its existing ecosystem by abandoning some its key elements in favour to new technologies, products, partners.

Platform Evolution as Entry into Geographical Markets

Entry into geographical markets (or global expansion) constitutes a significantly less researched aspect of PE. Watanabe et al. (2017), for example, investigate Uber's global expansion strategy. They argue that the success

of platform's global expansion strategy is dependent upon "balance of timing, pace, and selection of the host suitable enough to constructing a co-evolutionary acclimatization" (p. 45). Seamans and Zhu (2014) study the Craigslist's entry into several U.S. markets and the impact of this move on the local newspapers industry. Although Seamans and Zhu (2014) do not study PE, their study shows that a platform can evolve by entering various geographical markets.

Platform Evolution as Mergers and Acquisitions

Mergers and acquisitions (M&A) between two or more platforms can also occur throughout the PE (Beschorner 2008; Chandra and Collard-Wexler 2008; Eisenmann, 2006; Evans 2013; Evans and Noel 2008; Miguel and Casado 2016). Although M&A among platforms are primarily investigated from anti-trust perspective (e.g., Evans 2013; Evans and Noel 2008), they also represent the platform's owner efforts to diversify its service portfolio (Beschorner 2008) and strengthen its technological capabilities (Toppenberg et al. 2016). Miguel and Casado (2016), who investigate the evolutionary paths of the GAFA companies (Google, Amazon, Facebook and Apple) also view acquisitions as complementary to the innovation efforts undertaken by the platform owner. Thus, M&A are related to the perspective that platforms evolve through addition of functionalities.

Platform Evolution Views	Attributes	Authors (e.g.)
PE as Stage Models		
Growth Models	Initial growth Critical mass of users Post growth (slow, explosive) Profitability	Evans (2009), Evans and Schmalensee, (2010), Casey and Töyli (2012), Vogelsang (2010), Ruutu et al. (2017)
Maturity Models	Business Model Evolution User growth rate Portfolio optimization by complementors	Cennamo and Santaló (2015), Muzellec et al., (2015), Tan et al. (2015), Zhu and Mitzenmacher (2008)
Transformation Models	Attracting new types of platform participants	Gawer and Cusumano (2015), Tan et al. (2015), Yang et al. (2015)
Wide- Ranging Models	New features, bundling features, building a logistics and distribution system, multi-channel expansion, community-building, geographical expansion, acquisitions, ecosystem	Constantiou et al. (2016), Han and Cho (2015), Leong et al. (2013), Wang et al. (2015)
Reconfiguration Models	Evolution of platform architecture Participants Evolution Ecosystem Evolution Environment Dynamics Evolution Governance Mechanisms Evolution	Gawer (2014), Ghazawneh and Henfridsson (2011), Hanseth and Lyytinen (2010), Sedera et al. (2016), Tan et al. (2016b), Yang et al. (2016).
PE as Standalone Issues		

PE as the ability to grow MSP's user base	Growth of number of MSP participants based on same-side and cross-side effects Building communities around users, developers, partners	Chu and Manchanda (2016), Garcia- Swartza and Garcia-Vicente (2015), Ting et al. (2014), Kyprianou, 2015, Leong et al. (2013), Yang et al. (2015)
PE as a shift in the platform boundary	Introducing new features Degree of platform openness	Gawer (2015), Eisenmann et al. (2011), Um and Yoo (2016)
PE as introducing new features	Core features Complementory features Exploratory features Spin Off products Bundling of features Tying of features Integrating features to third-parties Features for all platform participants Features offered by platform owner Features offered by third-parties	Edelman (2015); Eisenmann et al., (2011), Evans (2013), Cuthbertson et al. (2015), Davis and Murphy (2002), Leong et al. (2013), Miguel and Casado (2016), Ozer and Anderson (2015), Saarikko (2014), Sen et al. (2011), Scholten (2011), Smedlund and Faghankhani (2015), Song and Wildman (2012)
PE as development of an ecosystem	Adding third-party complementors Tech boundary resources (API, SDK) Social boundary resources (IPR, agreements)	Boudreau and Jeppesen (2015), Gawer and Cusumano (2015), Kim (2016), Sen et al. (2011)
PE as Platform Ecosystem Evolution	Quantity of complementors Quality of complementors (governance) Evolution of boundary resources Relationship between MSP owner and complementors External partners (e.g., suppliers, stakeholders, distribution partners, etc.)	Cennamo and Santaló (2015), Inoue and Tsujimoto (2017), Isckia and Lescop (2015), Lee and Hwang (2016), Parker and van Alstyne (2008) Lihua et al. (2010), Tan et al. (2013)
PE as geographical expansion	Entry into new geographical markets	Seamans and Zhu (2014), Watanabe et al. (2017)
PE as mergers and acquisitions (M&A)	M&A of new features M&A of new tech capabilities	Beschorner (2008), Eisenmann (2006), Evans (2013), Evans and Noel (2008), Miguel and Casado (2016)

Table 3. Overview of the Views on PE and Their Attributes

General Notes on Platform Evolution

The analysis of the selected articles confirms the lack of unified, comprehensive view of platform evolution. Rather, researchers tend to label the journey, which MSP undergoes as part of its development (from launch to demise), with various terms: shift of platform boundaries (Gawer 2015), platform maturity (Cennamo and Santalo 2015), platform development (Ruutu et al. 2017, Watanabe et al. 2017), platform expansion (Hagiu 2006), platform evolution (Tiwana 2014), etc. Apart from the existence of multiple labels to denote this

phenomenon, there is also a variety of views on what platform evolution constitutes. Some researchers (see, e.g., Evans 2016) associate it with growing the size of the affiliated to the platform participants and adding new types of platform participants. Other researchers (e.g., Gawer and Cusumano 2014) view platform evolution in terms of adding external complementors who increase the value proposition of the platform. Studies demonstrate that platform evolution is also concerned with the development of the platform itself (e.g., adding new functionalities (e.g., Hagiu 2006), increasing platform openness through the evolution of its boundary resources (e.g., Ghazawneh and Henfridsson 2011), or the development of specific IT capabilities (e.g., Tan et al. 2016b) and the possibilities of M&A (e.g., Beschorner 2008). Different studies emphasize on one or several of these views when discussing platform evolution, but, in reality, platform evolution encompasses to a certain aspect almost all of them (for further discussion, see Empirical Investigation of Exemplary MSPs).

Researchers also outline different reasons, which prompt a MSP to evolve. Variety of factors, either imposed externally, or stemming from internal considerations, drive the evolution of MSPs. The main reason why MSPs evolve is to ensure that they survive, when facing internal and/or external challenges (Han and Cho 2015, Tiwana 2014). Platform's successful existence can come under threat due to environmental changes (Tan et al. 2015) such as imitation of rivals (Smedlund and Faghankhani 2015) or competitors shifts (Eisenmann et al. 2011). Platform owners also engage in subsequent development of their business in order to address internal inefficiencies. In particular, they focus on improving the capabilities of a platform to innovate and strengthen the governance mechanisms needed to operate an ecosystem of external complementors (Gawer 2015).

While MSP evolution is rarely a matter of choice (that is, platforms tend to evolve to one degree or another rather than remain static), a number of authors point out that the decision to evolve or not in a particular direction (e.g., enter complimentary market) is a strategic one (see, Bar-Gill 2014; Bhargava 2014; Gawer 2015; Sen et al. 2011). Thus, platform owners face numerous evolutionary options, which they can choose either to pursue or not to pursue. A number of researchers, however, view PE as being path dependent (Dobusch and Sydow 2011, Song and Wildman 2012, Hanseth and Lyytinen 2010). For example, Dobusch and Sydow (2011) view PE as path dependent phenomenon, characterized by three distinct phases - preformation (path emergence), formation, and lock- in to a specific path. Thus, the emergence of certain path is determined (enabled and restricted) by the strategic choices taken during the earlier stages of platform evolution (see, e.g., Dobush and Sydow 2011; Wang et al. 2015). Path dependency, however, locks the platform to a certain path, which can reduce significantly the number of option available for further evolution (Dobush and Sydow 2011).

The timing of platform evolution (e.g., early or delayed expansion, see Bhargava 2014), is also an important strategic consideration. As MSPs can choose to evolve in multiple ways (Evans 2009, Gawer 2014, Hanseth and Lyytinen 2010), their evolutionary paths will not follow a uniform pattern, but rather they evolve in a

diverse manner. For example, even though Evans (2009) sees platform evolution as a stage model with several distinct phases (see above, Growth Stage Models), he argues that different platforms do not exhibit the same evolutionary path as they adhere to different strategies to achieve critical mass of users (Evans, 2009) and to sustain growth once they manage to ignite (Evans and Pirchio 2015). Thus, different strategies are applied to different stages of the evolutionary path of a particular platform. We argue that platform evolution is a distinct concept from platform strategy as while platform evolution deals with the nature of platform development, platform strategy prescribes how such a development is to be carried out. For example, MSPs tend to evolve as to add external complementors (e.g., Gawer and Cusumano 2014), which constitute a specific instance of platform evolution. This process is associated with a number of strategic decisions such as prescriptions for degree of platform openness (how open a platform should be) and recommendations for exerting the right level of control over the activities of the external complementors. Despite being distinct, the two concepts are clearly interrelated as evident from the example above.

Although the topic of PE has a recent uptake, there are a number of significant gaps in the literature on platform evolution, which needs to be addressed further. Few of the selected studies have PE as their specific subject of investigation, with majority of them focusing on separate issues and processes associated with PE (e.g, acquisitions (see, Toppenberg et al. 2016)). Thus, there is a lack of comprehensive view of what platform evolution constitutes. Few authors also recognize the diversity of evolutionary trajectories, which a MSP can choose to undertake (Gawer 2014), as most of the work focuses on investigating separate modes of evolution in isolated manner (e.g., introducing innovative features, diffusion of innovation, etc.). There is also a lack of research investigating under which conditions certain evolutionary paths emerge and unfold. Topics such as platform evolution through entry into geographical markets and through M&A remain largely under-researched with only few studies addressing limited number of issues. There is also a lack of thorough integration of the two distinct streams in the platform literature (economic and technical) concerning platform evolution.

Empirical Investigation of Exemplary MSPs

The purpose of the empirical investigation is to validate the accuracy with which the above-identified attributes (see Table 3) capture the nature of PE. To do that, we conduct in-depth case studies of two exemplary MSPs – YouTube and Twitter. Our findings, summarized in Table 4, demonstrate that the majority of the identified PE attributes are present throughout the evolutionary paths of the two MSPs (see, YouTube and Twitter). This conclusion illustrates the complex and multi-faceted nature of PE as encompassing numerous, diverse attributes. Thus, none of the identified views on PE (and its attributes) captures in its entirety the actual evolutionary path of a MSP. Rather, the evolutionary path is constructed from a combination of multiple attributes, which span across all the identified views on PE.

While conducting the empirical investigation, we notice that while some of the identified attributes (e.g., acquisitions, introduction of spin off products, etc.) can be observed as events, others, such as critical mass of users, optimal user growth rate, etc., need to be further operationalized. While we argue that they are important for the PE, we could not provide more information about them due to the nature of the data we gathered. We also identify an attribute "building a logistics and distribution system", which although was mentioned by several researchers (e.g, Han and Cho, 2015; Leong et al. (2013)) was not part of the evolutionary paths of both YouTube and Twitter. This does not imply that this attribute is incorrect, but rather that not all MSPs tend to include all identified attributes as part of their evolutionary paths (see below for more details). Thus, we argue that all of the identified attributes are relevant for the conceptualization of PE. We, however, also identify a number of attributes, which are not mentioned in the MSP literature (see, Table 4, section Unidentified). We do not claim that our list of unidentified attributes is exhaustive or representative; rather, we want to point out that despite the existing knowledge, there are still under researched aspects concerning PE. We refer to this point again in the Discussion (see, below).

As PE is a dynamic phenomenon, we also investigate the distribution of attributes across the MSPs' evolutionary paths. For clarity, we choose to present the evolutionary paths of YouTube and Twitter as consisting of three stages of equal time span. This approach is undertaken in order to provide evidence for the presence or absence of various attributes during the different phases of PE as well as to allow for comparison between the evolutionary paths of the two MSPs. The MSP evolutionary path can be characterized as dynamic process throughout which novel attributes are introduced, as existing ones continue to evolve. For example, YouTube launched a spin off products (e.g., Vevo) four years after its inception (see, Table 4), thus adding a new attribute to its PE. At the same time, attributes, introduced during previous stages of PE, continue to evolve over time. Both YouTube and Twitter, for example, continue adding new core and complementary features to their initial value propositions as well as to develop the capabilities of their underlying infrastructures (see, Table 5, Technology Evolution). Thus, different attributes co-evolve and shape together the evolutionary paths of a MSP.

The comparison between the evolutionary paths of YouTube and Twitter indicates that these paths are constructed of similar attributes as the majority of the identified and the unidentified attributes are present (see, Table 5). Some of the attributes, however, are configured differently during the separate stages of PE. For example, after its launch YouTube added advertisers as a third distinct group of MSP participants (after users and developers) during the first phase of its development, while Twitter added advertisers during the second stage of its evolutionary path. The launch of spin-off products in different stages (YouTube in second phase, Twitter in third phase) also confirms this observation.

Attributes	YouTube			Twitter			AirBnb	
Identified	2005 - 2008	2009- 2012	2013- 2016	2005 - 2008	2009 - 2012	2013 - 2016	2008 – 2011	2011- 2014
Growth of participants	X	X	X	X	X	X	X	X
Optimal Growth Rate	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Initial growth	X	-	-	X	-	-	X	-
Critical mass of users	X	-	-	X	-	-	X	-
Post growth	-	X	X	X	X	X	X	X
Business Model Evolution	X	X	X	-	X	-	-	-
Profitability	-	-	-	-	-	-	-	-
New types of MSP participants (other than complementors)	X	-	-	-	X	-	-	-
Building a logistics and distribution system	-	-	-	-	-	-	-	-
Multi-channel expansion	X	X	X	X	X	X	X	X
Evolution of platform architecture (infrastructure)	X	X	X	X	X	X	X	X
Environment Dynamics Evolution	N/A	N/A	N/A			X	X	X
Governance Mechanisms Evolution	X	X	X	X	X	X	X	X
Core features	X	X	X	X	X	X	X	X
Complementory features	X	X	X	X	X	X	X	X
Exploratory features	X	X	X	-	-	X	X	X
Spin Off products	-	X	X	-	-	X	-	-
Envelopment	-	X	X	-	-	X	-	X
Bundling of features	-	-	X	-	-	X	-	-
Integrating features to third-parties	X	X	X	X	X	X	-	-
Features for all platform participants	X	X	X	X	X	X	X	X
Features offered by platform owner	X	X	X	X	X	X	X	X
Features offered by third-parties	-	-	-	X	X	X	-	-
Adding third-party complementors	X	-	-	X	X	X	-	-
Tech boundary resources (API, SDK)	X	X	X	X	X	X	-	-
Social boundary resources (IPR, agreements)	X	X	X	-	X	X	-	-
Growth of complementors	X	X	X	X	X	X	-	-

Governance Mechanisms for complementors	X	X	X	X	X	X	-	-
Boundary Resources Evolution	X	X	X	X	X	X	-	-
Business Ecosystem	X	X	X	X	X	X	X	X
Building community	X	X		X	X	X	X	X
Entry in geographical markets	X	X	X	X	X	X	-	X
M&A for new features		X	X	-	X	X	X	X
M&A for tech capabilities	X	X	X	X	X	X	-	-
Unidentified								
Optimization of features	X	X	X	X	X	X	X	X
Optimization of channels	X	X	X	X	X	X	-	X
Evolution of participants affiliation	-	X	-	X	-	X	X	X
Evolution of spin-off products	-	X	X	-	-	X	-	-
Connectivity between spin-off product and main product	-	X	X	-	-	X	-	-

Table 4. Overview of the Evolutionary Paths of YouTube, Twitter and Airbnb

Despite these differences, the evolutionary paths of YouTube and Twitter exhibit a high level of similarity. To further investigate the presence or absence of similarity across MSP's evolutionary paths, we decide to construct the evolutionary path of another exemplary MSP – Airbnb (see, Table 5). To this end, we utilize exclusively the study conducted by Constantinou et al. (2016), which provides a rich historical account of the Airbnb's evolutionary path from its launch until 2014. As the authors divide Airbnb's evolutionary path in two stages, we adopt this approach for consistency with their data. Furthermore, as we use the case of Airbnb to compare across evolutionary paths rather than across stages of evolutionary paths, the difference between the time span of the stages in comparison to YouTube and Twitters are of no significance.

AirBnb's evolutionary path differs from the evolutionary paths of YouTube and Twitter as it is composed of different configuration of attributes (see, Table 5). In particular, unlike YouTube and Twitter, which initially targeted specifically users, Airbnb was launched as a two-sided platform catering to two distinct types of platform participants (hosts and dwellers). Thus, Airbnb's efforts were concentrated on catering to these two sides from the onset, while YouTube and Twitter both catered initially to their users and gradually added advertisers as new types of platform participants. Airbnb also does not operate an ecosystem of external complementors and does not offer spin-off products. Thus, we find evidence about the presence of various MSP's evolutionary paths, which is consistent with the views of a number of researchers (e.g. Evans, 2009; Gawer, 2014; Hanseth and Lyytinen, 2010). The purpose of this study, however, is not to investigate the

existing types of evolutionary paths, their stages and the attributes, which belong to them. Due to the limited empirical evidence and the lack of comprehensive insights from previous work, we abstain from assigning given attributes to specific evolutionary phases and leave the investigation of this matter for future studies. We, however, used the observed heterogeneity of evolutionary paths to put forward our proposal of PE concept.

Discussion

As none of the identified views on PE captures in its entirety the nature of PE (see Table 5), we deem it necessary to propose an integrated view of MSP evolution as a complex, multi-faceted and dynamic process. The need for conceptualization of PE is further evident from the lack of coherence among the identified attributes associated with certain PE views (see, Table 3). The unsystematic presentation of these attributes as a list, indicating for no correlations among them, combined with the diverse nature of the attributes, cannot itself constitute a conceptualization of PE. Rather, building upon the conducted hermeneutic literature review, the identified attributes and the subsequent empirical investigation of three exemplary case studies, we propose an integrated, comprehensive view on PE.
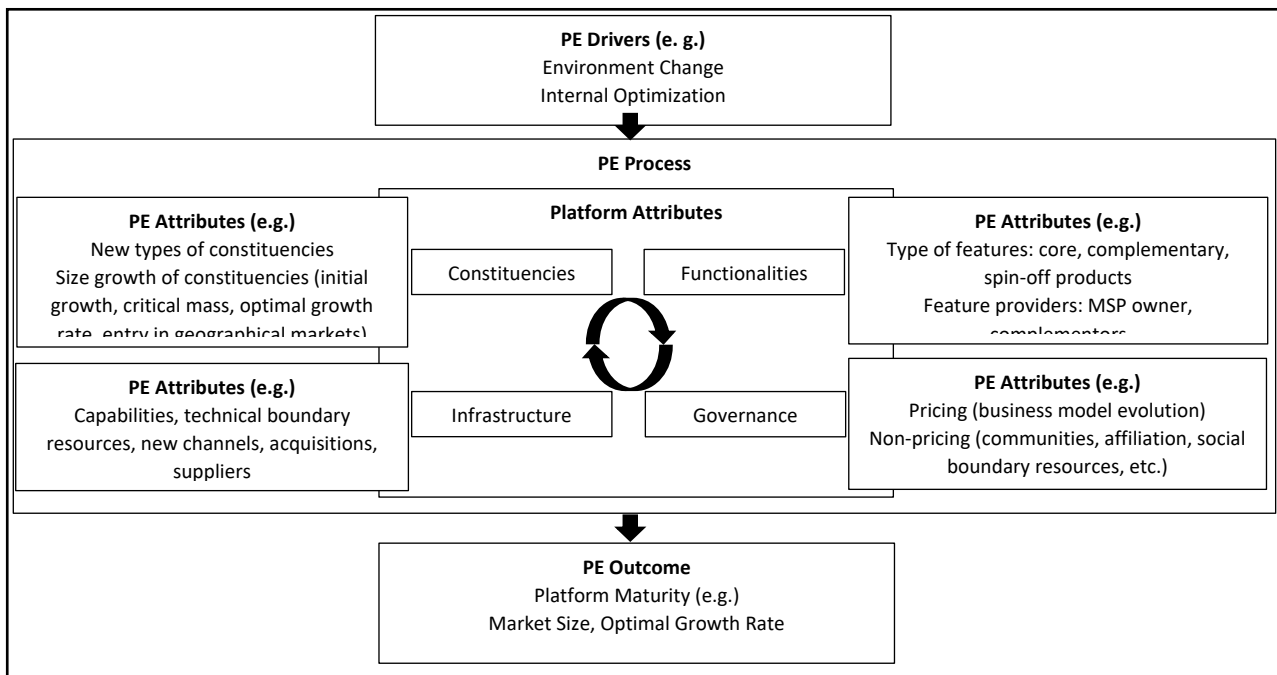
Figure 1. Conceptualization of Platform Evolution

We conceptualize PE as a process of co-evolution of MSP attributes, which is realized through the introduction and subsequent reconfiguration of various Platform Evolution attributes (see, Figure 1). In order to construct this conceptualization, we first draw a distinction between platform attributes (MSP attributes) and Platform Evolution attributes (PE attributes). We base this distinction on the analysis of the evolutionary paths of YouTube, Twitter and Airbnb, which indicates that MSP constituencies, infrastructure, functionalities and

governance regimes, as core characteristics of MSPs, co-evolve over time. For example, YouTube initially catered to one distinct type of platform constituencies (that is, users) and later introduced developers and advertisers as additional platform constituencies. Thus, we argue that the MSP constituencies has evolved in a particular manner. YouTube has also continued to evolve both its infrastructure and its governance regime (see, Table 4). We view these attributes as core characteristics of any MSP rather than PE attributes. That is, all MSPs can be characterized by the affiliated to them constituencies, the activities that those constituencies can engage in and which are enabled by the underlying infrastructure, and the governance regime, which regulates the functioning of the MSP. This conclusion also stems from the definition of MSPs as socio-technical entities (see, Section Multi-Sided Platforms). Researchers have already argued that PE can be presented as co-evolution of various attributes (see, Reconfiguration Model), but there is a lack of a model, which provides comprehensive account of such co-evolution. To address this, we present PE as a process of co-evolution of the core characteristics of MSP (MSP attributes), namely constituencies, infrastructure, functionalities and governance regime. It is important to note that as MSPs attributes co-evolve, there is a certain level of interdependency between them. For example, the introduction of new types of platform participants, such as third-party complementors, which form an ecosystem around the platform, requires a change in its underlying infrastructure and in its governance regime.

Such a general presentation of PE as a co-evolution of MSP attributes, however, does not take into account the observed heterogeneity of MSP evolutionary paths (see, Empirical Investigation of Exemplary MSPs). Furthermore, this approach "black boxes" the evolutionary process and hides the multi-faceted nature of PE (e.g., YouTube's evolutionary paths consists of multiple attributes - change in infrastructure, addition of core, complementary, exploratory features, spin-off products, acquisitions, entry into geographical markets, etc.). While all MSPs are characterized by the presence of MSP attributes, their evolutionary paths vary due to the different configurations of PE attributes (compare YouTube and Airbnb, Table 4). While it is appropriate to view, on a general level, PE as a process of co-evolution of MSP attributes, we argue that the manner, in which these co-evolution is realized is though PE attributes, such as addition or removal of functionalities, opening to third-party complementors, building a community around each of the MSP constituencies, etc. For example, the affiliated to YouTube constituencies (MSP attribute) have evolved through the introduction of new types of platform participants, such as advertisers (PE attribute). In another example, the number of guests on Airbnb grew from 800.000 in 2011 to 3 million in 2012 (Constantinou et al., 2016), thus leading to an increase in the size of each of the platform constituencies (or user growth, which constitutes a PE attribute). Twitter, for example, extended the technical capabilities of its infrastructure (MSP attribute) by acquiring various start-ups (acquisition, which is a PE attribute). Thus, while the MSP attributes point to what changes during the PE, the PE attributes identify how this change is carried out. Due to the limited empirical evidence, identifying an exhaustive list of PE attributes is beyond the scope of this study. The main goal of this paper is to present a general conceptualization of PE, whose operationalization, based on various empirical instances (from which

various PE attributes are identified) is a subject of future studies. We, however, try to demonstrate how some of the identified attributes (see, Table 4) relate to the MSP attributes (see, Figure 1) based on the literature review and empirical investigation. A more thorough revision and classification of the list of identified attributes in Table 4, however, is needed once more empirical data are collected.

We also present PE as a process influenced by certain drivers (PE drivers) and leading towards a certain outcome (PE maturity) (Figure 1). For example, due to the "undeniable need to search and filter" (Twitter, 2008, para 6) (PE driver - internal optimization), Twitter strengthened the technical capabilities of Twitter's infrastructure (Evolution of Infrastructure as Platform Attribute) through the acquisition of Summize (PE – acquisition). Such a representation of PE also stems from the conducted literature review (see, section 4, Platform Evolution as a shift in platform boundary and Maturity Stage Models). Similar to the PE attributes, we do not aim to provide a comprehensive overview of the PE drivers. Rather, we categorize some of the identified attributes as PE drivers. For example, a change in the environment (see, Tiwana, 2014) and the need for internal optimization of the MSPs' capabilities (Gawer, 2015) constitutes such PE drivers rather than PE attributes (see, Table 3, Reconfiguration Models). We apply the same logic to categorize PE outcome. We further argue that PE drivers and PE outcomes as a certain level of maturity remains two understudied topics in the MSP literature.

Conclusion

We contribute to the growing body of literature on MSPs by proposing a comprehensive conceptualization of platform evolution as a complex, multi-faceted and dynamic process. To do that, we build upon the existing fragmented views on PE and conduct further empirical investigation in order to precise the PE concept. We present PE as a process, triggered by various PE drivers and leading towards a certain outcome (Platform Maturity). Furthermore, we provide a general view of PE as co-evolution of platform constituencies, infrastructure, functionalities and governance regime as attributes, common to all MSPs. In order to account for the observed heterogeneity of MSP evolutionary paths, we introduce the notion of PE attributes, which MSPs introduce and re-configure differently. We argue that the evolutionary path of particular MSP is determined by the presence (or absence) of particular PE attributes and their re-configuration throughout the different evolutionary stages.

Our research is not without limitations. We focus on conceptualizing PE, but, although our proposal is based on empirical evidence, we did not verify the validity of the concept more thoroughly. We have also based our empirical investigation on three case studies relying exclusively on secondary data, which can restrict the generalizability of the model and diminish its explanatory powers when it comes to capturing the evolution occurring on all types of MSPs. Thus, although we have selected representative platforms, future work can

focus on studying empirically multiple cases of diverse platforms in order to verify and/or improve the proposed conceptual model of platform evolution.

A fruitful avenue for future research is to adopt Qualitative Comparative Research (QCA) approach, which can be used to outline various configurations of PA and PE attributes and thus, outline various types of evolutionary paths, which platforms can follow. An in-depth case study, which provides a detailed and comprehensive account (that is, including multiple PA and PE attributes) of the evolution of a single platform over time can also be used for further developing the model. Furthermore, due to the lack of sufficient empirical evidence, we abstain from providing an exhaustive list of PE attributes and PE drivers and from discussing them in details. As this is beyond the scope of this study, we leave these issues for future research.

A possible avenue for future research is the full-fledged integration of the different streams of platform literature. Although the proposed model of platform evolution (see, Figure 1) incorporates both perspectives on platforms (economic and technological), future research can improve further the integration of the two literature streams. In particular, an interesting matter for investigation is the interdependencies between the PA elements; for example, how the growth of user base (economic view) poses challenges for the platform technology (technology view) in terms of scaling and future development.

References

Bar-Gill, S. 2014. "*Game of Platforms: Strategic Expansion into Rival (Online) Territory*" Working Paper. Available at: http://questromworld.bu.edu/platformstrategy/files/2014/07/platform2014_submission_17.pdf

Baxter, P. and Jack, S. 2008. "Qualitative Case Study Methodology: Study Design and Implementation for Novice Researchers," *The Qualitative Report*, (13:4), pp. 544-559.

Beschorner, P. F. E. 2008. "*Do Consumers Benefit from Concentration in the New Economy? – A Review of Google's Mergers, Acquisitions, and Arrangements.*" Discussion Paper No. 08-121, 2008.

Bhargava, H. K. 2014. "Platform technologies and network goods: insights on product launch and management," *Information Technology and Management*, (15:3), pp. 199-209.

Boell, S, K. and Cecez-Kecmanovic, D. 2014 "A Hermeneutic Approach for Conducting Literature Reviews and Literature Searches," *Communications of the Association for Information Systems*, (34:12).

Boudreau, K. and A. Hagiu 2009. "Platforms Rules: Multi-sided Platforms as Regulators.", in *Platforms, Markets and Innovation*, Gawer (ed.), London: Edward Elgar.

Boudreau, K., and Jeppesen, L. B. (2015). "Unpaid crowd complementors: The platform network effect mirage," *Strategic Management Journal*, (36:12), pp. 1761–1777.

Casey. T. R., and Töyli, J. 2012. "Dynamics of two-sided platform success and failure: an analysis of public wireless local area access". *Technovation* (32), pp.703–716.

Ceccagnoli, M., Forman, C., Huang, P., Smith, R. H., and Wu, D. J. 2012. "Co-creation of Value in a Platform Ecosystem: The Case of Enterprise Software", *MIS Quarterly*, (36:1), pp. 263-290.

Cennamo, C. 2017. "Building the value of next-generation platforms: The paradox of diminishing returns," *Journal of Management*, Forthcoming.

Cennamo, C., and Santalo, J. 2015. "How to avoid platform traps," *MIT Sloan Management Review*, (51:1), p. 12.

Cennamo, C., and Santalo, J. 2013. "Platform competition: Strategic trade-offs in platform markets," *Strategic Management Journal*, (34:11), pp. 1331-1350.

Chandra, A. and Collard-Wexler, A. 2008. "*Mergers in Two-Sided Markets: An Application to the Canadian Newspaper Industry*". Leonard N. Stern School of Business Working Paper No. EC-07-03

Chu, J. and Manchanda, P. 2016. "Quantifying Cross and Direct Network Effects in Online Consumer-to-Consumer Platforms," *Marketing Science* (35:6).

Constantiou, I., Eaton, B., and Tuunainen, V. K. 2016. "*The Evolution of a Sharing Platform into a Sustainable Business*". Proceedings of the 49th Hawaii International Conference on System Sciences (HICSS 2016).

Cuthbertson, R., Furseth, P.E, and Ezell, S. J. 2015. "Facebook and MySpace: The Importance of Social Networks," in *Innovating in a Service-Driven Economy*, Cuthbertson, R., Furseth, P.E, and Ezell, S. J. (Eds.), London: Palgrave Macmillan UK, pp. 145-158.

Davis, S. J., MacCrisken, J., and Murphy, K. M. 2002 "Economic Perspectives on Software Design: PC Operating Systems and Platforms," in *Microsoft, Antitrust and the New Economy: Selected Essays*, D.S. Evans (Ed.), Springer, pp. 361–419.

Dietl, H., Grütter, A., and Lutzenberger, M. 2009. "Defensive competitive strategies in two-sided markets: The example of the mail industry," *Competition and Regulation in Network Industries*, (10:1), pp. 3-15.

Dobusch, L. and Sydow, J. 2011. "*Path Dependent Platforms: A Process Perspective on Enterprise Ecosystem Governance*," Paper prepared for Workshop "The Role of Platforms for Enterprise Ecosystems" at the 41st annual GI conference INFORMATIK 2011. October 04-07, 2011, Berlin.

Eaton, B., Elaluf-Calderwood, S., Sorensen, C., and Yoo, Y. 2015. "Distributed Tuning of Boundary Resources: The Case of Apple's iOS Service System," *MIS Quarterly*, (39: 1) pp. 217-243.

Eck, A., Uebernickel, F., and Walter, B. 2015. "*The Generative Capacity of Digital Artifacts: A Mapping of the Field*". PACIS 2015 Proceedings. 231.

Edelman, B. 2015. "How to Launch Your Digital Platform," *Harvard Business Review*, April 2015, pp. 90-97.

Eisenmann, T. 2006. "Internet companies' growth strategies: determinants of investment intensity and long-term performance," *Strategic Management Journal*, (27:12), pp. 1183–1204.

Eisenmann, T., Geoffrey P., and van Alstyne, M. 2011. "Platform envelopment," *Strategic Management Journal*, (32:12), pp. 1270-1285.

Evans, D. S. 2013. "*Economics of Vertical Restraints for Multi-Sided Platforms*," Research Paper No. 626, University of Chicago Institute for Law & Economics Olin.

Evans, D. S. 2009. "How Catalysts Ignite: The Economics of Platform-Based Start-Ups," in *Platform, markets and innovation*, A. Gawer (Ed.), London, UK: Edward Elgar.

Evans, D. S. and Noel, M. D. 2008. "The Analysis of Mergers that Involve Multisided Platform Businesses," *Journal of Competition Law and Economics*, (4:3), pp. 663-695.

Evans, D, and Pirchio, A. 2015. "*An Empirical Examination of Why Mobile Money Schemes Ignite in Some Developing Countries but Flounder in Most*," Coase-Sandor Working Paper Series in Law and Economics No. 723.

Evans, D. S. and Schmalensee, R. 2016. *Matchmakers: The New Economics of Multisided Platforms*, Harvard Business Publishing: Boston, Massachusetts, USA.

Evans, D. S., and Schmalensee, R. 2010. "*Failure to Launch: Critical Mass in Platform Businesses*," Review of Network Economics, (9:4).

Furstenau, D. and Auschra, C. 2016. "*Open Digital Platforms in Health Care: Implementation and Scaling Strategies*," International Conference on Information Systems, 2016, Dublin, Ireland.

Garcia-Swartza, D. D., and Garcia-Vicente, F. 2015. "Network effects on the iPhone platform: An empirical examination," *Telecommunications Policy*, (39:10), pp. 877–895.

Gawer, A. 2015. "*What Drives Shifts in Platform Boundaries: An Organizational Perspective,*" Conference Paper, DRUID Summer Conference, Copenhagen, Copenhagen Business School, Denmark.

Gawer, A. 2014. "Bridging differing perspectives on technological platforms: Toward an integrative framework," *Research Policy*, (43:7), pp. 1239–1249.

Gawer, A. and Cusumano, M. A. 2015. "Business Platforms," *International Encyclopedia of the Social & Behavioral Sciences* (Second Edition), pp. 37-42.

Gawer, A., and Cusumano, M. A. 2014. "Industry platforms and ecosystem innovation," *Journal of Product Innovation Management*, (31:3), pp. 417-433.

Gawer, A., and Cusumano, M. 2007. "*A strategy toolkit for platform leader wannabes*," Conference Paper, DRUID Summer Conference on Appropriability, Proximity, Routines and Innovation, Copenhagen, Copenhagen Business School, Denmark.

Gerring, J. 1999. "What makes a concept good?: An integrated framework for understanding concept formation in the social sciences," *Polity*, 31, pp. 357-393.

Ghazawneh, A., and Henfridsson, O. 2011. "*Micro-strategizing in platform ecosystems: a multiple case study*," Thirty Second International Conference on Information Systems (ICIS), Shanghai.

Hanseth, O. and K. Lyytinen 2010. "Design theory for dynamic complexity in information infrastructures: the case of building internet," *Journal of Information Technology*, (25:1), pp. 1- 19. doi: 10.1057/jit.2009.19.

Hagiu, A. 2014. "Strategic Decisions for Multi-sided Platforms." *MIT Sloan Management Review*, (55:2).

Hagiu, A. 2006. "*Multi-Sided Platforms: From Microfoundations to Design and Expansion Strategies*," Working Paper 07-094. Harvard Business School.

Hagiu, A. and J. Wright 2013. "Do You Really Want to Be an eBay?," *Harvard Business Review*, (91:3), pp. 102–108.

Hagiu, A. and J. Wright 2011. "Multi-Sided Platforms," Harvard Business School Working Paper 12-024.

Han, J. and Cho, O. J. 2015. "Platform business Eco-model evolution: case study on KakaoTalk in Korea". *Journal of Open Innovation: Technology, Market, and Complexity*, (1:6).

Holmström, J. 2013. "On the Shoulders of Giants: Understanding Internet-based Generative Platforms", in *The Immersive Internet*, Robin Teigland and Dominic Power (Eds.), Palgrave Macmillan UK, pp 204-213.

Isckia, T., and Lescop, D. 2015. "Strategizing in Platform-based ecosystems: Leveraging Core Processes for Continuous Innovation," *Communications & Strategies*, (1:99), pp. 91-111.

Isckia, T., and Lescop, D. 2013. "Platform-based ecosystems: Leveraging Network-Centric Innovation", in *Understanding Business Ecosystems: How firms succeed in the new world of convergence*, S. B. Letaifa, A. Gratacap and T. Isckia (Eds.), Brussels: De Boeck.

Inoue, Y. and Tsujimoto, M. 2017. "New market development of platform ecosystems: A case study of the Nintendo Wii," *Technological Forecasting and Social Change*, In Press, Available online from January 2017.

Kim, J. 2016. "The platform business model and business ecosystem: quality management and revenue structures," *European Planning Studies*, (24:12), pp. 2113-2132.

Kim, J, Leem, C., Kim, B., and Cheon, Y. 2013. "Evolution of Online Social Networks: A Conceptual Framework," *Asian Social Science*, (9:4).

Kumar, R., Lifshits, Y., and A. Tomkins 2010. "*Evolution of two-sided markets*," in Third ACM International Conference on Web Search and Data Mining (WSDM '10), New York, NY, USA, Feb. 2010.

Kyprianou, C. 2015. "*Community-Building Strategies in Peer-to-Peer Marketplaces*," Working Paper. Available at: https://cdn.questromworld.bu.edu/platformstrategy/files/2015/06/platform2015_submission_21.pdf

Lee, C., and Hwang, J. 2016. "*The influence of giant platform on content diversity. Technological Forecasting and Social Change*," In Press, Corrected Proof, Available online 15 December 2016.

Leong, M. L., Pan, S. L., and Huang, J. 2013. "*Towards A Two-Sided Online Platform: The Case Of China's Largest Online Ticketing Firm*," European Conference on Information Systems, 2013.

Levy, Y., and Ellis, T. J. 2006. "A Systems Approach to Conduct an Effective Literature Review in Support of Information Systems Research," *Informing Science Journal*, 9, pp. 181–212.

Lihua, H., Hu, G., and Lu, X. 2010. "E-business Ecosystem and its Evolutionary Path: The Case of the Alibaba Group in China," *Pacific Asia Journal of the Association for Information Systems*, (4:3).

Lindgren, R., Eriksson, O., Lyytinen, K. 2015. "Managing identity tensions during mobile ecosystem evolution," *Journal of Information Technology*, (30:3), pp 229–244.

Manner, J., Nienaber, D., Schermann, M., and Krcmar, H. 2013. "*Six Principles for Governing Mobile Platforms*". Wirtschaftsinformatik Proceedings 2013. 86. http://aisel.aisnet.org/wi2013/86

Miguel, J.C, and Casado, M.A. 2016. "GAFAnomy (Google, Amazon, Facebook and Apple): The Big Four and the b-Ecosystem," in *Dynamics of Big Internet Industry Groups and Future Trends*, Gómez Uranga, Mikel, Zabala-Iturriagagoitia, Jon Mikel, Barrutia Guenaga, Jon (Eds.), Springer International Publishing, pp. 127-148.

Muzellec, L., Ronteau, S., and Lambkin, M. 2015. "Two-sided Internet Platforms: A Business Model Lifecycle Perspective," *Industrial Marketing Management*, (45:1), pp. 139-150.

Olleros, F. X. 2008. "The Lean Core in Digital Platforms," *Technovation*, (28:5), pp. 266-276.

Ozer, G. T., and Anderson, E. G,, Jr. 2015. "*Innovation and Breaching Strategies in Multi-Sided Platform Markets: Insights from a Simulation Study*," International Conference on Information Systems, 2015, Forth Worth, Texas, USA.

Parker, G. and van Alstyne, M. 2008. "*Managing Platform Ecosystems*". International Conference on Information Systems, 2008, Proceedings. 53.

Podsakoff, P., MacKenzie, S., and Podsakoff, N. 2016. "Recommendations for creating better concept definitions in the organizational, behavioral, and social sciences," *Organizational Research Methods*, (19:2), pp. 159-203.

Rochet, J., and Tirole, J. 2003. "Platform Competition in Two-Sided Markets," *Journal of the European Economic Association*, (1:4), pp. 990-1029.

Ruutu, S., Casey, T., and Kotovirta, V. 2017. "Development and competition of digital service platforms: A system dynamics approach," *Technological Forecasting and Social Change*, 117, pp. 119–130.

Saarikko T. 2014. "Here Today, Here Tomorrow: Considering Options Theory in Digital Platform Development," in *Creating Value for All Through IT*, Bergvall-Kåreborn B., Nielsen P.A. (Eds.), TDIT 2014. IFIP Advances in Information and Communication Technology, vol 429. Springer, Berlin, Heidelberg.

Sartori, G. 1984. "Guidelines for concept analysis," in *Social science concepts: A systematic analysis*, G. Sartori (Ed.), Beverly Hills, CA: Sage Publications, pp. 15-85.

Seamans, R., and Zhu, F. 2013. "Responses to Entry in Multi-Sided Markets: The Impact of Craigslist on Local Newspapers," *Management Science*, (60:2).

Sedera, D., Lokuge, S., Grover, V., Sarker, S., and Sarker, S. 2016. "Innovating with enterprise systems and digital platforms: A contingent resource-based theory view," *Information & Management*, (53:3), pp. 366-379.

Sen, S. Guerin, R. and Hosanagar, K. 2011. "Functionality-rich versus minimalist platforms: a two-sided market analysis," *ACM SIGCOMM Computer Communication Review*, (41:5), pp. 36-43.

Scholten, S. 2011. "*Platform-based Innovation Management A Framework to Manage Open Innovation in Two-sided Platform Businesses*," Dissertation.

Scholten, S., and Scholten, U. 2012. "Platform-based Innovation Management: Directing External Innovational Efforts in Platform Ecosystems," *Journal of the Knowledge Economy*, (3:2), pp. 164-184.

Schiborr, L. A. 2016. "*How to emerge as a digital platform leader? Envelopment and business model innovation at eBay and Amazon (2006-2011),*" Master's Thesis. Available at: http://essay.utwente.nl/71344/1/Schiborr_BA_BMS.pdf

Shao, T., Lu, P., and Liu, Z. 2014. "*The impact of firm's network on the growth of e-commerce platform*," in Proceedings of Pacific-Asia Conference on Information Systems 58. http://aisel.aisnet.org/pacis2014/58

Smedlund, A. and Faghankhani, H. 2015. "*Platform Orchestration for Efficiency, Development and Innovation*," in Proceedings of 48th Hawaii International Conference on System Sciences (HICSS). Annual Hawaii International Conference on System Sciences. Proceedings., IEEE Computer Society, pp. 1380-1388, Annual Hawaii International Conference on System Sciences, United States, 6-9 January. DOI: 10.1109/HICSS.2015.169.

Song, S. Y., and Wildman, S. S. 2013. "Evolution of Strategy and Commercial Relationships for Social Media Platforms: The Case of YouTube," in *Handbook of Social Media Management Value Chain and Business Models in Changing Media Markets*, Mike Friedrichsen, and Wolfgang Mühl-Benninghaus (Eds.), Berlin, Heidelberg: Springer Berlin Heidelberg, pp. 619-632.

Sriram, S., Manchanda, P., Bravo, M. E., Chu, J., Ma, L., Song, M., Shriver, S., and Subramanian, U. 2014. "*Platforms: A Multiplicity of Research Opportunities*". Research Paper. Can be found at: https://www0.gsb.columbia.edu/mygsb/faculty/research/pubfiles/6257/Platforms_033114.pdf

Staykova, K. S., and Damsgaard, J. 2016. "*Platform Constellations: The case of KakaoTalk and LINE*," in Proceedings of Pacific-Asia Conference on Information Systems 286. http://aisel.aisnet.org/pacis2016/286

Staykova, K., and Damsgaard, J. 2015. "*A Typology Of Multi-Sided Platforms: The Core and the Periphery*," in Proceedings of the 23rd European Conference on Information Systems (ECIS 2015), Münster, Germany.

Tan, F. T.C., Pan, S. L., and Liu, J.U. 2016a. "*Towards a Self-Organizing Digital Business Ecosystem: Examining IT-Enabled Boundary Spanning Practice of China's LeEco*," in Proceedings of International Conference on Information Systems, 2016, Dublin, Ireland.

Tan, F. T. C., Tan, B. and Pan, S. L. 2016b. "Developing a Leading Digital Multi-sided Platform: Examining IT Affordances and Competitive Actions in Alibaba.com," *Communications of the Association for Information Systems*, (38:36).

Tan, B.; Pan, S. L.; Lu, X., and Huang, L. 2015. "The Role of IS Capabilities in the Development of Multi-Sided Platforms: The Digital Ecosystem Strategy of Alibaba.com", *Journal of the Association for Information Systems*, (16:4).

Tan, F. T. C, Tan, B., and Pan, S. P. 2013. "*Interdependencies and Collaborative Action for Platform Leadership: A Comparative Analysis of Two Leading Chinese Multi-Sided Digital Platforms*," in Proceedings of Pacific-Asian Conference on Information Systems, 32.

Taube, A. 2014. "The 20 Most Valuable Brands In The World," *Business Insider*, Can be found at: http://www.businessinsider.com/the-20-most-valuable-brands-in-the-world-2014-   5?op=1#ixzz3KMHUTYmY (visited on 23/10/2014).

Thomas, D. 2006. "A General Inductive Approach for Analyzing Qualitative Evaluation Data," *American Journal of Evaluation*, 27, pp. 237-246. http://dx.doi.org/10.1177/1098214005283748.

Thomas, L. D. W., Autio, E., and Gann, D. 2011. "*Architectural leverage: putting platforms in context*," Paper presented at DRUID 2011 on INNOVATION, STRATEGY, and STRUCTURE - Organizations, Institutions, Systems and Regions. Copenhagen Business School, Denmark, June 15-17, 2011.

Tiwana, A. 2014. *Platform ecosystems, Aligning architecture, governance, and strategy*. Amsterdam: Morgan Kaufmann.

Tiwana, A., Konsynski, B. and Bush, A. 2010. "Platform Evolution: Coevolution of Platform Architecture, Governance, and Environmental Dynamics," *Information Systems Research*, (21:4).

Toppenberg, G., Henningsson, S., Eaton, B. 2016. "*Reinventing the Platform Core Through Acquisition: A Case Study*," in Proceedings of the 49th Hawaii International Conference on System Sciences (HICSS 2016). ed. / Tung Bui; Ralph H. Sprague, Jr.Loa Alamitos, CA : IEEE, 2016. p. 4634-4643 (Annual Hawaii International Conference on System Sciences. Proceedings, Vol. 2016).

Twitter 2008. "*Finding A Perfect Match*," Official Blog Post. Available at: https://blog.twitter.com/2008/finding-a-perfect-match

Um, S. Y. and Yoo, Y. 2016. "T*he Co-Evolution of Digital Ecosystems*" in Proceedings of International Conference on Information Systems, 2016, Dublin, Ireland.

Vogelsang, M. 2010. "Dynamics of two-sided internet markets," *International Economics and Economic Policy*, (7:1), pp. 129-145.

Wang, S., Li, P., and Wang, Y. 2015. "*How do IT Competence, Organizational Agility and Entrepreneurial Actions Coevolve:The Case of Entrepreneurial Etailers on Ecommerce Platforms*," in WHICEB 2015 Proceedings. 17.

Watanabe, C., Naveed, K., Neittaanmäki, P., and Fox, B. 2017. "Consolidated challenge to social demand for resilient platforms-lessons from Uber's global expansion," *Technology in Society*, 48, p. 33.

Welsch, C., Rumyantseva, M., and Hewerdine, L. J. 2016. "Using Case Research to Reconstruct Concepts," *Organizational Research Methods*, (19:1), p. 111-130.

West, J. 2003. "How open is open enough? Melding proprietary and open source platform strategies," *Research Policy*, 32, pp. 1259-1285.

Weyl, E. G. 2006. "*The Price Theory of Two-Sided Markets*". Can be retrieved at: http://economics.uchicago.edu/pdf/Weyl_011507.pdf

Yang, N., Ouyang, T., Hu, J., and Zeng; D. 2015. "*The Strategy of E-Commerce Platform Based on the Perspective of Resource Orchestration: A Case Study of Haier*," In Proceedings of the 22nd International Conference on Industrial Engineering and Engineering Management 2015, pp 629-637.

Yin, R. K. 2003. *Case study research: Design and methods*, 3rd Edition. Thousand Oaks, CA: Sage.

Yoo, Y., Boland, R. J., Lyytinen, K., and Majchrzak, A. 2012. "Organizing for Innovation in the Digitized World," *Organization Science*, (23:5), pp. 1398–1408.

Zhu, X., Song, B., Ni, Y., Ren, Y., and Li, R. 2016. "Platforms—From the One-Sided Market to the One-Sided + Two-Sided Market," in *Business Trends in the Digital Era*, Zhu, X., Song, B., Ni, Y., Ren, Y., Li, R., Springer Singapore, pp. 43-61.

Paper II Generative Mechanisms for Digital Platform Ecosystem Evolution: A Punctuated Equilibrium Theory

Authors: Staykova, K., S., Mathiassen, L., Rai, A., and Damsgaard, J.

Generative Mechanisms for Digital Platform Ecosystem Evolution: A Punctuated Equilibrium Theory

Kalina S. Staykova, Department of Digitalization, Copenhagen Business School, Denmark

Lars Mathiassen, CEPRIN, Georgia State University, USA

Arun Rai, CEPRIN, Georgia State University, USA

Jan Damsgaard, Department of Digitalization, Copenhagen Business School, Denmark

Abstract

Previous studies present digital platform ecosystems as highly evolvable socio-technical arrangements that need to rapidly develop and adapt to ensure long-term sustainability. However, rather than account for and explain the triggers and mechanisms, which shape this complex process, current research provides largely descriptive accounts of digital platform ecosystem evolution with findings distributed across studies. Against that backdrop, we combine the notion of Generative Mechanism with Punctuated Equilibrium Theory to analyze the evolution of a digital payment platform ecosystem from the initial creation of the platform to market leadership. As a result, we offer a comprehensive account of the triggering events and generative mechanisms that drove the evolutionary path of this ecosystem. Based on these empirical insights and extant literature, we advance theory to explain how external and internal events trigger reinforcing and transforming generative mechanisms to shape digital platform ecosystem evolution.

Introduction

Some of today's most successful businesses such as Airbnb, Google and Facebook are at the centre of digital platform ecosystems with multiple participants that interact enabled by the underlying platform architecture (Hagiu and Wright, 2011; Tiwana, 2014; Parker et al., 2016). Despite their growing economic importance and significant entrepreneurial attempts to discover successful platform business models, prosperous digital platform ecosystems remain a rare find (Hagiu, 2014; van Alstyne et al., 2016). Most ecosystems fail due to inappropriate initial platform design (Hagiu, 2006), ill-designed ignition strategies (Evans, 2009), and early focus on profitability rather than growth (Hagiu and Rothman, 2016; van Alstyne et al., 2016). Even when digital platform ecosystems ignite (Datee et al., 2017; Ojala and Lyytinen, 2018), their long-term survival may come under threat because of inability to rapidly develop and adapt in response to frequent changes in external and internal circumstances (Tiwana, 2014; van Alstyne et al., 2016).

Against that backdrop, it is not surprising that there is a growing number of studies on digital platform ecosystem evolution. Some studies focus on specific evolutionary outcomes, such as growth (Evans, 2009), variety of complementors (Ghazawneh and Henfridsson, 2013), or market dominance (Eisenmann et al., 2006); others offer descriptive stage models of platform evolution (Evans, 2009; Evans and Schmalensee, 2010; Tan et al., 2016); there are also studies that investigate how changes in platform context lead to certain evolutionary outcomes (Datee et al., 2017; Eaton et al., 2015; Gawer, 2009; Ojala and Lyytinen, 2018; Tan et al., 2015; Tiwana et al., 2010). However, extant research is mostly descriptive with findings distributed across individual studies, suffering from two major weaknesses. First, it does not fully account for the events that trigger digital platform ecosystem evolution (Gawer, 2015; de Reuver et al., 2017). Second, it does not conceptualize the generative mechanisms that shape digital platform ecosystem evolution in response to external and internal events (Ojala and Lyytinen, 2018). As such, we lack theory that explains why and how digital platform ecosystems follow different evolutionary trajectories that leads to certain outcomes.

To address this important gap, we ask the following research question: *How do triggering events and generative mechanisms drive the evolution of digital platform ecosystems?* Our goal is to advance theory by combining the notion of Generative Mechanism (Bhaskar, 1975; Henfridsson and Bygstad, 2013) with Punctuated Equilibrium Theory as expression of the evolutionary change paradigm (Gersick, 1991; Van de Ven and Poole, 1995). Empirically, we rely on a four-year longitudinal study of a prominent digital payment platform ecosystem to trace its evolutionary path from platform launch to market domination. As a result, we integrate and extend current knowledge into a theory, which differentiates between transforming and reinforcing generative mechanisms, which collectively drive digital platform ecosystem evolution. The theory offers insights into the evolution of digital platform ecosystems, which can help platform owners and other actors respond appropriately to the critical external and internal events they face.

Our argument proceeds as follows. First, we summarize existing perspectives on digital platform ecosystem evolution. We then present the theoretical framework we use to guide our empirical analysis and theory development. Subsequently, we outline our methodology, introduce the case study, and present the findings from the empirical inquiry. Finally, we combine these findings with extant literature to advance theory that explains how triggering events and generative mechanisms drive digital platform ecosystem evolution.

Literature Background

Digital platform ecosystems constitute a specific research stream within the broad literature on ecosystems (Adner, 2017; Datee et al., 2017; Jacobides et al., 2018; Tsujimoto et al., 2017). Tsujimoto et al. (2017) identify platform ecosystems as one of four streams, along with industrial ecology, business ecosystems and multi-actor networks. Like Gawer and Cusumano (2014), they view platform ecosystems as a specific subset of business ecosystems that in addition to business organizations involve platform users and platform developers as key actors. Similarly, Jacobides et al. (2018) present three research streams that include business

ecosystems, innovation ecosystems and platform ecosystems. Adner (2017) identifies overlaps between the different streams and points out that it is important to move beyond ecosystem affiliations and instead investigate the value-creating activities that various actors perform.

Digital platform ecosystems have been investigated by scholars from different fields including management, strategy, industry economics, information systems, and innovation (Constantinides et al., 2018; Datee et al., 2017; Gawer, 2009; Jacobides et al., 2018; Parker et al., 2016; Thomas et al., 2014; Tiwana, 2014; Wareham et al., 2014). Because of this fragmentation, researchers have emphasized different characteristics, such as actors (Constantinides et al., 2018; Parker and Van Alstyne, 2008;), architecture (Datee et al., 2017; Thomas et al., 2014; Tiwana et al., 2014; Wareham et al., 2014) and governance (Huber et al., 2017; Kapoor and Agarwal, 2017).

Moreover, as most studies focus on one characteristic (e.g., actors in Constantinides et al., 2018), or combinations of two characteristics (e.g., architecture and governance in Tiwana, 2014), there is a lack of studies that consider all these major characteristics of digital platform ecosystems (Gawer, 2014; Thomas et al., 2014). To address this, we integrate them and present digital platform ecosystems as highly evolvable socio-technical arrangements (Constantinides et al., 2018; de Reuver et al., 2017; Gawer, 2014; Tiwana, 2014) that orchestrate interactions between various actors (van Alstyne et al., 2016) through modular architectures (Baldwin and Woodward, 2009) and emergent governance regimes (Boudreau and Hagiu, 2009).

As foundation for our empirical investigation and theorizing, we have identified three dominant perspectives on the evolution of digital platform ecosystems in the literature, namely growth, co-evolution and competition. In the following, we elaborate on each of these perspectives.

Growth Perspective. Early studies focus on the initial formation and subsequent development of digital platforms from a growth perspective, typically proposing stage models, in which reaching a critical mass of actors is a pre-condition for platform survival (Casey and Töyli, 2012; Evans, 2009; Evans and Schmalensee, 2010). After initial ignition (Evans, 2009), a digital platform can enter a period of slow growth or continue to grow at a rapid pace (Evans and Pirchio, 2014). During this stage, digital platform ecosystems expand by including not only more actors but also new types of actors (Evans, 2009; Hagiu, 2006).

Extending this perspective, scholars identify enablers and constraints of sustainable growth. While strong cross-side network effects enable sustained growth (Evans and Schmalensee, 2010), various constraints, such as ill-designed pricing and revenue sharing strategies (Casey and Toyli, 2010, Volelsang, 2010), under-developed alliance strategy (Casey and Toyli, 2010) and limited platform access (Ondrus et al., 2015, Ruutu et al., 2017), can inhibit growth. Overall, platform owners seek growth rates that help establish a winner-takes-all or winner-takes-most market (Eisenmann et al., 2006; Ruutu et al., 2017), after which growth rates typically decrease (Cennamo and Santaló, 2015). Although research into this mature stage of growth is limited, digital

platform ecosystems usually experience fluctuations in the number of actors as choices of end-users and platform owners may lead to reduction in external complementors (Boudreau and Jespersen, 2015; Inoue and Tsujimoto, 2017).

Co-evolution Perspective. Building upon early research on evolvability of digital platforms (Baldwin and Woodward, 2009), Tiwana et al. (2010) argue that digital platform ecosystems develop through co-evolution of architecture and governance in response to environmental dynamics. Ghazawneh and Henfridsson (2013) adopt a similar view to study co-evolution of platform generativity, which spurs variety of complements, and platform control. On one hand, they argue that platform owners can increase the generativity of the ecosystem by introducing boundary resources (architecture) through a process of resourcing. On the other hand, increased openness towards external complementors can undermine the owner's position and may require the introduction of stricter rules for accessing and using boundary resources (governance) through a process of controlling. External complementors can then either accommodate or reject the introduced changes through a co-creation process of tuning, which in turn affects the evolution of boundary resources (Eaton et al., 2015).

Elaborating the co-evolution perspective further, researchers investigate platform generativity and the variety of external complements it spurs. Woodward and Clemons (2014), for example, argue that generativity results in variety of complements, which evolve in an endogenous manner with no specific interference from platform owners. Similarly, Um et al. (2016) argue that changes in boundary resources such as APIs drive platform generativity, although such interventions may not always result in increased variety of external complements.

Other researchers investigate variations of external complements in relation to governance. Tiwana (2015), for example, studies the evolution of third-party complements, arguing that platform owners can accelerate platform evolution (through variety) by leveraging input control and modularizing architecture. Along the same lines, Wareham et al. (2014) suggest that platform owners can rely on variety-increasing mechanisms, which promote different complements and nurture autonomy of third-party complementors, and on variety-decreasing mechanisms, which ensure standardization and thus, strengthen platform owner control.

Moving beyond architecture and governance, researchers have pointed out that actors evolve when architecture changes (Ojala and Lyytinen, 2018; West and Wood, 2014) and that groups of actors (e.g., users and complementors) may co-evolve and adapt to each other over time (Song et al., 2018). Further, Tan et al. (2015), propose a three-stage co-evolutionary model of information systems capabilities and business strategies across the nascent, formative and mature stages of platform ecosystem evolution; Tan et al. (2016) trace the co-evolution of IT affordances, platform configuration and competitive strategies; and recently, Ojala and Lyytinen (2018) focus on the interactions between architecture, governance, actors and environment during the evolution of a digital platform ecosystem.

Competition Perspective. Moving to a competition perspective, researchers have started to outline strategies that platform owners can follow during ecosystem formation and expansion to gain a favourable market position. During the initial formation stage, researchers recommend creating a strong value proposition (Hagiu, 2006; Gawer and Cusumano, 2014) while postponing decisions about which specific direction to pursue because of high environmental uncertainty (Datee et al., 2017). At later stages, as the digital platform expands, Hagiu (2006) advises owners to balance carefully platform depth (addition of new functionalities) and breadth (inclusion of new types of actors). Gawer and Cusumano (2014) argue that ecosystem evolution eventually becomes a matter of competitive survival. At this stage, platform owners should strive to become market leaders by adopting a tipping strategy that encompasses bundling of features, offering unique features and expanding into rival markets (Eisenmann et al., 2006; Eisenman et al. 2011). Ozer and Anderson (2015) argue that, to succeed, such strategies require combination with other innovation initiatives.

Despite these different perspectives and the growing number of studies on digital platform ecosystem evolution, current research is limited in two important ways. First, it focuses mainly on identifying various evolutionary outcomes (e.g., growth, variety of complementors, market dominance), while failing to fully account for the events that trigger digital platform ecosystem evolution (Gawer, 2015; de Reuver et al., 2017; Ojala and Lyytinen, 2018). Although current research identifies several triggering events, the findings remain dispersed across studies without theoretical explanation of how they lead to various evolutionary outcomes. Digital platform ecosystems may, for example, evolve when threatened by external events (Baldwin and Woodard, 2009; Tan et al., 2015; Tiwana, 2014), such as imitation moves by rivals (Smedlund and Faghankhani, 2015), shifts in competitive dynamics (Eisenmann et al., 2011) and regulatory changes (Evans, 2012; Hagiu and Rothman, 2016). At the same time, various internal events, such as release of platform versions in response to customer needs, architectural modifications that accommodate technological innovations, preventing loss of platform control (Gawer, 2009) and alterations in actors' expectations (West and Wood, 2014), may also trigger changes in digital platform ecosystem evolution.

Second, current research does not conceptually account for the mechanisms that shape digital platform ecosystem evolution in response to external and internal triggering events (Ojala and Lyytinen, 2018). Although Henfridsson and Bygstad (2013) study generative mechanisms in the general context of digital infrastructures, there is a lack of studies that specifically conceptualize such mechanisms in the context of digital platform ecosystems. Different researchers have identified several generative mechanisms through which platform ecosystems respond to external and internal events, such as information system affordances (Tan et al., 2016), distributed tuning (Eaton et al., 2015), asymmetric influence mechanism (Song et al., 2018) and value influence mechanisms (Wareham et al., 2014). However, these insights remain largely fragmented without conceptual foundation that can help explain how generative mechanisms shape evolutionary trajectories. Due to the constantly evolving and disruptive nature of digital platform ecosystems, we expect

some mechanisms, such as engaging more actors of similar type or adding platform features to support existing actors, will reinforce current evolutionary trajectories, while other mechanisms, such as engaging new types of actors or adding new types of platform features to enter new markets, will radically change current trajectories.

In response to these shortcomings in extant literature, we combine Punctuated Equilibrium Theory (Gersick, 1991; Lyytinen and Newman, 2008) with the notion of Generative Mechanism (Henfridsson and Bygstad, 2013) to advance theory on the triggers and mechanisms that shape digital platform ecosystem evolution. As such, we build on two fundamental assumptions: 1) that some generative mechanisms will reinforce while others will cause radical changes in the evolutionary trajectory (Gersick, 1991; Lyytinen and Newman, 2008), and 2) that similar generative mechanisms can produce different outcomes depending on the events that trigger them and the context in which they unfold (Henfridsson and Bygstad, 2013).

Theoretical Framework

Previous studies, which have conceptualized generative mechanisms for studying the evolution of complex socio-technical systems, such as digital infrastructures (Henfridsson and Bygstad, 2013), have not considered the punctuated nature of the triggering events, which set these mechanisms in motion. Thus, while we build upon this conceptualization of generative mechanisms to study the evolution of digital platform ecosystems as another example of complex socio-technical systems, we turn to Punctuated Equilibrium Theory to understand the impact of triggering events on the evolutionary trajectory (Gersick, 1991). Moreover, although Punctuated Equilibrium Theory considers the underlying generative mechanisms (Van de Ven and Poole, 1995), studies that apply it to investigate changes in socio-technical systems (Lyytinen and Newman, 2008) do not zoom in on generative mechanisms as drivers of change. Thus, drawing on the punctuated nature of triggering events for causing socio-technical change (Lyytinen and Newman, 2008) and on the role of generative mechanisms in shaping such change (Henfridsson and Bygstad, 2013), we combine these two lenses into one theoretical framework to investigate and explain evolution of digital platform ecosystems (Table 1 and Table 2).

Punctuated Equilibrium Theory states that socio-technical systems evolve through relatively long periods of stability, followed by shorter periods of rapid and pervasive change, which destabilize the existing deep structure (Gersick, 1991; Romanelli and Tushman, 1994; Tushman and Romanelli, 1985; Street and Denford, 2012; Street and Meister, 2004). To drive the change process and to produce various change outcomes (Liechtenstein et al., 2006; Romanelli and Tushman, 1994; Van de Ven and Poole, 1995), Punctuated Equilibrium Theory relies on generative mechanisms as causal structures, which account for the ongoing reinforcement and transformation in a system's deep structure (Bunge, 2004; Van de Ven and Poole, 1995).

The deep structure of complex socio-technical systems is a highly durable configuration of elements from various system dimensions (Gersick, 1991; Lyytinen and Newman, 2008; Wollin, 1999), which remain

unchanged during periods of stability (Street and Denford, 2012). Building upon the literature on digital platform ecosystems, we define the deep structure of a digital platform ecosystem as a configuration of actors, architecture and governance at a specific stage of its evolution. The deep structure reflects the choices made by the owner and other participants about the platform and its usage (Gersick, 1991). In Table 1, we conceptualize the main dimensions of a digital platform ecosystem, namely actors, architecture, and governance, and their corresponding sub-constructs. The deep structure is then a specific configuration of these dimensions, which remain unchanged during a stable period of platform ecosystem evolution.

There are three categories of actors, which play different roles. The platform user role can be mapped into two categories: demand-side actors, or those that use platform services, and supply-side actors, or those that provide services through the platform (Eisenman et al., 2008; Evans, 2012; Hagiu and Rothman, 2016; Ondrus et al., 2015). The platform owner role retains ownership of the platform and control over its development and participation in its ecosystem (Eisenmann et al., 2008; Parker et al., 2016). The ownership of the digital platform can be shared among several actors (Eisenman et al., 2008). While platform owners often initially assume the role of platform providers, other providers can join later and possibly obtain ownership over time (Eisenmann et al., 2008; Ondrus et al., 2015; Parker et al., 2016). Finally, the platform provider role contributes to the production (e.g., technology providers) of the platform and distribution (e.g., distribution partners) of its services (Eisenmann et al., 2008; Gawer and Cusumano, 2014; Ondrus et al., 2015, Tiwana, 2014).

Table 1. Conceptualization of Digital Platform Ecosystem				
Concept	*Definition*	*Construct*	*Definition*	*References*
Actors	The heterogeneous actors involved in a digital platform ecosystem	Platform User	Demand-side actors that use services on a digital platform and supply-side actors that provide services through a digital platform	Eisenmann et al., 2008; Evans, 2012; Gawer and Cusumano, 2014; Hagiu, 2016; Ondrus et al., 2015; Parker et al., 2016; Tiwana, 2014
		Platform Owner	Actors who retain ownership of the platform and control its development and participation in its ecosystem	
		Platform Provider	Actors who participate in the production of a digital platform and distribution of its services	
Architecture	The structuring of a digital platform's core, periphery and boundary resources	Platform Core	Main functionalities of a digital platform provided through its software and hardware	Baldwin and Woddward, 2009; Eaton et al., 2015; Gawer and Cusumano, 2014; Ghazawneh and Henfridsson, 2013;
		Platform Periphery	Additional functionalities related to a digital platform provided through modules developed by external developers	
		Boundary Resources	Software tools that provide interconnectivity and	

			interoperability between a digital platform's core and periphery	Tiwana, 2014;
Governance	The rules that regulate membership, conduct, and value appropriation in a digital platform ecosystem	Access Rules	Rules defining membership of actors in a digital platform ecosystem	Boudreau and Hagiu, 2009; Evans, 2016; Parker et al., 2016; Tiwana, 2014
		Participation Rules	Rules defining the permissible activities by heterogeneous actors of a digital platform ecosystem	
		Appropriation Rules	Rules governing distribution of created value between actors in a digital platform ecosystem	

The architecture represents the structuring of its core, periphery and boundary resources (Baldwin and Woodward, 2009; Gawer, 2014; Gawer and Cusumano, 2014; Tiwana et al., 2010; Tiwana, 2014). The platform core encompasses the main functionalities provided through software and hardware (Olleros, 2008; Tiwana et al., 2010; Tiwana, 2014). Initially, the core consists of a limited number of key functionalities, which make the platform scalable (Olleros, 2008). External service modules provide additional functionalities around the core to form the platform periphery (Baldwin and Woodward, 2009; Olleros, 2008; Tiwana, 2014). A digital platform's boundary resources are software tools (e.g., APIs) that ensure interconnectivity and interoperability between the core and its periphery (Ghazawneh and Henfridsson, 2013; Um and Yoo, 2016).

The governance refers to the collection of rules that regulate membership, conduct, and value appropriation in a digital platform ecosystem. Access rules define membership of actors (Boudreau and Hagiu, 2009). As heterogeneous actors with diverse interests become part of the ecosystem, the platform owner imposes strict participation rules that define permissible actions (Boudreau and Hagiu, 2009; Parker et al., 2016). The goal is to nurture productive interactions and to minimize undesirable activities that could undermine value creation (Boudreau and Hagiu, 2009). Appropriation rules govern distribution of created value between actors in a digital platform ecosystem and, as such, regulate the relations between platform owners and other participants. These rules usually encompass revenue sharing agreements, ownership agreements including intellectual property rights, division of responsibilities, decision rights, and more (Evans and Schmalensee, 2016; Hagiu, 2014; Parker et al., 2016; Tiwana, 2014). Platform owners rely on "contractual, technical and informational instruments" (Boudreau and Hagiu, 2009, p. 3) to enforce and maintain the governance regime.

When an appropriate configuration of actors, architecture and governance is established in relation to its environment, the deep structure of a digital platform ecosystem enters a period of stability (Gersick, 1991; Street and Denford, 2012). However, various external and internal events may challenge the established configuration and trigger transformation towards a new deep structure (Table 2). Accumulated internal inefficiencies, such as congestion of supply-side actors, and exogenous shocks, such as entry of new

competitors or introduction of a new technology standard, that challenge the current ecosystem's deep structure are examples of such triggering events (Gersick, 1991). Many change triggers may be accommodated within the deep structure, thus reinforcing the period of stability (Lyytinen and Newman, 2008; Romanelli and Tushman, 1994). Some events, however, can have significant, disruptive impact on the established deep structure and as a result throw the digital platform ecosystem in a state of flux (Gersick, 1991; Street and Denford, 2012; Wollin, 1999). When facing such disruptive events, the established configuration can no longer guarantee the efficient functioning of the digital platform ecosystem (Gersick, 1991; Lyytinen and Newman, 2008; Street and Denford, 2012; Street and Meister, 2004). As result, the digital platform ecosystem enters a period of transformation (Gersick, 1991).

Table 2. Conceptualization of Digital Platform Ecosystem Evolution	
Platform Evolution	The ongoing changes in a digital platform ecosystem in relation to its actors, architecture and governance
Deep Structure	A sustained configuration of actors, architecture and governance during a stable period of ecosystem evolution
Change Trigger	An external event that challenges the current configuration of the ecosystem or an internal event that creates a misfit between the configuration of the ecosystem and the environment, thereby challenging the performance of the ecosystem
Generative Mechanism	Latent deep structure properties (related to one or more of a platform ecosystem's actors, architecture and governance) that can be activated to change the ecosystem.
Transforming Mechanism	Mechanism that leads to radical change in the deep structure of a digital platform ecosystem
Reinforcing Mechanism	Mechanism that leads to incremental adjustment of a digital platform ecosystem without affecting its deep structure
Change Outcome	A change in the properties of a digital platform ecosystem (related to one or more of its actors, architecture and governance) in response to a change trigger

Regardless of whether the digital platform ecosystem transforms or sustains, change triggers can activate one or several generative mechanisms as a context-specific response (Bunge, 2004; Pawson and Tilley, 2009) (Figure 1). Generative mechanisms are latent deep structure properties related to one or more of an ecosystem's actors, architecture and governance, which, when activated, drive a change process in the digital platform ecosystem (Hedström and Swedberg, 1998; Henfridsson and Bygstad, 2013). The latent properties of the existing deep structure enable or constrain the socio-technical activities, which interact to produce change outcomes (Hedström and Swedberg, 1998; Henfridsson and Bygstad, 2013). These outcomes in turn impact the existing constitution of the deep structure.
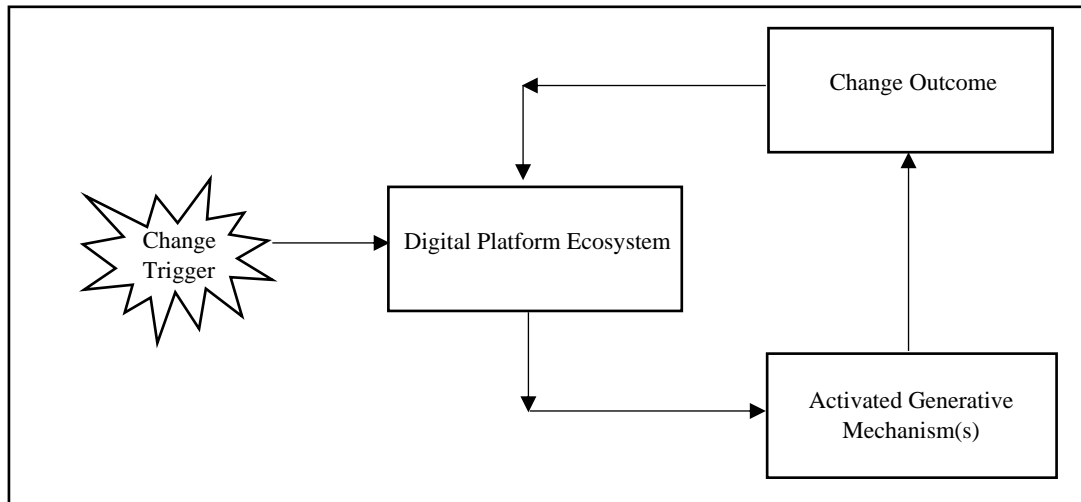
Figure 1. Operation of Generative Mechanisms adapted from Henfridsson and Bygstad (2013)

We define a change outcome as the change in one or more properties of the deep structure of a digital platform ecosystem in response to a change trigger, which may be an external event that challenges the current configuration of the ecosystem or an internal event that creates a misfit between the configuration of the ecosystem and the environment, thereby challenging the performance of the ecosystem. As the outcomes of generative mechanisms depend on the triggering event and the context in which they operate (Henfridsson and Bygstad, 2013), similar mechanisms can produce different outcomes. Transforming change requires alterations in the existing deep structure of a digital platform ecosystem in response to destabilizing triggering events. The subsequent period of instability ends when a new deep structure emerges that is better fitted to ensure effective performance of the ecosystem (Gersick, 1991; Romanelli and Tushman, 1994; Wollin, 1999). The digital platform ecosystem then enters a period of relative stability (Romanelli and Tushman, 1994), where actors can engage in reinforcing changes in response to triggering events that do not challenge the current evolutionary trajectory. Reinforcing changes involve incremental adjustments of the platform ecosystem without changing the deep structure (Gersick, 1991; Street and Denford, 2012). As new triggering events appear, a generative mechanism may be activated leading to a new transformation.

Building upon this integrated understanding of generative mechanisms and punctuated socio-technical change, we define the evolution of a digital platform ecosystem as the ongoing changes of a digital platform ecosystem in relation to its actors, architecture and governance (Table 2). We further identify two main characteristics of generative mechanisms: dominance, which reflects its change focus in terms of actors, architecture and governance, and impact, which reflects whether the change is reinforcing or transforming. As such, we suggest that a generative mechanism predominantly affects one component of the deep structure of a digital platform ecosystem although it also may cause changes to the other two components, and that a generative mechanism can produce change outcomes, which have reinforcing or transforming impact on the existing deep structure.

Research Method

To advance theory on why and how triggering events and generative mechanisms drive the evolution of digital platform ecosystems, we engage in mid-range theory building by conducting a longitudinal case study guided by our theoretical framework (Table 1 and Table 2) and later combining the empirical findings with extent literature (Dooley, 2002; Eisenhardt, 1989; Eisenhardt and Graebner, 2007). As longitudinal single case studies are suitable for investigating ongoing changes in their context (Menard, 2008; Leonard-Barton, 1990; Pettigrew, 1990; Van de Ven and Huber, 1990), adopting this research design helped us reveal patterns of change in a real-world case of platform ecosystem evolution by tracking all key change events over time and how they came into being (Hassett and Paavilainen-Mäntymäki, 2013; Menard, 2008). Although such studies can provide "holistic, dynamic and multi-faceted information" (Hassett and Paavilainen-Mäntymäki, 2013; p. 2), longitudinal studies based on primary data sources are largely absent from the platform literature (de Reuver et al., 2017), reinforcing fragmentation of findings.

We studied the evolution of a digital payment platform ecosystem in Denmark, MobilePay, launched in 2013 by the largest bank in Denmark, Danske Bank, and used by approximately 90 per cent of the Danish population in 2017. Various digital payment solutions (e.g., ApplePay, SamsungPay, Venmo) function as digital platforms orchestrating an ecosystem of actors around them (Evans and Schmalensee, 2010; Hagiu and Wright, 2011; Ondrus et al., 2015; de Reuver et al., 2017). Similarly, MobilePay is a digital payment application, which functions as a digital platform by providing an underlying IT architecture enabling the direct and regulated interactions between affiliated to its ecosystem actors (e.g., peer-to-peer money transfers and consumer-to-business transactions) (Hagiu and Wright, 2011). As such, MobilePay constitutes a digital platform ecosystem.

We choose to study MobilePay for several reasons. First, since its inception, the MobilePay ecosystem has evolved rapidly by introducing numerous changes across its actors, architecture and governance (e.g., adding new actors, enabling a myriad of services, and continuously adapting its governance regime). Second, MobilePay operates in an uncertain and volatile environment, which constantly challenges its evolutionary trajectory. Third, we had unique access to this specific case as the first author was employed at MobilePay during part of this research (Eisenhardt and Graebner, 2007; Yin, 2003). Hence, we had sufficiently rich access to relevant documentation and real-time observation of MobilePay's evolutionary journey to develop a comprehensive and detailed account of this process.

To reconstruct the evolutionary path of MobilePay over the span of four and a half years, we relied on both retrospective and real-time methods of data collection (Leonard-Barton, 1990). The first author researched and closely followed the evolution of MobilePay since its inception in May 2013, and she entered the company as employee from October 2015 until the end of the investigated period. Thus, we triangulated between several data sources: interviews, informal conversations, archival presentations, press releases, to help reconstruct evolution of the ecosystem from May 2013 until October 2015. Data triangulation was particularly useful as

retrospective interviews may suffer from recall bias by emphasizing events that put some actors in a more favorable light than others (Pettigrew, 1990).

After the first author entered the research site, we adopted participant observation as our preferred approach for real-time data collection (Leonard-Barton, 1990). This method allows researchers to "learn about the activities of the people under study in the natural setting through observing and participating in those activities" (Kawulich, 2005, p. 1). Participant observation is a suitable method for theory building and it is particularly fruitful when researchers seek to understand the context, in which a phenomenon is situated, and the events and actions that shape it (Iacono et al., 2009). During the two years of real-time data collection, from October 2015 until October 2017, the first author spent three days per week in Danske Bank, the creator and initial owner of MobilePay, assuming the role of "participant as observer" (Kawulich, 2005, p. 8). She joined the team responsible for proposing and delivering new innovative features and had frequent interactions with members of other MobilePay teams. Furthermore, she attended weekly status updates and bi-weekly department meetings where the CEO of MobilePay discussed key issues with all employees. As such, she had either retrospective access through colleagues and documents or direct access to all key events that shaped the evolution of the payment platform and its wider ecosystem. As participant observer, she selectively took part in projects, meetings and tasks as part of the team's day-to-day activities. While the main purpose of her participation was to collect data, she occasionally engaged in activities to obtain better understanding of ongoing events and to gain the trust and credibility that would prompt colleagues to willingly share information (Pettigrew, 1990; Van de Ven and Hubert, 1990).

Due to the embeddedness into the field, the "participant as observer" can eventually lose her objectivity (Bernard, 1994; Leonard-Barton, 1990; Pettigrew, 1990). It therefore became important for the first author to detach herself from the site to support objective interpretation of the observed events. During her employment with MobilePay, she met on a regular basis and at a separate location with the fourth author, a leading researcher in the field of digital payment platforms in Europe, to discuss observations and to balance her interpretations (Eisenhardt, 1989; Pettigrew, 1990). In addition, during the subsequent data analysis, the first author removed herself completely from the research site and spent four months in the USA to make sense of the rich data and start advancing theory in close collaboration with the second and third author with research interests in digital innovation (Bernard, 1994; Kawulich, 2005).

The first author's engagement in the field generated vast amounts of primary data. Importantly, she maintained a research diary and noted down her detailed observations from meetings, seminars, workshops and informal conversations with employees, resulting in a rich narrative. As method for data collection, participant observation is not without limitations and researchers are advised to combine it with other techniques such as interviews and archival data (Kawulich, 2005). Thus, she complemented the observation notes and archival data with 12 semi-structured interviews with key Danske Bank employees (DeWalt and DeWalt, 2002). As

the information from these interviews often overlapped with already documented insights, the first author preferred to engage mainly in observations and informal conversations with colleagues at MobilePay to gather data (as discussed by Leonard-Barton, 1990). In addition, we had access to all relevant archival documents about the evolution of MobilePay such as news releases, project plans, presentations, emails, meeting minutes, and more.

To identify change events and to trace how they emerged over time, we adopted a step-wise approach to data analysis based on recommendations from previous studies (Henfridsson and Bygstad, 2013). We commenced by constructing a timeline of all key change events and related outcomes during the evolution of MobilePay as they emerged from our data (Henfridsson and Bygstad, 2013; Van de Ven and Huber, 1990). Although we could identify a myriad of changes, in the final timeline we included only those that MobilePay employees consistently and collectively referred to as important. In the next step, we analysed each identified change event based on our theoretical framework (Table 1 and Table 2) (Van de Ven and Huber, 1990). Hence, we analyzed 1) which event triggered the change; 2) the mechanism leading to the change; 3) the impact of the mechanism (transforming or reinforcing) on the existing configuration of the digital payment ecosystem (its actors, architecture and governance); and 4) the dominance of the mechanism, i.e., which dimension of the configuration predominantly changed and how that impacted the other dimensions. Although there are different methods to identify generative mechanisms (through affordances (Bygstad et al., 2016; Tan et al., 2015) or grounded theory (Vintzce, 2013), we adopted an approach like the one proposed by Henfridsson and Bygstad (2013) due to similarity of the observed phenomenon. Hence, we traced the socio-technical activities occurring between the triggering event and the observed outcomes to identify the activated generative mechanism. In the next step, we organized our analysis results into two separate accounts focused on transforming mechanisms (Table 3) and reinforcing mechanisms, respectively (Table 4). This allowed us to clearly see how the punctuated equilibrium perspective had materialized and it offered a strong foundation for theory building. Hence, in a final activity we engaged in analytical generalization (Yin, 2003) by combining our empirical findings, the theoretical framework and extant literature to advance theory about the evolution of digital platform ecosystems (Eisenhardt, 1989). Throughout, we iterated between the various steps as insights emerged and the theoretical contribution took shape (Eisenhardt, 1989).

Empirical Analysis

In the following, we offer a detailed analysis of the triggering events and generative mechanisms that shaped the evolution of the MobilePay ecosystem from the launch of the platform in May 2013 until September 2017. We apply our theoretical framework (Table 1 and Table 2) to identify transforming and reinforcing mechanisms, the triggers that activated them and the consequential change outcomes in actors, architecture and governance.

Transforming Generative Mechanisms

We first present the transforming generative mechanisms, which changed the deep structure of the MobilePay ecosystem—from the appearance of the triggering event to the establishment of a transformed deep structure (period of instability). Table 3 offers a summary of this analysis.

Table 3 Transforming Generative Mechanisms		
(italicized items indicate dominant change focus)		
Mechanism	*Trigger*	*Deep Structure Change*
Change of ownership (Actor-dominant) December 2012	Divergence of interests between Danske Bank and other actors in original platform consortium Summer 2012	Actors: One platform owner and technology provider Architecture: No interoperability between Danske Bank and other banks *Governance: Danske Bank retains intellectual property rights of platform and has full control over its development*
Launch of app for C2C payments (Architecture–dominant) May 2013	Race with competitors to reach private customers December 2012	Actors: Private customers of all Danish banks *Architecture: A dedicated app for C2C payments enabled by Danske Bank's existing IT solutions* Governance: Open and free access for Danish private bank customers with C2C transactions limited to $3000 per year
Expansion to include C2B transactions (Architecture-dominant) February 2014	Reaching critical mass of private customers spurs demand for C2B solution June 2013	Actors: Inclusion of commercial customers *Architecture: Platform core expands with configurable functionalities for C2B payments* Governance: Only Danske Bank's commercial customers can freely access and only for in-store trade (no online)
Openness to third-party complementors (Actor-dominant) June 2014	Demand for in-app payments December 2013	*Actors: Inclusion of third-party complementors* Architecture: An API is added as boundary resource to allow integration of third-party complements to platform core Governance: Only access for third-party complementors, who offer services and products in non-digital environments, based on fee-based agreement with Danske Bank
Partnering with platform technology providers	Developments in online and in-store payment markets and	*Actors: Inclusion of Payment Service Providers (PSPs) distributing MobilePay Online solution; inclusion of hardware platform complementors to enable in-store payments; collaboration with ecosystem integrators*

(Actor-dominant) January 2015	demand from large merchants January 2014	Architecture: Release of APIs to enable connectivity to actors; adding modules offered by platform technology providers to platform periphery Governance: For online payments access through PSPs, and for in-store payments access through platform owner; rules for participation jointly defined between platform owner and platform technology providers with agreements for sharing revenue, liability and maintenance costs
Architectural renewal of the platform (Architecture - dominant) August 2015	Frequent problems with platform performance and development March 2014	Actors: No change *Architecture: Partial decoupling from Danske Bank's systems improves performance; building new core capabilities (stand-in procedure) decreases dependencies on existing solutions* Governance: No change
Resolving accumulated governance issues (Governance-dominant) April 2016	High operating costs due to increased volume of transactions July 2014 Problems with private customer verification August 2014	Actors: No change Architecture: Moving Danske Bank customers from card-based infrastructure to account-to-account infrastructure reduces transaction fees; integration of differentiated ID verification process for private customers *Governance: Private customer access and use require identification; owner renegotiates contracts with infrastructure providers to reduce cost; additional sources of revenue added*
Engaging financial partners (Actor-dominant) September 2016	Platform owner lacks resources to compete with global and regional players Summer 2015	*Actors: New types of platform providers, who also act as financial providers (partner banks)* Architecture: Further decoupling from Danske Bank's IT systems towards account-to-account infrastructure between partner banks Governance: Partner banks invest in MobilePay and are rewarded for their distribution efforts; business customers can access MobilePay through their own bank

Change of ownership (Summer 2012 – December 2012)

As an incumbent financial institution in a rapidly changing environment, Danske Bank faced many uncertainties in 2012—including shifting consumer preferences due to the rapid adoption of emerging technologies, entry of new competitors, and a stricter regulatory environment. To avoid disruption, Danske Bank initially joined forces with other major Danish banks to develop a common mobile payment platform. In summer 2012, however, interests began to diverge, and the consortium failed to agree on a common vision. After the collaboration had stalled for a couple of months, Danske Bank left the consortium in December 2012

and announced plans to develop a digital payment platform on its own. The decision to change from joint to solo ownership transformed the governance regime, with Danske Bank as the solo platform owner and technology provider. As a result, the architecture was not designed to be interoperable with the systems of other Danish banks, and Danske Bank retained the intellectual property rights of the platform and full control over its subsequent development.

Launch of app for C2C payments (December 2012 – May 2013)

The change to solo ownership triggered a first mover race between Danske Bank, its former partners and other actors such as the Danish telecom operators. The intensified competitive environment forced Danske Bank to accelerate the development of its own mobile payment platform, which resulted in the introduction of a simple configuration of actors, architecture and governance. After just six months, in May 2013, Danske Bank, as platform owner and provider, launched MobilePay as a dedicated app that allowed Danish private bank customers to exchange money using their mobile phones. Thus, MobilePay initially offered consumer-to-consumer (C2C) payments to one distinct group of demand-side actors. The MobilePay architecture consisted of a lean core that only supported C2C payments enabled by the owner's back office systems and utilizing the existent card payment infrastructure. The resulting limited features required a relatively simple governance regime to regulate access to and use of the platform. To encourage fast adoption, the platform owner opened MobilePay for all Danish bank private account holders. In addition, the owner subsidized the development and maintenance costs allowing private customers to use MobilePay free of charge until a critical mass was established. Due to regulatory requirements, however, private customers could at most transact $3000 per year.

Expansion to include C2B transactions (June 2013 – February 2014)

MobilePay proved to be hugely popular and the initial goal of attracting 250,000 private customers (6 % of the Danish market) in one year was surpassed in just two months after the launch (June 2013). The reach of critical mass of private customers, together with the widespread use of MobilePay, which went beyond C2C payments and included transactions at small businesses such as coffee shops, food stalls and at flea markets, drew the attention of businesses customers, who wished to join the ecosystem. As a result, Danske Bank added new types of actors, namely commercial customers (initially, only small and medium sized merchants) and opened the platform for consumer-to-business transactions (C2B) in February 2014. This transformation of the actors with inclusion of new types of participants required corresponding changes in architecture and governance. To support the increased number of functionalities, the platform core expanded to include a separate app, Mobile Pay Business, which business customers used to receive payments from their customers. To regulate access to the platform, Danske Bank decided that only its own commercial customers could join. They also regulated the interactions between the new and existing actors by defining the scope of platform use—e.g., commercial customers could use the business solution only for in-store trade (e.g., no online) and were not allowed to send

marketing material to private customers through the platform. To stimulate adoption, commercial customers could initially access and use MobilePay for free.

Openness to third-party complementors (December 2013 – June 2014)

Responding to customer demands for various functionalities resulting from the increased adoption of C2C and C2B transactions by the end of 2013, Danske Bank extended its portfolio of payment options by enabling in-app payments in June 2014. This resulted in another transformation of the ecosystem of actors with the inclusion of third-party complementors as supply-side actors, who sought to incorporate MobilePay as a payment method in their applications. To enable connectivity towards third-party complementors, the owner added boundary resources (e.g., APIs) to the platform core, which resulted in the formation of a periphery consisting of various external complements. Thus, the ecosystem architecture expanded to include platform core, boundary resources and periphery. In addition, the owner introduced rules to govern the access to and usage of the platform by these new types of actors. Initially, only select third-party complementors, who had business agreements with Danske Bank and MobilePay, could offer in-app payments for services, redeemable in a non-digital environment, (e.g., tickets). To cover the development costs, the owner collected a fee from third-party complementors.

Partnering with platform technology providers (January 2014 – January 2015)

In January 2014, the continuous success of MobilePay drew the attention of large in-store merchants (e.g., supermarket chains) and online stores, who wanted to join the ecosystem. Simultaneously, the advancements in technology for online and in-store payments, as well as the demand from private customers, encouraged Danske Bank to support such types of payments. To enable online and in-store payments, the platform had to become part of the already established in-store and online payment ecosystems, prompting the owner to collaborate with other platform technology providers. For example, MobilePay partnered with payment service providers (PSPs) to distribute its online payment solution to online stores. Similarly, to offer in-store payments, the owner relied on hardware complementors (e.g., Point of Sale (PoS) terminal providers), who co-produced the MobilePay in-store solution, and on integrators (e.g., PoS vendors) who enabled it technically in-store. To establish connectivity towards the platform technology providers, the owner released additional boundary resources (APIs). As a result, the platform periphery expanded further by including complements offered by platform technology providers (e.g., hardware components). The introduction of platform providers required Danske Bank to share some of its control over the platform ecosystem with the new actors by, for example, jointly defining the rules for participation of commercial customers (e.g., online stores). To regulate its relations with providers, the platform owner also entered individual agreements for revenue sharing, ownership of intellectual property rights over software and hardware complements, and division of responsibilities for maintenance, continuous innovation, liability, and more.

Architectural renewal of the platform (March 2014 – August 2015)

As the development of the MobilePay platform core was quick and relied heavily on existing back office systems, the initial focus was not on long-term architecture scalability and sustainability. However, the growing number of C2C and C2B transactions (app. 40 % of the market share in 2014) led to numerous instances in early 2014 where the platform did not function optimally, which decreased its value to all actors and inhibited further innovation. These frequent performance and development issues triggered Danske Bank to redesign and improve the architecture. To avoid low performance spill-overs, the platform owner partially disentangled the core from its existing systems. The efforts included building additional core capabilities, such as a stand-in procedure, which allowed customers to continue transacting even though the back-end payment systems had shut down. The owner also commenced a major IT transformation project to increase the overall flexibility of the platform by leveraging cloud-computing capabilities and improving the connectivity with third-party providers and supply-side actors through new state-of-the-art APIs. These activities strengthened the core and added new boundary resources that increased the platform's generative capabilities. Although the platform owner changed the core and the boundary resources, the actors and platform governance did not change at this stage. However, the architectural revisions supported better the activities of the many heterogeneous actors that were now operating in the MobilePay ecosystem by removing the inefficiencies resulting from the initial configuration of actors, architecture and governance.

Resolving accumulated governance issues (August 2014 – April 2016)

Although the architecture performance improved, the rapidly growing number of diversified actors resulted in accumulated governance issues. Seeking fast adoption, Danske Bank had afforded access to the platform through a simple sign-up process, avoiding strict verification of its private customers because financial regulations allowed for relaxed access rules up to two years after the launch. The initial goal of reaching private customers as quickly as possible had also given priority to platform adoption over platform profitability with users still enjoying free access and usage of MobilePay as the owner subsidized the costs. The rapid adoption, however, led to an increase in transaction volume and to higher operational costs, which the revenue collected from commercial customers could not cover. Thus, the initial choice of governance led to the accumulation of critical governance issues, which the platform owner had to resolve in due time. In April 2015, in close cooperation with legal authorities since August 2014, Danske Bank designed a model for private customer verification, which included differentiated ID access corresponding to different levels of use. For example, if private customers wanted to have a higher yearly transaction limit, they needed to identify themselves with a higher level of identification, such as national ID. The platform owner also adopted several measures to reduce the costs associated with developing and operating the platform. The high transaction fees due to the initial choice to base the platform on card-based infrastructure were the main source of costs. In response, the platform owner moved its private customers to an account-to-account infrastructure, which lowered the costs.

Thus, to address critical inefficiencies in governance, Danske Bank altered the platform core in a manner that mainly affected its own private customers. In addition, the owner renegotiated the contracts with infrastructure providers in a bid to reduce operational costs, thus altering the appropriation regime around the platform. To balance the high operational costs, Danske Bank also introduced additional sources of revenue collected from commercial customers and platform technology providers.

Engaging financial partners (Summer 2015 – September 2016)

Early on, Danske Bank had decided to replicate its success with the rapid adoption of MobilePay in Denmark by offering the platform to other markets where the bank has significant market positions. As a result, they had entered the Finish market in late 2014 and the Norwegian market in 2015, but with limited success. In summer 2015, the owner sought to reinforce its Nordic ambition and protect itself from upcoming international payment platforms such as ApplePay and SamsungPay. To strengthen its market position in the region, the owner opened up MobilePay through a partnership model with other Nordic banks. Following prolonged negotiations, Nordea, a major Nordic bank, joined MobilePay in September 2016, which triggered a new stage in the evolution of the ecosystem. The inclusion of partner banks as distribution and financial partners transformed the actors. Apart from distributing MobilePay to their commercial customers, the partner banks also acted as financial partners, investing resources in the future development of the platform. As such, their role in the ecosystem differed significantly from previous distribution partners (e.g., PSPs for online payments). The incorporation of partner banks also changed the architecture significantly and complemented the earlier efforts to resolve accumulated governance issues. By plugging into the existing payment systems of partner banks, Danske Bank further modified the platform core to complete the migration from card-based infrastructure to account-to-account infrastructure. This required development of new boundary resources (APIs) that integrated the core with the partner banks' systems. Rather than implementing a comprehensive governance regime, the owner introduced a minimum set of rules to avoid stalling the continued innovation of the platform. To access the platform and as an initial investment towards the development of MobilePay, partner banks paid an up-front fee. When partner banks invested further in MobilePay, Danske Bank rewarded their distribution efforts if they resulted in increased platform usage in terms of volume of transactions or growing number of commercial customers. Prioritizing speedy innovation, the platform owner restricted the participation of partner banks in the development of the platform. While Danske Bank created a dialogue with them to inquire about their innovation ideas, partner banks did not acquire any ownership over the platform despite their investments and as a result, had limited influence on MobilePay development.

Reinforcing Generative Mechanisms

Next, we outline the reinforcing generative mechanisms, which led to incremental changes in the MobilePay ecosystem without affecting the established deep structure. For each reinforcing mechanism, Table 4 identifies the triggering event and the changes it caused during a period of stability between two transformations of the

deep structure. As we observed that several reinforcing mechanisms, for example, the adoption by private customers, continued to be active in the MobilePay ecosystem evolution beyond this initial period, we have marked these mechanisms with '*'.

Development of digital platform with limited scope (January 2012 – May 2013)

In January 2012, the change of ownership further reinforced Danske Bank's role as technology provider (Table 4). As former partners turned into competitors racing to enter the market, Danske Bank speeded up the development of the digital payment platform by limiting the scope of its functionality. Although initially considered for both private and commercial customers, the platform owner decided to focus solely on enabling C2C payments.

Building on existing IT solutions (December 2012 – February 2013)*

As solo owner, Danske Bank relied on its own competencies to develop the digital payment platform, thus retaining control over the architecture. Initially, the owner considered multiple technologies (such as Near Field Communication (NFC), QR codes, and dongles), which required more development time and collaborating with other technology providers. Facing time constraints, the owner built the platform on the existing Danske Bank's IT solution and the card payment infrastructure.

Adoption by private customers (May 2013 – February 2014)*

After the launch of the C2C payment app in May 2013, both Danske Bank and other Danish bank private customers adopted swiftly MobilePay—with approximately 250 000 Danes (or 9 % of the Danish population) in two months after launch—due to its ease of use based on the lean architecture of the platform core. The inclusion of private customers from all Danish banks, combined with functionalities encouraging further adoption (e.g., sending payments to peers who did not have MobilePay, prompting them to download the solution) created strong same-side network effects among private customers. Consequently, in February 2014, approximately one million Danes had adopted the platform.

Innovation for private customers (May 2013 – September 2013)*

The race to launch MobilePay before competitors forced Danske Bank to initially offer few core functionalities. Hence, after the launch in May 2013 the owner continued developing the platform by releasing additional functionalities to the core. In September 2013, the MobilePay architecture extended to include incremental innovations for private customers (e.g., functionalities such as split the bill, request money from peers) with the purpose of driving adoption and usage.

Adoption by commercial customers (February 2014 – June 2014)*

In early 2014, in addition to continuous adoption by private customers, commercial customers started to join MobilePay ecosystem. Initially, a few select owners of coffee shops and street food stalls participated in a pilot

launch, which proved to be successful, with private consumers readily engaging in C2B transactions. In addition, the presence of strong cross-side network effects prompted other commercial customers to adopt MobilePay. As result, approximately 2,900 SMEs had joined MobilePay ecosystem by June 2014.

Innovation for commercial customers* (March 2014 – April 2014)

With commercial customers adopting MobilePay at steady pace, in the end of March 2014 Danske Bank initiated ongoing dialogue to collect feedback and suggestions for further development. These inquiries led to the identification of new functionalities, some of which the platform owner decided to include in the platform core (e.g., donations). By doing so, the owner aimed at creating new interactions between private and commercial customers, thus driving further the adoption and usage of MobilePay.

Table 4 Reinforcing Generative Mechanisms			
Transforming Mechanism	*Reinforcing Mechanism*	*Trigger*	*Ecosystem Change*
Change of Ownership (December 2012)	Development of digital platform with limited scope (Architecture-dominant) (January 2012 – May 2013)	Change of Ownership	Initially considered for both private and commercial customers, but developed solution focused on C2C payments due to time constraints
	Building on existing IT solutions* (Architecture-dominant) (December 2012 – February 2013)	Change of Ownership	Considered multiple technological options but built on Danske Bank's existing IT solutions due to time constraints
Launch of app for C2C payments (May 2013)	Adoption by private customers* (Actor-dominant) (May 2013 – February 2014)	Launch of app for C2C payments	Fast initial adoption of private customers with one million private customers by February 2014
	Innovation for private customers* (Architecture-dominant) (September 2013)	Launch of app for C2C payments	Implementation of new functionalities for private customers to platform core
Expansion to include C2B transactions (February 2014)	Adoption by commercial customers* (Actor-dominant) (February 2014 – June 2014)	Adoption by private customers	Fast initial adoption of commercial customers with 2,900 SMEs by June 2014

	Innovation for commercial customers* (Architecture-dominant) (March 2014 – April 2014)	Commercial customer demands for functionality	Implementation of new functionalities for commercial customers to platform core
Openness to third-party complementors (June 2014)	Optimization of adoption by commercial customers (Governance-dominant) (September 2014)	Adoption of commercial customers	Incremental improvement of functionalities to platform core
	Improvement of connectivity for third-party complementors* (Architecture-dominant) (December 2014)	Openness to third-party complementors	Release of new boundary resources (APIs) to improve integration of third-party complementors to platform core
	Customization of offerings for commercial customers (Governance-dominant) (November 2014)	Adoption of commercial customers	Introduction of new customized prices adjusting the value appropriation
Partnering with platform technology providers (January 2015)	Standardization of boundary resources to foster platform periphery development (Architecture-dominant) (June 2015)	Demand to extend scope of in-app payments to all relevant commercial customers	Standardization of APIs and removal of customized functionalities
Architectural renewal of the platform (August 2015)	Adoption by platform technology providers* (Actor-dominant) (August 2015 – April 2016)	Adoption of commercial customers	More platform technology providers adopt platform
	Introduction of third-party services to platform offerings* (Architecture-dominant) (September 2015 – November 2015)	Encouraging adoption of C2B payments	Implementation of third-party service modules in platform periphery
	Relaxing participation rules for private customers* (Governance-dominant) (September 2015)	Adoption of private customers	Increase of daily spending limit for private customers

Resolving accumulated governance issues (April 2016)	Improvement of connectivity for technology providers* (Architecture-dominant) (September 2016)	Commercial customer demands to improve functionalities	Release of new boundary resources (APIs) to connect to third-party hardware components
	Removing functionalities from platform core (Architecture-dominant) (June 2016)	Low adoption of functionalities by private customers	Removing functionalities from the platform core as a separate internal module connected to platform core
Engaging financial partners (October 2016)	Adoption by financial partners* (Actor-dominant) (October 2016 – September 2017)	Main competitor Swipp loses its key supporter, Nordea	More financial partners adopt platform with 70 financial partners by August 2017
	Tightening participation rules for commercial customers (Governance-dominant) (March 2017)	Non-regulated use of platform by commercial customers	Stricter participation rules for commercial customers
	Adjustment of value appropriation (Governance-dominant) (April 2017)	Introduction of new competitive solution	Lowering prices for commercial customers using in-store solution
	Change in MobilePay ownership model (Actor-dominant) (September 2017)	Partner banks want legal separation between Danske Bank and MobilePay	MobilePay as separate legal entity with platform ownership

Optimization of adoption by commercial customers (June 2014 – September 2014)

While an increasing number of commercial customers wanted to join MobilePay ecosystem in June 2014, they often ended up waiting for weeks before getting access to the platform. The reason for the delay was the slow and mostly manual affiliation process, which relied heavily on existing Danske Bank systems and processes (e.g., requiring physical copies of documents). To address these inefficiencies, the platform owner automated the process, which required an incremental innovation to the platform core.

Improvement of connectivity for third-party complementors (June 2014 – December 2014)*

After opening MobilePay to third-party complements in June 2014, the platform owner received request for additional functionalities to extend platform usage. To improve third-party complementors' access to a wider range of functionalities in the platform core, the owner released new boundary resources (APIs). For example, apart from solely receiving payments in their apps, third-party complementors could refund their customers for in-app purchases using a new API.

Customization of offerings for commercial customers (June 2014 – November 2014)

As commercial customers with divergent needs and requirements kept adopting MobilePay, Danske Bank realized it had to customize its offerings. Subsequently, the owner introduced different packages (i.e., bundles of functionalities) targeting specific commercial customer segments. Thus, commercial customers could choose to pay different fees to either adopt limited functionalities on one mobile device or include more functionalities on multiple devices. In addition, to reflect the actual use of MobilePay, the owner also adjusted the value appropriation regime by introducing corresponding customized prices for commercial customers.

Standardization of boundary resources to foster platform periphery (December 2014 – June 2015)

Initially, Danske Bank released customized boundary resources to a few select third-party complementors. After the successful pilot, however, other external complementors wished to join the ecosystem. To enable wider access to its platform, the owner needed to standardize the existing boundary resources and remove all customizations (e.g., customized screen colours and user interaction flows). By introducing standardized APIs utilized by a growing number of complementors, the platform owner aimed to foster further development of the platform periphery.

Adoption by platform technology providers* (August 2015 – April 2016)

In August 2015, the demand from commercial customers to enable online and in-store payments triggered several platform technology providers to join the MobilePay ecosystem as distributors or integrators. Various PSPs offering online payments brought MobilePay to more than 3500 online stores across the Nordic countries. Simultaneously, more than 80 PoS vendors enabling in-store payments and two hardware providers distributing MobilePay-branded payment terminals had joined the MobilePay ecosystem by April 2016.

Introduction of third-party services to platform offerings* (September 2015 – November 2015)

In late 2015, Danske Bank included value-added services (VAS) to nurture the growth of C2B transactions and unlock new sources of revenue. Initially, the owner decided to develop its own loyalty solution, Bonus, but the uptake was slow. After struggling to ignite Bonus, Danske Bank concluded it lacked the necessary knowledge and resources to offer VAS. As a result, it collaborated with third-party complementors by integrating their services (e.g., receipts, invoices, and loyalty programmes) as part of the platform offerings. The third-party services were implemented as modules in the platform periphery, from which commercial

customers could choose to plug and play while private customers could access VAS as part of the MobilePay portfolio of functionalities.

Relaxing participation rules for private customers* (August 2014 – September 2015)

As more private and commercial customers adopted MobilePay, the volume of C2C and C2B transactions had significantly increased by August 2014. As result, the daily and yearly spending limits imposed on private customers when paying with MobilePay mismatched the actual use of the platform. To accommodate this, Danske Bank relaxed the existing rules by twice increasing the daily spending limit for private customers.

Improvement of connectivity for technology providers* (April 2016 – September 2016)

The existing MobilePay in-store solution required use of a dongle, provided by external hardware complementors and constituted yet another payment terminal, which large merchants needed to display to their customers at the cashier. Responding to a demand to display only one payment terminal, Danske Bank collaborated with payment terminal providers (e.g., Verifone and Bambora), who incorporated MobilePay as a payment option in their terminals, already in use by a number of large merchants. This required the release of additional boundary resources to connect to the new platform technology providers.

Removing functionalities from platform core (November 2015 – June 2016)

In late 2015, Danske Bank observed that private customers did not use on a regular basis some of the functionalities within the MobilePay private app (e.g., request payments). After considering different options, the owner removed the unpopular functionality from the platform core in June 2016 and instead offered it as a separate app, WeShare, which allowed private customers to keep track and settle group payments. The owner introduced WeShare as a separate internal complement, part of the MobilePay periphery and connected tightly to the platform core.

Adoption by financial partners* (October 2016 – September 2017)

After its biggest supporter, Nordea, left the common bank digital payment initiative, Swipp, to join MobilePay, other Danish banks followed suite and abandoned the consortium. As result, more than 70 local Danish banks joined the MobilePay ecosystem, thus cementing its dominance in the Danish market (approximately 90 % market share).

Tightening participation rules for commercial customers (January 2017 – March 2017)

Although Danske Bank had introduced a set of rules regulating the use of the platform, certain actors began to utilize MobilePay in ways, which put the owner in disadvantageous positions. For example, some commercial customers aggregated payments from private customers and settled them as a single transaction through MobilePay, thus reducing the amount of fees they had to pay. As the existing governance regime did not

sanction this use pattern, the owner tightened the participation rules for commercial customers and prohibited such behaviour.

Adjustment of value appropriation (March 2017 – April 2017)

The introduction of new competitive solutions on the Danish market (e.g., mobile Dankort by Nets), which competed with the MobilePay in-store solution, triggered Danske Bank to adjust the governance regime in March 2017 towards in-store commercial customers. As result, the value appropriation rules changed so in-store commercial customers paid lower prices for using MobilePay.

Change in MobilePay ownership model (September 2016 – September 2017)

The inclusion of partner banks in late 2016 redefined Danske Bank's role as platform owner. As the other partner banks competed with the owner in areas other than mobile payments, they agreed to join if MobilePay became a separate company, thereby reduce the influence of Danske Bank on future developments. Subsequently, MobilePay applied for a license as e-money institution, which, after a lengthy regulatory approval process, resulted in establishment of MobilePay as a separate legal entity that acquired the platform ownership from Danske Bank. The new legal entity (MobilePay Inc.) became the owner in September 2017, with Danske Bank acting as the only investor taking every seat in its board of directors.

Discussion

To ensure their long-term survival, digital platform ecosystems need to evolve in response to internal and external challenges (Gawer, 2015; Tiwana et al., 2010; Tiwana, 2014). However, operating in uncertain environments with increasing complexity of actors, architecture and governance, digital platform ecosystems need to be able evolve in unpredictable ways, without necessarily following predefined patterns and scripts (Datee et al., 2017; Ojala and Lyytinen, 2018). As many challenges compete simultaneously for attention, the platform owner and other key actors need to carefully evaluate the impact such challenges can have on the evolutionary trajectory of the ecosystem and dedicate resources accordingly.

Despite the importance of knowing why and how digital platform ecosystems evolve, extant research offers limited insights into the complex nature of the evolutionary process that leads to impactful outcomes. The growth, co-evolution and competitive perspectives that dominate extant research have advanced our knowledge about digital platform ecosystem evolution, but studies focus predominantly on identifying evolutionary outcomes, either as standalone topics or as part of descriptive stage models. As such, our knowledge about the various events, which trigger the evolution of a digital platform ecosystem, and the generative mechanisms, which lead to certain evolutionary outcomes in response to these events, remains limited (Gawer, 2015; Ojala and Lyytinen, 2018).

Against this backdrop, we have combined concepts about the punctuated nature of triggering events (Gersick, 1991; Lyytinen and Newman, 2008) and about the causal nature of generative mechanisms (Bhaskar, 1975; Henfridsson and Bygstad, 2013), to develop a theoretical framework (Table 1 and Table 2) aimed at explaining why and how digital platform ecosystems evolve over time. Moreover, we have demonstrated the utility of the framework by offering a comprehensive and detailed account of the evolution of a prominent digital payment platform ecosystem, MobilePay, from the launch of the platform to market dominance. In the following, we draw on the theoretical framework, the insights from our empirical analysis and extant theory to further advance theory on why and how digital platform ecosystems evolve over time.

The triggering of platform ecosystem evolution

While the path of a digital platform ecosystem is paved with a myriad of events, only some of them trigger the generative mechanisms that shape ecosystem evolution. Such change triggers may constitute as external events that challenge the current configuration of the ecosystem, or as internal events that create misfits between the established configuration of the ecosystem and its environment, thereby challenging the performance of the ecosystem (Table 2).

Consistent with extant literature (Eisenmann et al., 2011; Gawer, 2015; Tan et al., 2015), we found that external events, such as changes in the competitive environment (e.g., divergent interests with competitors, competition to enter the market and introduction of new competitors), regulatory requirements (e.g., stricter ID verification) and technology advancements (e.g., new technology for online payments), triggered generative mechanisms that shaped the evolution of the MobilePay ecosystem. We found similar triggering of generative mechanisms by internal events, such as demands from actors (e.g., release of new functionalities, extending access to boundary resources), performance issues (e.g., downtime), mounting operating costs and non-regulated use of the platform. Interestingly, it was a combination of internal and external events that triggered disruptive changes (Table 3), while reinforcement of the ecosystem configuration was predominantly triggered by internal events (Table 4). For example, high operating costs (internal event) and regulatory requirements (external event) triggered a change in the existing governance regime (disruptive change); whereas, low adoption of functionalities (internal event) triggered incremental changes in the platform core (reinforcement of the ecosystem configuration).

Building on the general notion that generative mechanisms can act as change triggers of other generative mechanisms (Bhaskar, 1975; Henfridsson and Bygstad, 2013), we found that various combinations of transforming and reinforcing mechanisms fed upon one another. Most typically, transforming mechanisms triggered one or more subsequent reinforcing mechanisms, e.g., the transformation when MobilePay opened to third-party complementors triggered the platform owner to reinforce this move by improving the connectivity for third-party complementors (Table 4). We attribute this to the fact that transformation of the

ecosystem deep structure often requires or causes subsequent revisions in the ecosystem's actors, architecture and governance. As another example, the launch of the C2C app (transformation) triggered two reinforcing mechanisms—one related to the actors (adoption by private customers), and one related to the platform architecture (innovation for private customers) (Table 4). Reinforcing mechanisms can also trigger other reinforcing mechanisms as when adoption of MobilePay by private customers triggered continuous adoption by commercial customers through strong cross-side network effects (Table 4). Further, we found that reinforcing mechanisms can indirectly trigger transforming mechanisms. For example, the ongoing adoption by private users in combination with the continuous building upon existing IT systems led to frequent instances of problematic platform performance (Table 3 and Table 4). To address these problems, the platform owner initiated architectural renewal, which transformed the ecosystem's deep structure.

The contextual configuration of generative mechanisms

Combining different perspectives in extant literature, we propose that digital platform ecosystems represent context-dependent evolving configurations of actors, architecture and governance (Table 1). The deep structure of the ecosystem is then a configuration, which remains unchanged during a stable period of evolution (Lyytinen and Newman, 2008), and which influences the evolution of the ecosystem both during and after this stable period (Gersick, 1991). For example, the initial choice to build upon existing Danske Bank's IT solutions allowed for a quick launch and ignition of MobilePay, but it also led to performance and development issues over time, which eventually required transformation of the deep structure (Table 3).

The empirical findings support our conceptualization that generative mechanisms are anchored in latent properties of the deep structure, which can be activated to shape ecosystem evolution (Table 2). Hence, a specific configuration of actors, architecture and governance, resulting from previous activation of generative mechanisms, renders certain latent properties, which can be activated as subsequent mechanisms. For example, during its initial launch the MobilePay ecosystem consisted of a limited number of actors, namely Danske Bank as platform owner and private customers as demand-side actors. Over time, strong same-side network effects led to rapid adoption of the platform by private customers (reinforcing mechanism). This resulted in a considerable user base, which made the platform attractive to other types of actors as a latent property of the actor dimension of the ecosystem. This led to demands from commercial customers to join the ecosystem and eventually to expansion of the ecosystem to include C2B transactions (transforming mechanism) (Table 3 and Table 4). Similarly, as MobilePay opened for third-party complementors (transforming mechanism) through the release of boundary resources, the platform became more malleable as a latent property of the architecture dimension of the ecosystem (Henfridsson and Bygstad, 2013). This malleability subsequently resulted in adoption of the platform by other third-party complementors (reinforcing mechanism) (Table 3 and Table 4). Hence, generative mechanisms are activated in a specific context (Bhaskar, 1975; Henfridsson and Bygstad,

2013), characterized by a triggering event as well as current latent properties of the deep structure, which stem from previous deep structure choices (Gersick, 1991) and the impacts of preceding generative mechanisms (Henfridsson and Bygstad, 2013).

The dominance and impact of generative mechanisms

The generative mechanisms in the evolution of the MobilePay ecosystem had different change focus in terms of actors, architecture and governance as detailed in Table 3 and Table 4. Actor-dominant mechanisms changed the actor types within the ecosystem (e.g., private customers, commercial customers, platform technology providers) or they changed the actor population within a specific type (e.g., increased adoption by private customers). Architecture-dominant mechanisms introduced new components to the platform core, boundary resources and platform periphery (e.g., new APIs or introduction of external and internal complements) or they adjusted existing architecture over time (e.g., renewal of platform core, removal of functionalities). The governance-dominant generative mechanisms added new rules to the governance regime (e.g., ID verification process) or they modified existing governance rules (e.g., relaxing participation rules). Although the observed mechanisms exhibited a dominant change focus, changes in one dimension of the ecosystem configuration during transformation typically led to changes in the other dimensions as a reflection of the intrinsic interdependencies between the constitutive dimensions of platform ecosystems. For example, introduction of third-party complementors into the MobilePay ecosystem was clearly actor-dominant, but it also led to changes in architecture (an API is added as boundary resource to allow for integration of third-party complements to platform core) and platform governance (only access for third-party complementors, who offered services and products in non-digital environments) (Table 3).

Regardless of their dominance, the change outcomes of generative mechanisms can have transforming or reinforcing impact on the existing deep structure of the ecosystem (Gersick, 1991). Transforming mechanisms produce change outcomes, which significantly alter the configuration of actors, architecture and governance, while reinforcing mechanisms lead to incremental changes, which elaborate on the existing configuration (Lyytinen and Newman, 2008). During the evolution of MobilePay ecosystem, transforming mechanisms focused on introducing new actor types (e.g., third-party complementors) and shifts in owners (e.g., from co-owners to single owners); on extending the platform core (e.g., expansion to include C2B transactions), including boundary resources to facilitate the creation of the platform periphery (e.g., release of APIs towards external complementors) and renewing the platform core (e.g., utilizing cloud-based infrastructure); and, on fixing critical governance issues (e.g., decreasing operating costs). After the establishment of a new configuration of actors, architecture and governance, various generative mechanisms were set in motion, reinforcing the new deep structure of the ecosystem. For example, after including a new actor types (e.g., technology providers), subsequent changes in these populations (e.g., adoption by technology providers) acted

as reinforcing mechanisms. Similarly, after introducing new elements to the architecture and renewing its core, the new deep structure was reinforced through mechanisms such as leveraging existing IT solutions, introducing incremental innovations to the platform core, optimizing functionalities in platform core and improving platform connectivity for actors through release of boundary resources and their standardization.

In Table 5, we have summarized these empirical findings on generative mechanisms based on the proposed conceptualization that differentiates generative mechanisms based on their dominance and impact. The mechanisms included in the table represent, in slightly generalized form, the multiplicity of mechanisms we identified during the evolution of the MobilePay ecosystem (Table 3 and Table 4). As such, Table 5 demonstrates the utility of the proposed concepts and it provides evidence of how the dominance and impact of the observed generative mechanisms manifested during the evolution of the MobilePay ecosystem.

Table 5 The Dominance and Impact of Generative Mechanisms			
		Impact	
		Transforming	**Reinforcing**
Dominance	**Actor**	• Changing actor types • Shifting owners	• Changing actor populations* • Changing the role of platform owner
	Architecture	• Extending platform core • Including boundary resources • Developing platform periphery • Renewing platform core	• Leveraging existing IT solutions* • Introducing incremental innovation in platform core* • Optimizing functionalities in platform core* • Improving platform connectivity for actors*
	Governance	• Developing governance regime	• Customizing rules for actor types • Improving affiliation process • Tightening and relaxing participation rules* • Adjusting value appropriation rules

The temporality of generative mechanisms

Consistent with existing theory (Henfridsson and Bygstad, 2013), we found that multiple transforming and reinforcing mechanisms were activated simultaneously and interacted to drive the evolution of the MobilePay ecosystem. Thus, considering the temporality of when the generative mechanisms were active and how they unfolded, our findings confirm that digital platform ecosystems evolve in unpredictable ways, without necessarily following a predefined pattern (Datee et al., 2017; Ojala and Lyytinen, 2018). As exceptions, we observed that some mechanisms were more likely to appear at early or late stages of ecosystem evolution. Certain transforming mechanisms, such as renewal of platform core and resolving accumulated governance issues, were triggered by internal inefficiencies, and certain reinforcing mechanisms, such as tightening and

relaxing of participation rules, were triggered by accumulated governance issues, and as such they appeared at later stages of the MobilePay ecosystem evolution (Table 3 and Table 4). Similarly, there were mechanisms such as development and launch of platform that naturally appeared at the very early stages of platform evolution. Beside these exceptions, most changes in actors, architecture and governance did not follow pre-defined order. For example, changes in ecosystem actors, which constitute a transforming mechanism, occurred throughout the evolution of the MobilePay ecosystem, even in the latest stage with engagement of financial partners (Table 3). Similarly, incremental changes to the platform core took place at early as well as later stages of ecosystem evolution (Table 4).

Interestingly, Punctuated Equilibrium Theory presents evolution as a sequential process consisting of long periods, during which the deep structure remains relatively stable, followed by shorter periods of rapid, reinforcing change of the deep structure (Gersick, 1991; Lyytinen and Newman, 2008). However, we observed that the transforming mechanisms, which changed the existing deep structure of the MobilePay ecosystem, could span across considerable periods of time and overlap with other generative mechanisms (Table 3 and Table 4). For example, the transforming mechanisms that expanded the platform to include C2B transactions became active in June 2013, with the transformation of the deep structure occurring in February 2014. Surprisingly, the trigger for the next transforming mechanism (openness to third-party complementors), appeared in December 2013, months before the inclusion of C2B transactions. Furthermore, during the activation of this transforming mechanism, other reinforcing mechanisms were set in motion related to the previous deep structure (e.g., adoption by private customers, innovation for private customers) (Table 4). There are several explanations for this inconsistency between the theoretical sequentially and the observed temporal complexity.

First, generative mechanisms are socio-technical in nature, with various actors taking part of their activation and operation (Henfridsson and Bygstad, 2013). Hence, different actors are involved in specific mechanisms, such as partnering with platform technology providers (large commercial customers, PoS vendors, PSPs, and more) (Table 3). As these different actors participate in a transforming mechanism, they need to align their interests and introduce required technical changes in their own systems to integrate with the digital platform. The operation of the mechanism can therefore take considerable time. This explanation is consistent with Njihia and Merali's (2013) observation that the duration of generative mechanisms depends on the interventions made by the different participating actors. As most studies applying Punctuated Equilibrium Theory do not have an ecosystem focus (Gersick, 1991; Lyytinen and Newman, 2008; Tushman and Romanelli, 1985), they do not consider changes that take longer time to accommodate due to differences and interdependencies between actors.

Second, the complexity of change brought by transforming mechanisms may vary. For example, compare the incorporation of financial partners and the expansion to include external complementors, two MobilePay transforming mechanisms with different duration (Table 3). The incorporation of financial partners involved other Danish banks, which were already part of a competitive digital payment ecosystem. As this mechanism therefore had significant consequences for the Danish digital payment market, the negotiations with the first new partner bank, Nordea, took a long time. Furthermore, incorporation of financial partners led to changes in the platform ownership model and to changes in the relationships with commercial customers. In contrast, the incorporation of third-party complementors required Danske Bank to develop new boundary resources for a handful of select developers with limited impact on the overall ecosystem. Thus, transforming mechanisms with complex discontinuous ecosystem impacts are likely to cover large time span.

Third, when transforming mechanisms are set in motion, reinforcing mechanisms continue to operate, because digital platform ecosystems evolve not only discontinuously but also cumulatively along multiple dimensions. A transformation is discontinuous with respect to the existing deep structure of actors, architecture and governance and establishes a new deep structure, as when the introduction of third-party developers in the MobilePay ecosystem transformed the configuration of actors, architecture and governance (Table 4). However, while this transformative mechanism added a new type of actors and changed the relationships between actors, it continued to evolve by expanding the populations of other types of actors from the previous deep structure such as private customers. Hence, while transforming mechanisms operate and eventually terminate, many reinforcing mechanisms operate concurrently and some of them may continue be active throughout subsequent transformations (marked with * in Table 5).

In summary then, we answer our research question as follows: digital platform ecosystems evolve through networks of *distributed* and *concurrent* generative mechanisms, which transform and reinforce the deep structure of the ecosystem triggered by internal and external events and other mechanisms. While transforming mechanisms fundamentally change the existing deep structure of actors, architecture and governance, the reinforcing mechanisms sustain it. The dominant focus of mechanisms is distributed across the constituting dimensions of the ecosystem's deep structure. As such, they operate concurrently and interact across actors, architecture and governance to stimulate or slow down ecosystem evolution, depending on whether the implicated mechanisms are convergent or divergent.

The complex interactions between the timing of triggering events and the distributed and concurrent nature of generative mechanisms highlight the unpredictable ways in which digital platform ecosystems evolve (Datee et al., 2017; Ojala and Lyytinen, 2018). As a result, it is difficult for platform owners and other key actors to plan in detail how to push the ecosystem in specific directions. However, these actors can evaluate the likely impact of various triggering events by carefully assessing the dominance and impacts of the generative

mechanisms these triggers can set in motion. Further, they can consider the effects generative mechanisms may have by acting as triggers for subsequent mechanisms. Such continuous assessments can help owners and other key actors make deliberate decisions that increase the likelihood of preferred ecosystem trajectories and reduce the likelihood of problematic misfits between the ecosystem deep structure and platform performance.

Conclusion

We propose a punctuated equilibrium theory of digital platform ecosystem evolution and support it by a longitudinal study of the evolution of a Danish mobile payment ecosystem from its inception in 2013 until it had penetrated approximately 90 % of the market in 2017. We suggest that the evolution of a digital platform ecosystem can be understood as a network of distributed and concurrent generative mechanisms, with dominance of mechanisms distributed across deep structure dimensions and with concurrent activation of mechanisms collectively achieving both transforming and reinforcing impacts. As our theorizing relies on a single case study, it is not without limitations. Although we build on rich data, our empirical inquiry is set within the Scandinavian financial industry. Researchers and practitioners are therefore advised to carefully consider and adapt the proposed punctuated equilibrium theory to the specific and different circumstances in which other digital platform ecosystems may operate.

References

Adner, R. 2017. "Ecosystem as Structure: An Actionable Construct for Strategy," *Journal of Management*, (43:1), pp. 39 – 58.

Baldwin, C. Y., and J. C. Woodard. 2009. "The Architecture of Platforms: A Unified View". In A. Gawer (ed.) *Platforms, Markets and Innovation*, pp. 19-44.

Bernard, H. R. 1994. *Research methods in anthropology: qualitative and quantitative approaches* (second edition). Walnut Creek, CA: AltaMira Press.

Bhaskar, R.A., 1997 [1975], *A Realist Theory of Science*, London: Verso

Boudreau, K. and A. Hagiu. 2009. "Platforms Rules: Multi-sided Platforms as Regulators." In A. Gawer (ed.) *Platforms, Markets and Innovation*. London: Edward Elgar.

Boudreau, K., and Jeppesen, L. B. 2015. "Unpaid crowd complementors: The platform network effect mirage," *Strategic Management Journal*, (36:12), pp. 1761–1777.

Bunge, M. 2004. "How does it work? The search for explanatory mechanisms." Philosophy of the Social Sciences, (34:2), 182-210.

Bygstad, B., B. E. Munkvold, and O. Volkoff 2016. "Identifying generative mechanisms through affordances: a framework for critical realist data analysis," *Journal of Information Technology*. (31:1), pp. 83- 96.

Casey. T. R., and Töyli, J. 2012. "Dynamics of two-sided platform success and failure: an analysis of public wireless local area access". *Technovation* (32), pp.703–716.

Cennamo, C., and Santalo, J. 2015. "How to avoid platform traps," *MIT Sloan Management Review*, (51:1), p. 12.

Constantinides, P., Henfridsson, O., G. G. Parker . 2018. "Introduction—Platforms and Infrastructures in the Digital Age," *Information Systems Research,* 29(2), pp. 381-400.

Datee, B., O. Alexy, and E. Autio. 2017. "Maneuvering in Poor Visibility: How Firms Play the Ecosystem Game when Uncertainty is High," *The Academy of Management Journal*, (61:2).

de Reuver, M., Sørensen, C., and Basole, R. C. 2017. "The digital platform: a research agenda*." Journal of Information Technology*. ISSN 0268-3962.

DeWalt, K. M. and DeWalt, B. R. 2002. *Participant observation: a guide for fieldworkers*. Walnut Creek, CA: AltaMira Press.

Dooley, L.M., 2002. "Case Study Research and Theory Building," *Advances in Developing Human Resources*, (4:3), pp. 335-354

Eaton, B., Elaluf-Calderwood, S., Sorensen, C., and Yoo, Y. 2015. "Distributed Tuning of Boundary Resources: The Case of Apple's iOS Service System," *MIS Quarterly*, (39: 1) pp. 217-243.

Eisenhardt, K. M. 1989. "Building theories from case study research," *Academy of Management Review*, 14, pp. 532–550.

Eisenhardt K. M. and M. Graebner 2007. "Theory building from cases: opportunities and challenges," *Academy of Management Journal*, (50:1), pp. 25-32.

Eisenmann, T. 2006. "Internet companies' growth strategies: determinants of investment intensity and long-term performance," *Strategic Management Journal*, (27:12), pp. 1183–1204.

Eisenmann, T., Geoffrey P., and van Alstyne, M. 2011. "Platform envelopment," *Strategic Management Journal*, (32:12), pp. 1270-1285.

Evans, D. S. 2009. "How Catalysts Ignite: The Economics of Platform-Based Start-Ups," in *Platform, markets and innovation*, A. Gawer (Ed.), London, UK: Edward Elgar.

Evans, D, and Pirchio, A. 2015. "An Empirical Examination of Why Mobile Money Schemes Ignite in Some Developing Countries but Flounder in Most," Coase-Sandor Working Paper Series in Law and Economics No. 723.

Evans, D. S. and Schmalensee, R. 2016. *Matchmakers: The New Economics of Multisided Platforms*, Harvard Business Publishing: Boston, Massachusetts, USA.

Evans, D. S., and Schmalensee, R. 2010. "*Failure to Launch: Critical Mass in Platform Businesses*," Review of Network Economics, (9:4).

Gawer, A. 2009. "Platform Dynamics and Strategies; from products to services", In Platforms, Markets and Innovation; Gawer, A., Ed.; Edward Elgar Publishing: Northampton, MA, USA; Northampton, MA, USA, 2009, pp. 45-77.

Gawer, A. 2015. "*What Drives Shifts in Platform Boundaries: An Organizational Perspective,*" Conference Paper, DRUID Summer Conference, Copenhagen, Copenhagen Business School, Denmark.

Gawer, A. 2014. "Bridging differing perspectives on technological platforms: Toward an integrative framework," *Research Policy*, (43:7), pp. 1239–1249.

Gawer, A., and Cusumano, M. A. 2014. "Industry platforms and ecosystem innovation," *Journal of Product Innovation Management*, (31:3), pp. 417-433.

Gersick, C. J. (1991). Revolutionary change theories: A multilevel exploration of the punctuated equilibrium paradigm. Academy of Management Review, 16(1), 10–36

Ghazawneh, A. and O. Henfridsson. 2013. "Balancing platform control and external contribution in third-party development: the boundary resources model," *Information Systems Journal*, (23:2), pp. 173–192.

Hagiu, A. 2014. "Strategic Decisions for Multi-sided Platforms." *MIT Sloan Management Review*, (55:2).

Hagiu, A. 2006. "Multi-Sided Platforms: From Microfoundations to Design and Expansion Strategies," Working Paper 07-094. Harvard Business School.

Hagiu, A. and S. Rothman. 2016. "Network Effects Aren't Enough," Harvard Business Review, April 2016.

Hagiu, A. and J. Wright. 2011. "Multi-Sided Platforms," Harvard Business School Working Paper 12-024.

Hassett, M., and Paavilainen-Mäntymäki, E. (Eds.). 2013. Handbook of longitudinal research methods in organisation and business studies. Cheltenham:UK.

Henfridsson, O. and B. Bygstad. 2013. "The Generative Mechanisms of Digital Infrastructure Evolution,"*MIS Quarterly*, (37: 3) p.896-931.

Huber T, T. Kude, and J. Dibbern. 2017. "Governance Practices in Platform Ecosystems: Navigating Tensions Between Co-Created Value and Governance Costs". *Information Systems Research*.

Iacono, J. Brown, A. and Holtham, C. 2009. "Research Methods – a Case Example of Participant Observation." The Electronic Journal of Business Research Methods, (7:1), pp.39 - 46.

Inoue, Y. and Tsujimoto, M. 2017. "New market development of platform ecosystems: A case study of the Nintendo Wii," *Technological Forecasting and Social Change*, In Press, Available online from January 2017.

Jacobides, M., C. Cennamo, and A. Gawer. 2018. Towards a Theory of Ecosystems. *Strategic Management Journal*.

Kapoor, R. and S. Agarwal. 2017. "Sustaining Superior Performance in Business Ecosystems: Evidence from Application Software Developers in the iOS and Android Smartphone Ecosystems," Organization Science, (28:3).

Kawulich, B. B. 2005. "Participant observation as a data collection method". *Forum Qualitative Sozialforschung / Forum: Qualitative Social Research*, 6(2).

Lichenstein, B.B., M. Uhl-Bien, R. Marion, A. Seers, J.D. Orton, C. Schreiber. 2006. "Complexity leadership theory: An interactive perspective on leading in complex adaptive systems," *Emergence: Complexity and Organization*, (8:4), pp. 2-12.

Leonard-Barton, D. 1990. "A dual methodology for case studies: Synergistic use of a longitudinal single site with replicated multiple sites," *Organization Science* (1:3), pp. 248–66.

Lyytinen, K., and Newman, M. 2008. "Explaining information systems change: a punctuated socio-technical change model." *European Journal of Information Systems*, (17:6), pp 589–613.

Menard, S. (ed.). 2008. Handbook of Longitudinal Research: Design, Measurement, and Analysis. Burlington, MA: Elsevier.

Njihia, M. J., and Merali, Y. 2013. "The broader context for ICT4D projects: A morphogenetic analysis," *MIS Quarterly*, (37:3), pp. 881–906.

Ojala, A., and K.Lyytinen 2018. "Competition Logics during Digital Platform Evolution," In Proceedings of the 51st Hawaii International Conference on System Sciences (HICSS 2018) (pp. 1026-1035). University of Hawai'i at Manoa.

Olleros, F. X. 2008. "The Lean Core in Digital Platforms," *Technovation*, (28:5), pp. 266-276.

Ondrus, J., Gannamaneni, J., and Lyytinen, K. 2015. "The impact of openness on the market potential of multi-sided platforms: a case study of mobile payment platforms", *Journal of Information Technology*, (30:3), pp 260–275.

Ozer, G. T., and Anderson, E. G,, Jr. 2015. "*Innovation and Breaching Strategies in Multi-Sided Platform Markets: Insights from a Simulation Stud*y," International Conference on Information Systems, 2015, Forth Worth, Texas, USA.

Parker, G. and van Alstyne, M. 2008. "*Managing Platform Ecosystems*". International Conference on Information Systems, 2008, Proceedings. 53.

Parker, G., van Alstyne, M. and Choudary, S.P. 2016. Platform Revolution: How Networked Markets Are Transforming the Economy and How to Make Them Work for You. NY: WW Norton Company, Inc.

Pettigrew, A. M. 1990. "Longitudinal field research on change: Theory and practice," *Organization Science* (1:3), pp. 267–92.

Romanelli, E., and M. Tushman. 1994. "Organization Transformation as Punctuated Equilibrium." Academy of Management Journal, 37, pp. 1141-1166

Ruutu, S., Casey, T., and Kotovirta, V. 2017. "Development and competition of digital service platforms: A system dynamics approach," *Technological Forecasting and Social Change*, 117, pp. 119–130.

Smedlund, A. and Faghankhani, H. 2015. "Platform Orchestration for Efficiency, Development and Innovation," in Proceedings of 48th Hawaii International Conference on System Sciences (HICSS). Annual Hawaii International Conference on System Sciences. Proceedings., IEEE Computer Society, pp. 1380-1388, Annual Hawaii International Conference on System Sciences, United States, 6-9 January. DOI: 10.1109/HICSS.2015.169.

Street, C. T., and Meister, D. B. 2004. "Small business growth and internal transparency: The role of information systems." *MIS Quarterly*, 28(3), pp. 473–506.

Street, S. T. and Denford, J. S. 2011. "Punctuated Equilibrium Theory in IS Research", In Y. K. Dwivedi, M. R. Wade, and S. L. Schneberger (Eds.) *Information Systems Theory*, pp. 335-354.

Song, P., L. Xue, A. Rai, and C. Zhang. 2018. "The Ecosystem of Software Platform: A Study of Asymmetric Cross-Side Network Effects and Platform Governance," *MIS Quarterly*, 42:1, pp. 121-142.

Tan, F. T. C., Tan, B. and Pan, S. L. 2016. "Developing a Leading Digital Multi-sided Platform: Examining IT Affordances and Competitive Actions in Alibaba.com," Communications of the Association for Information Systems, (38:36).

Tan, B.; Pan, S. L.; Lu, X., and Huang, L. 2015. "The Role of IS Capabilities in the Development of Multi-Sided Platforms: The Digital Ecosystem Strategy of Alibaba.com", *Journal of the Association for Information Systems*, (16:4).

Tan, F. T. C, Tan, B., and Pan, S. P. 2013. "Interdependencies and Collaborative Action for Platform Leadership: A Comparative Analysis of Two Leading Chinese Multi-Sided Digital Platforms," in Proceedings of Pacific-Asian Conference on Information Systems, 32.

Thomas, L.D.W., E. Autio, and D. M. Gann. (2014) "Architectural Leverage: Putting Platforms in Context", *The Academy of Management Perspectives*, (28:2), pp. 1–28.

Tiwana, A. 2015. "Evolutionary Competition in Platform Ecosystems," *Information Systems Research*, (26:2).

Tiwana, A. 2014. Platform ecosystems, Aligning architecture, governance, and strategy. Amsterdam: Morgan Kaufmann.

Tiwana, A., Konsynski, B. and Bush, A. 2010. "Platform Evolution: Coevolution of Platform Architecture, Governance, and Environmental Dynamics," *Information Systems Research*, (21:4).

Tsujimoto, M., Y. Kajikawa, J. Tomita, and Y. Matsumoto. 2017. "A review of the ecosystem concept — Towards coherent ecosystem design," *Technological Forecasting and Social Change*, In press.

Tushman, M. and E. Romanelli. 1985. "Organizational Evolution: A Metamorphosis Model of Convergence and Reorientation." In B. Staw and L. Cummings, *Research in Organizational Behavior*, 7. Greenwich, CT: JAI Press, pp. 171-222.

Um, S. Y. and Yoo, Y. 2016. "*The Co-Evolution of Digital Ecosystems*" in Proceedings of International Conference on Information Systems, 2016, Dublin, Ireland.

van Alstyne, M. G. G. Parker, and S. P. Choudary. 2016. "Pipelines, Platforms, and the New Rules of Strategy," *Harvard Business Review*, April 2016.

van de Ven, A. H., and Huber, G. P. 1990. "Longitudinal field research methods for studying processes of organizational change," *Organization Science*, (1:3), pp. 213–219.

van de Ven. A., and Poole, M.S. 1995. "Explaining Development and Change in Organizations," *Academy of Management Review*, (20: 3), pp. 510-540.

Vincze, Z. 2013. In search of generative mechanism: the grounded theory approach to process theory building. In: Hassett, M., and Paavilainen-Mäntymäki, E. (Eds.) *Handbook of longitudinal research methods in organisation and business studies*. Cheltenham:UK

Vogelsang, M. 2010. "Dynamics of two-sided internet markets," *International Economics and Economic Policy*, (7:1), pp. 129-145.

Wareham, J., P. B. Fox, and J. L. C. Giner. 2014. "Technology Ecosystem Governance," *Organization Science* 25(4), pp.1195-1215.

West , J., and D. Wood. 2014. "Evolving an Open Ecosystem: The Rise and Fall of the Symbian Platform", in Ron Adner , Joanne E. Oxley , Brian S. Silverman (ed.) *Collaboration and Competition in Business Ecosystems* (Advances in Strategic Management, Volume 30) Emerald Group Publishing Limited, pp.27 – 67.

Wollin, A. 1999. "Punctuated equilibrium: Reconciling theory of revolutionary and incremental change," *Systems Research and Behavioral Science*, 16, pp. 359-367.

Woodard, C.J. and E.K. Clemons. 2014. "Modeling the Evolution of Generativity and the Emergence of Digital Ecosystems", ICIS 2014 Proceedings.

Yin, R. K. 2003. Case study research: Design and methods, 3rd Edition. Thousand Oaks, CA: Sage.

Yoo, Y., Boland, R. J., Lyytinen, K., and Majchrzak, A. 2012. "Organizing for Innovation in the Digitized World," *Organization Science*, (23:5), pp. 1398–1408.

Zhu, X., Song, B., Ni, Y., Ren, Y., and Li, R. 2016. "Platforms—From the One-Sided Market to the One-Sided + Two-Sided Market," in *Business Trends in the Digital Era*, Zhu, X., Song, B., Ni, Y., Ren, Y., Li, R., Springer Singapore, pp. 43-61.

Paper III Dialetics of Digital Platform Ecosystem Evolution

Authors: Staykova, K., S., Mathiassen, L., and Homlstrom, J.

Paper Under Development

The Dialectics of Digital Platform Ecosystem Evolution

Kalina S. Staykova, Department of Digitalization, Copenhagen Business School, Denmark

Lars Mathiassen, CEPRIN, Georgia State University, USA

Jonny Holmstrom, Department of Informatics, Umeå University, Sweden

Abstract

Throughout their evolution, digital platform ecosystems encounter multiple tensions, for example, between actors with conflicting interests or between short-term profitability and long-term sustainability. While current studies acknowledge the existence of such tensions, there are no comprehensive frameworks that integrate them and theorize how their emergence and resolution drive digital platform ecosystem evolution. Against that backdrop, we offer a dialectic theory that articulates the inherent, latent contradictions within the ecosystem, how the involved actors experience these contradictions over time through manifestation of specific, salient tensions, and how the actors address the tensions they face through various responses. Specifically, we suggest four contradictions with regards to performance, architecture, governance and development as the underlying logic that drives digital platform ecosystem evolution and articulate three types of responses, accommodating, splitting and synthesis, through which actors can address the salient tensions they face.

1. The Opportunity to Theorize Digital Platform Ecosystem Evolution

Digital platform ecosystems facilitate direct and regulated interactions among multiple actors by providing an underlying IT architecture and a set of rules (Boudreau and Hagiu, 2009; Constantinides et al., 2018; Huber et al., 2017; Parker et al., 2016; Tiwana, 2014). Thus, digital platform ecosystems refer to the digital platform itself (IT architecture) and all actors (e.g., demand-side users, third-party developers, and more) that interact through it by following specific rules.

In the past couple of years, digital platform ecosystems have become important economic phenomena due to the high complexity and interconnectivity of market products and services that drive organizations to collaborate and combine their knowledge, skills and technological systems to achieve common goals (Ceccagnoli et al. 2012; Jacobides et al. 2018). Due to their inherent digital properties, such as edibility, reprogrammability, communicability and extensibility (Yoo et al., 2010; Kallinikos et al., 2013), digital platform ecosystems are easy to build and scale and they allow for aggregation of previously dispersed services (Bakos, 1998; Hagiu, 2006; Hagiu and Wright, 2011). Digitization, however, comes with certain drawbacks, such as increases in the risk of imitation as competitors can easily replicate successful digital platforms (Gawer,

2014), the introduction of more competitors due to lower barriers to entry (Eisenmann et al., 2009) and compressed evolutionary process (Tiwana, 2014).

In addition, a variety of contradictions characterizes digital platform ecosystems (Eaton et al., 2015; Gawer and Cusumano, 2002; Tiwana, 2014; Wareham et al., 2014). For instance, the contradictions between the platform owner seeking to secure control and the requests for autonomy among independent developers (Eaton et al., 2015; Tiwana et al., 2010) or between growth and efficiency (Hagiu, 2006; 2014) emerge and manifest in different ways during the evolution of digital platform ecosystems. When these contradictions become salient, they require attention and responses from the involved actors as they seek to shape to future trajectory of the ecosystem. Failure to attend to salient tensions may jeopardize the sustainability of the ecosystem and trigger its demise.

While researchers have identified tensions and even outlined specific recommendations to resolve them (.g., Boudreau and Hagiu, 2009; Gawer and Cusumano, 2002; Tiwana, 2014), these tensions remain isolated and dispersed across studies, without providing a comprehensive overview or theoretical anchoring that can help us understand and explain the role of contradictory forces across different ecosystems. Furthermore, few studies (see Eaton et al., 2015; Tiwana, 2014; Wareham et al., 2014) have focused on investigating the role of tensions in the evolution of digital platform ecosystems. To address this gap, we seek to theorize about the process through which the emergence and resolution of tensions drive digital platform ecosystem evolution.

To this end, we draw upon the literature on Dialectics (Benson, 1977; Carlo et al., 2012; Lewis, 2000; Seo and Creed, 2002; Smith and Lewis, 2011) and combine it with key insights from the platform literature to develop a Dialectical theory of digital platform ecosystem evolution. As such, our study aims to demonstrate how the emerging tensions within a digital platform ecosystem and the actions taken to address them shape its evolution. Specifically, we argue that the actors involved in the evolutionary process need to consider different aspects of the ecosystem simultaneously as contradictions appear across them. Furthermore, they need to combine different responses to address tensions without necessarily giving priority to one opposing force over another.

2. The Dialectics of Digital Platform Ecosystems

Digital Platform Ecosystems are ripe with tensions occurring both within and outside their boundaries (Baldwin and Woodward, 2009; Eaton et al., 2015; Wareham et al., 2014; Tiwana, 2014). Tensions within an ecosystem, for example, can occur among heterogeneous actors, whose interests clash (Boudreau and Hagiu, 2009), or between the platform owner and certain types of actors (e.g., third-party developers) in relation to access and use of the underlying IT architecture (Gawer, 2014; Wareham et a., 2014) or in relation to revenue sharing, intellectual property rights and more (Ceccagnoli et al., 2012; Parker et al., 2017). A digital platform

ecosystem can also encounter tensions from actors outside its boundaries, such as rivals (Armstrong, 2006; Eisenmann et al., 2009) and regulators (Evans, 2012; Evans and Schmalensee, 2010).

The emergence and resolution of tensions can play an important role for driving the evolution of a digital platform ecosystem. Wareham et al. (2014), for example, outline contradictions related to the IT architecture within the digital platform ecosystem to understand how these tensions impact ecosystem's evolution. Eaton et al. (2015) further demonstrate empirically how tensions emerging between the platform owner and third-party developers result in a process of "distributed tuning", consisting of resistance and accommodation, which altogether drive the evolution of the ecosystem's boundary resources (APIs and SDKs).

Despite the merits of these studies, they do not provide a comprehensive overview and theoretical anchoring of the tensions related to digital platform ecosystem. While Wareham et al. (2014), for example, focus on the tensions related to the architecture and Eaton et al. (2015) focus on evolution of boundary resources, none of them offers comprehensive theoretical insights into why and how various emerging tensions shape the digital platform ecosystem evolution. To understand and explain the variety of tensions within digital platform ecosystems and how their emergence and resolution drive ecosystem evolution, we build upon extant literature on design, use and governance of digital platform ecosystems and on key principles of dialectics (Benson, 1977) to propose a Dialectical theory of digital platform ecosystem evolution (Figure 1).

Dialectics is a process theory, which scholars can apply to study ongoing transformation of complex phenomenon (Benson, 1977; Van de Ven and Poole, 1995). Dialectics presupposes that contradictory opposites exist and drive the process through emergence of struggles between the opposites and attempts at resolution (Ven de Ven and Poole, 1995). To theorize about digital platform ecosystem evolution from dialectical perspective, we adopt the foundational framework proposed by Benson (1977) as it is comprehensive and at the same time informative (Seo and Creed, 2002). Benson's dialectical framework consists of four overarching concepts—social construction, totality, contradictions and praxis (Benson, 1977)—which we build upon to guide our analysis and synthesis of extant literature.

Building upon Benson's conceptualization of Dialectics (1977), we propose a Dialectical theory of digital platform ecosystem evolution. As summarized in Figure 1, the theory draws on Benson's four foundational concepts (outer circle) to articulate the inherent contractions, salient tensions and managerial responses that drive the evolution of digital platform ecosystems (inner circle). Hence, we present the digital platform ecosystem as a socially constructed totality (Benson, 1977; Carlo et al., 2012; Seo and Creed, 2012) consisting of actors, architecture and governance. The existing configuration of actors, architecture and governance (totality) contains inherent, latent contradictions (Smith and Lewis, 2011) related to performance, architecture, governance and development. When triggered by contextual factors of plurality, change and scarcity (Smith and Lewis, 2011), these contradictions manifest as salient tensions that actors experience (Seo and Creed, 2002). To address them, the platform owner and other actors engage in managerial responses as part of their

praxis (Benson, 1977; Smith and Lewis, 2011), thereby re-constructing the existing ecosystem configuration of actors, architecture and governance. In the following, we explain these constitutive elements of the proposed Dialectical theory of digital platform ecosystem evolution (Figure 1) by drawing upon Dialectics (Benson, 1977; Seo and Creed, 2002; Smith and Lewis, 2011) and an extensive review on the relevant digital platform literature (see Appendix).
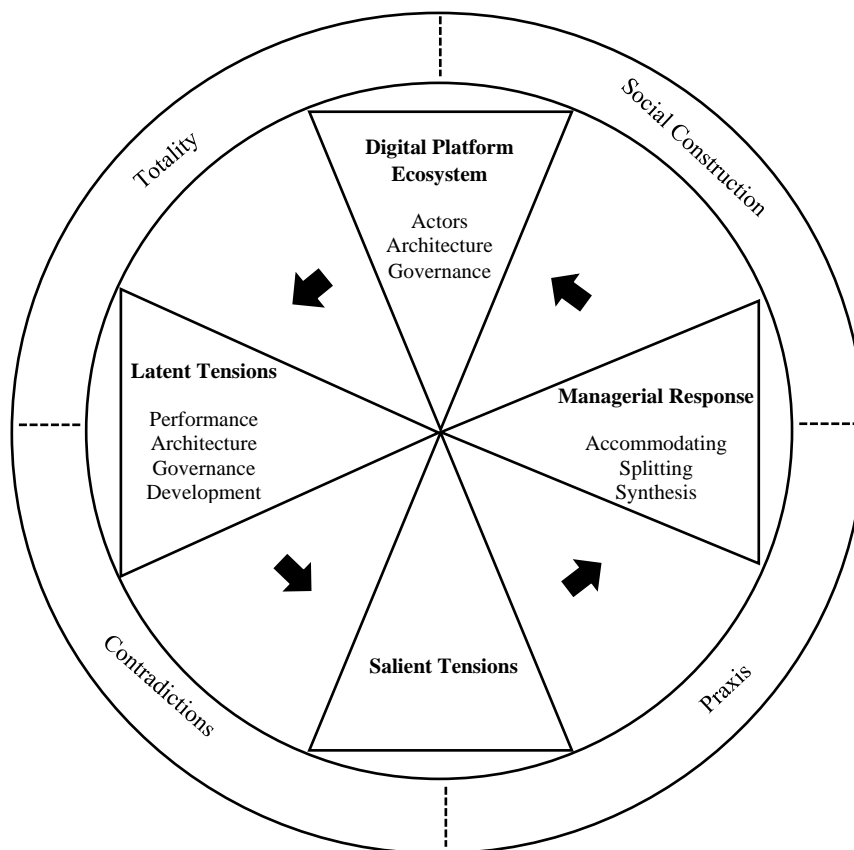
Figure 1. A Dialectical Theory of Digital Platform Ecosystem Evolution

3. The Social Construction of Digital Platform Ecosystems as Interconnected Totality

Digital platform ecosystems are evolving socio-technical arrangements that orchestrate interactions between multiple actors (Parker et al., 2016) through the provision of digital platform architecture (Constantinides et al., 2018; Tiwana, 2014) and emerging governance regimes (Boudreau and Hagiu, 2009; Huber et al., 2017). As such, they comprise of various actors, an IT architecture and a set of governance rules as constructive elements, which intertwine and build on one another in shaping the evolution of the ecosystem (Eaton et al., 2015; Tiwana, 2014). The key components of digital platform ecosystems are summarized in Table 1.

The actors within a digital platform ecosystem play different roles. Platform owners retain the intellectual property rights and provide access to the platform either on their own or through other platform providers, who act as distribution partners (Constantinides et al., 2018; Eisenmann et al., 2011; Ondrus et al., 2015; Parker et

al., 2016). Importantly, the platform facilitates interactions between supply-side users, who provide services through the platform, and demand-side users, who use services provided by the platform owner or supply-side users (Eisenman et al., 2009; Evans, 2012; Hagiu, 2006; Ondrus et al., 2015).

The ecosystem architecture consists of platform core, periphery and boundary resources (Baldwin and Woodward, 2009; Gawer, 2014; Gawer and Cusumano, 2014; Tiwana et al., 2010; Tiwana, 2014). The platform core contains a set of main functionalities provided by the platform owner, which supply-side users, such as third-party developers, can access and use through boundary resources (APIs and SDKs) (Ghazawneh and Henfridsson, 2013; Tiwana, 2014). The complements offered by third-party contributors then form the platform periphery around the platform core (Baldwin and Woodward, 2009; Tiwana, 2014).

To regulate access, interactions and value appropriation among the various actors, the platform owner implements, monitors and enforces a wide set of rules (Boudreau and Hagiu, 2009; Evans, 2009; Ghazawneh and Henfridsson, 2013; Tiwana, 2014). The enforcement of these rules relies on combinations of legal, technical, pricing and informational tools (Boudreau and Hagiu, 2009; Evans, 2012).

Table 1. Concepts of Digital Platform Ecosystems		
Concept	**Definition**	**References**
Actors	The heterogeneous actors (platform owner(s), platform provider(s), supply-side users, demand-side users) involved in the social construction and reconstruction of a digital platform ecosystem	Eisenmann et al., 2009; Evans, 2012; Gawer and Cusumano, 2014; Hagiu, 2016; Ondrus et al., 2015
Architecture	The structuring of a digital platform's core, periphery and boundary resources	Baldwin and Woddward, 2009; Eaton et al., 2015; Gawer and Cusumano, 2014; Ghazawneh and Henfridsson, 2013; Tiwana, 2014
Governance	The rules that regulate access, participation and value appropriation in a digital platform ecosystem	Boudreau and Hagiu, 2009; Evans and Schmalensee, 2016; Parker et al., 2016; Tiwana, 2014

While some researchers study specific components of digital platform ecosystems, such as actors (Evans, 2009) and governance (Boudreau and Hagiu, 2009; Huber et al., 2017), most scholars consider them interconnected. For example, as platform owners extend the platform core through the provision of boundary resources, they nurture the development of an ecosystem of third-party complementors as supply-side actors, who use the boundary resources to offer new functionalities (Boudreau and Jeppersen, 2015; Gawer and Cusumano, 2014; Gawer, 2014; Hagiu, 2006). As the architecture becomes more open, platform owners need

to establish rules for compatibility between external service modules and the platform core (Baldwin and Woodward, 2009; Gawer, 2014) and they need to consider new rules or modify existing ones to retain control over the ecosystem (Eaton et al., 2015; Ghazawneh and Henfridsson, 2013). As new ecosystem participants join, platform owners also need to adjust the rules in connection to a number of issues such as ownership, revenue sharing, interactions with existing participants, and more (Ghazawneh and Henfridsson, 2013; Hagiu, 2014; Parker et al., 2016; Tiwana, 2014). Thus, while actors, architecture and governance can be considered separately, they interlock to mutually constitute the digital platform ecosystem as an interconnected totality (Benson, 1977; Seo and Creed, 2002).

As ecosystem actors engage in regulated interactions with one another and with the underlying architecture, they continuously construct and reconstruct the structure of the digital platform ecosystem (Benson, 1977; Eaton et al., 2015). In these interactions, they draw upon their power, interests, resources, and environmental constraints and opportunities (Benson, 1977; Carlo et al., 2012; Seo and Creed, 2002). For example, platform owners may encourage collaboration with third-party complementors by providing them with boundary resources to access the architecture because they lack resources to enter all possible markets on their own (Gawer and Henderson, 2007). Platform owners can also restrict the access to the boundary resources of the platform, if they believe that their control over them weakens (Ghazawneh and Henfridsson, 2013). Because of the high level of uncertainty in the ecosystem environment, platform owners are generally, at the initial stages of evolution, cautious about opening for external complementors and therefore limit access to the platform's boundary resources (Dattee et al., 2017).

Ecosystem actors are heterogeneous (Ceccagnoli et al., 2012; Eaton et al., 2015) and they interact to construct and reconstruct the ecosystem based on a plurality of interests and power positions (Eaton et al., 2015; Ghazawneh and Henfridsson, 2013; de Rond and Bouchikhi, 2004). Specifically, platform owners as ecosystem creators and orchestrators exert asymmetric level of power over the other ecosystem actors by encouraging fruitful interactions and sanctioning harmful exchanges (Boudreau, 2017; Boudreau and Hagiu, 2009; Evans, 2012). As a result of this power imbalance, third-party complementors, for example, can have difficulties defending their interests (Boudreau and Hagiu, 2009; Eaton et al., 2015; Gawer and Henfridsson, 2007; Ghazawneh and Henfridsson, 2013; Tiwana, 2015). In its role, the platform owner exercises regulatory power (Boudreau and Hagiu, 2009) and relies on its ability to command communal resources (Tan et al., 2015) to institutionalize certain interaction patterns (Benson, 1977; Carlo et al., 2012; Boudreau and Hagiu, 2009; Seo and Creed, 2002).

At the same time, the established structure of a digital platform ecosystem enables and constrains its ongoing construction and re-construction (Benson, 1977; McQuire, 1988; Seo and Creed, 2002). For example, the presence of many demand-side users attracts supply-side users due to strong cross-side network effects (Hagiu, 2006; Eisenmann et al., 2006; Evans, 2009; Casey and Toyli, 2012; Ruutu et al., 2017). Further, by initially

narrowing down the possible uses of the platform, the platform owner determines the subsequent interactions with third-party complementors (Datee et al., 2017; Tan et al., 2015).

The existing structure of a digital platform ecosystem is of temporal order and subject to change (Benson, 1977; McQuire, 1988). As ecosystem actors interact with one another and with the architecture provided by the platform owner to construct and reconstruct the digital platform ecosystem, they modify the existing structure as new interaction patterns emerge (Benson, 1977). For example, tensions can occur between actors (e.g., demand-side users and supply-side users), which require the owner to modify the existing governance regime (Evans, 2012; Parker et al., 2016). Similarly, the introduction of new types of actors, such as new platform providers, can change the existing architecture (Eisenmann et al., 2011; Olleros, 2008; Ondrus et al., 2015; Tiwana, 2014). Hence, during the ongoing construction of a digital platform ecosystem as an interconnected totality, its constitutive elements (actors, architecture and governance) interlock as changes in one element often lead to changes in the other two (Benson, 1977; Hagiu, 2014; Tiwana, 2014).

4. The Contradictions Inherent in the Totality of Digital Platform Ecosystem

Although a digital platform ecosystem may seem as an orderly structure, its ongoing construction through the regulated interactions between ecosystem actors and architecture produces a myriad of tensions (Benson, 1977; Carlo et al., 2012; Cho et al., 2007; Seo and Creed, 2002; Smith and Lewis, 2011). These tensions are by-products of the construction process and, as such they are manifestations of inherent contradictions embedded into the digital platform ecosystem (Hargrave and Van de Ven, 2017; Lewis, 2000; Seo and Creed, 2002; Smith and Lewis, 2011). As the ecosystem constitutes an interconnected totality, these inherent contradictions may manifest as specific salient tensions across the whole ecosystem and interact with other tensions (Benson, 1977; Carlo et al., 2012; Seo and Creed, 2002).

Contradictions consist of two conflicting, yet connected and mutually dependent opposites, which form a unity (Cho et al., 2007; Hargrave and Van de Ven, 2017; Lewis, 2000; Smith and Lewis, 2011). A contradiction has two characteristics—identity and the fight between its two opposite forces (Cho et al., 2007). The identity of a contradiction captures the occurring juxtaposition between its two co-existing opposites, while the fight refers to the dynamic, disharmonious relationship between them, which changes over time by giving a prevalence of one opposite over the other (Bjerknes, 1991; Cho et al., 2007; Lewis, 2000).

We identify four inherent contradictions in digital platform ecosystems, namely performance, architecture, governance related to the constituting elements of a digital platform ecosystem, and development related to the evolution of the ecosystem (Table 2). During the ongoing construction of the ecosystem, these contradictions may manifest as multiple, coexisting salient tensions that actors then experience and respond to in various ways (Cho et al., 2007; Hargrave and Van de Ven, 2017).

Performance Contradiction. To achieve long-term sustainability of a digital platform ecosystem, the platform owner must ensure its stable and appropriate performance over time by resolving tensions between growth and efficiency. This performance contradiction refers to the accumulated tensions between the growth of actors and the need to maintain efficiency in the digital platform ecosystem (Evans and Schmalensee, 2010; Hagiu, 2006, 2014; Halaburda and Piskorski, 2010). As the two opposites co-exist, forming a unity, the platform owner must direct resources to ensure appropriate contributions to the actors within the digital platform ecosystem.

To ensure that a digital platform ecosystem ignites after its launch, the platform owner needs to attract sufficient number of actors (Evans and Schmalensee, 2010; Evans, 2009; Hagiu, 2006; Parker et al., 2016; Ruutu et al., 2017). After reaching a critical mass of actors, which is necessary, but not sufficient condition for sustainability (Ondrus et al., 2015), the platform owner seeks to further improve the performance of the ecosystem by attracting more actors both in terms of volume (e.g., more demand-side users) and type (e.g., inclusion of platform providers in addition to the platform owner) (Hagiu, 2006; 2014). The addition of more actors increases the number of interactions between existing and new actors and strengthens the network effects between them (Parker et al., 2016). The continuous growth improves the overall performance of the ecosystems as actors increasingly interact with other actors (Evans, 2009; Parker et al., 2016).

While the growth of actors may ensure the sustainability of the digital platform ecosystem over time, it can also create inefficiencies that challenge the overall performance of the ecosystem (Evans and Schmalensee 2010; Evans, 2012; Inoue and Tsujimoto 2017; Hagiu and Rothman, 2016; Tiwana, 2014; van Alstyne et al. 2016). To improve performance, the platform owner seeks to foster efficiency through fine-tuning of the existing ecosystem structure.

Architecture Contradiction. The platform owner should design and maintain the architecture of the ecosystem to serve current and future needs of the participating actors. To this end, the owner needs to address ongoing tensions stemming from the inherent contradiction between reliability and evolvability of the architecture (Baldwin and Woodward, 2009; Wareham et al., 2014; Tiwana, 2014). While platform reliability ensures platform evolvability, the development of the platform ecosystem also challenges its ongoing reliability (Tilson et al. 2010, Tiwana et al. 2010; Wareham et al., 2014). For example, although the architecture typically consists of lean platform core during the early stages of development (Olleros, 2008; Tiwana, 2014), the architecture tends to evolve over time in complexity by adding and expanding its periphery (de Reuver et al., 2017), which can undermine its reliability to existing actors due to accumulated technology debt (Rolland et al., 2018).

To support reliably the ongoing interactions within the digital platform ecosystem, the platform owner must design a scalable and resilient architecture (Olleros, 2008; Tiwana, 2014). When the architecture is scalable, its performance is independent from the number of participating demand-side and supply-side users (Kohler,

2018; Tiwana, 2014). Thus, even as the number of actors increases over time, the architecture can reliably support growth without leading to failures. Subsequently, the architecture also needs to be resilient to avoid or minimize adverse effects failure (Tiwana, 2014). Thus, reliability forces seek to improve the capability of the architecture to serve the current needs of ecosystem actors.

At the same time, the architecture must remain evolvable to address changes within the ecosystem (Wareham et al., 2014) and its surrounding environment (Baldwin and Woodward, 2009). Due to digital capabilities, such as edibility, re-programmability and integration (Kallinikos et al. 2013; Yoo et al., 2012) and the initially lean design of its core (Gawer and Cusumano, 2002; Olleros, 2008), the platform core, boundary resources and periphery evolve over time. The platform owners, for example, evolve the core by incorporating new functionalities and removing irrelevant ones from it (Tiwana, 2014). Similarly, to enable further platform evolvability, owners provide boundary resources, which allow third-party complementors to access and contribute to the platform core (Baldwin and Woodward, 2009; Gawer, 2014; Ghazawneh and Henfridsson, 2013; Tiwana, 2014). These external complements form the platform periphery, which evolves through fluctuation of external complements, which either increase with the introduction of more boundary resources and complementors (Baldwin and Woodward, 2009; Gawer and Cusumano, 2002) or decrease as a result of competitive selection by demand-side users and platform owners (Ceccagnoli et al., 2012; Inoue and Tsujimoto, 2017). Thus, evolvability forces seek to improve the capability of the architecture to serve the future needs of existing and new ecosystem actors.

Governance Contradiction. To ensure optimal functioning of the digital platform ecosystem, the platform owner should encourage access to the ecosystem on different levels, while also ensuring that existing and new actors do not diverge significantly from established practices (Boudreau and Hagiu, 2009; Ghazawneh and Henfridsson, 2013; Parker and van Alstyne, 2008; Tiwana, 2014; Wareham et al., 2014). As a result, two opposing forces, namely openness and control, co-exist and interact to constitute the governance contradiction inherent within a digital platform ecosystem.

The platform owner can open the digital platform ecosystem on two levels—actors (owner, provider, user) and architecture (Eisenmann et al., 2006; Ondrus et al., 2015). To spur adoption, for example, the platform owner can open the access to the ecosystem for both demand-side and supply-side users (Ondrus et al., 2015). To encourage further innovation, the platform owner can also open the architecture to external contributors (supply-side users) instead of innovating solely in-house (e.g., innovation from external complementors or technology from platform providers) (Eisenmann et al., 2011; Gawer and Cusumano, 2002). Third-party complementors then decide whether to join the ecosystem depending on the size of the demand-side users (Evans, 2009; Hagiu, 2006), the return on partnerships (Gawer and Cusumano, 2002; Gawer and Hendersson, 2007; Parker et al, 2017), and the level of autonomy (Wareham et al., 2017). The introduction of new actors and the opening of the architecture to varying degrees (Eisenmann et al., 2009; West, 2003) leads to new

interactions within the ecosystem, which can conform or deviate from the existing ones (Boudreau and Hagiu, 2009; Tiwana, 2014). As such, openness forces introduce mechanisms that drive platform ecosystem renewal by encouraging increased variety of actors and emerging practices.

While an increase in openness supports adoption and innovation within a digital platform ecosystem, it also challenges and, in some cases, decreases the control of the platform owner over it (Eaton et al., 2015; Evans, 2012; Gawer and Cusumano, 2002; Tiwana, 2014; Wareham et al., 2014; West, 2003). Due to their desire to act autonomously, some new actors engage in practices, which challenge the control of the platform owner over the ecosystem (Eaton et al., 2015; Wareham et al., 2014). For example, third-party complementors can resist the efforts of the platform owner to control access to and use of boundary resources (Eaton et al., 2015; Ghazawneh and Henfridsson, 2013). Similarly, the inclusion of supply-side users may lead to unregulated practices where certain ecosystem actors engage in harmful behaviour towards other actors (e.g., non-delivery of purchased goods) (Hagiu, 2006). Thus, to ensure appropriate functioning of the ecosystem, control forces seek to introduce mechanisms that drive alignment of platform ecosystem actors and their practices.

Development Contradiction. Throughout the evolution of a digital platform ecosystem, the platform owner struggles to consolidate the existing structure of actors, architecture and governance, while at the same time adapting to emerging internal and external challenges. Thus, the development contradiction encompasses consolidation and adaptation as two opposites, which intertwine to shape the development trajectory of the ecosystem. While consolidation forces seek to respond to internal and external challenges by reinforcing the current development trajectory of the ecosystem, adaptation forces seek to respond by transforming the trajectory.

This development contradiction, which refers to the overall evolutionary process, relates closely to the above contradictions in performance, architecture, and governance (Table 2). Consolidation of the existing path presupposes an emphasis on the efficiency of interactions (performance), reliability of the architecture and ensuring an appropriate level of control over the digital platform ecosystem (Boudreau and Hagiu, 2009; Tiwana, 2014; Wareham et al., 2014). Thus, rather than seeking new developments, the platform owner consolidates the previously introduced changes to the existing structure of actors, architecture and governance. Some of the occurring internal and external events, however, challenge the existing trajectory and require adaptation of the ecosystem structure by emphasizing growth in ecosystem actors, evolvability of the architecture and the ability of the ecosystem to open further (Gawer, 2015; Parker et al., 2017).

Table 2. Inherent Contradictions in Digital Platform Ecosystems		
Contradiction	**Identity**	**Opposites**
Performance	A digital platform ecosystem must direct resources to ensure	Opposite: *Efficiency* forces seek to improve performance through fine

	appropriate contributions to its participants	tuning of the existing ecosystem configuration Opposite: *Growth* forces seek to improve performance through strengthening network effects from new ecosystem participants
Architecture	A digital platform ecosystem must design and maintain the platform to serve current and future needs of its participants	Opposite: *Reliability* forces seek to improve the capability of the platform architecture to serve the current needs of ecosystem participants Opposite: *Evolvability* forces seek to improve the capability of the platform architecture to serve the future needs of existing and new ecosystem participants
Governance	A digital platform ecosystem must enable the access and support the practices of its participants	Opposite: *Control* forces seek to introduce mechanisms that drive alignment of platform ecosystem participants and their practices Opposite: *Openness* forces seek to introduce mechanisms that drive platform ecosystem renewal through new participants and emerging practices
Development	A digital platform ecosystem must respond to internal and external events that challenge its status quo	Opposite: *Consolidation* forces seek to respond by reinforcing the current trajectory of the digital platform ecosystem Opposite: *Adaptation* forces seek to respond by transforming the current trajectory of the digital platform ecosystem

5. The Salient Tensions in the Contradictory Praxis of Digital Platform Ecosystems

While contradictions are inherent and enduring within the existing structure of digital platform ecosystems, they remain latent or dormant if ecosystem actors are unaware of them (Lewis and Smith, 2014; Seo and Creed, 2002; Smith and Lewis, 2011). When triggered, however, inherent contradictions manifest as salient tensions (Table 2) that draw the attention of the platform owner and other ecosystem actors during ecosystem evolution (Lewis, 2000).

Plurality, change and scarcity in the digital platform ecosystem can transform the inherent contradictions into salient (Smith and Lewis, 2011). Plurality refers to the presence of multiple heterogeneous interests among ecosystem actors, which may be incompatible. Internal and external changes (Gawer, 2015) can create inconsistency between existing and new arrangements and may require ecosystem actors to reconsider their

roles and actions. Further, due to scarcity of resources, the platform owner may have to decide how to allocate them between several competing alternatives (Smith and Lewis, 2011).

Salient Tensions from Performance Contradiction. The performance contradiction, which constitutes a struggle between stimulating ecosystem growth and maintaining ecosystem efficiency, can manifest in salient tensions, such as decrease in the quality of offerings that leads to inefficient interactions, architecture and governance that misfit growth, and collaborations that turn into competition over resources (Table 3).

Change in type of ecosystem actors (e.g., the introduction of third-party developers; Tan et al., 2016) and change in volume of actors (e.g., more demand-side and supply-side users join; Evans and Schmalensee 2010) may lead to congestion as too many actors join the ecosystem at the same time. Increase in supply-side users (e.g., third-party developers (Boudreau, 2012) or fundraising backers (Wessel et al., 2017)) often results in decrease in the quality of their offerings (Halaburda and Piskorski, 2010; Kohler, 2018; Wessel et al., 2017). Boudreau (2012), for example, found that third-party developers, who joined the ecosystem early, offer more innovative complements in comparison to late comers, who often offer complements similar to the already existing ones. The increased intra-competition between supply-side users can also lead to the exit of some of them (Tiwana, 2015; Wessel et al., 2017), which can result in both demand-side and supply-side users leaving the platform ecosystem (Inoue and Tsujimoto, 2017) or multi-homing to rival ecosystems (Eisenmann et al., 2006), which undermines the overall performance.

Apart from decrease in quality, growth of ecosystem actors can lead to high search and coordination costs between demand-side and supply-side users, which reduce the number of efficient interactions between them (Evans and Schmalensee 2010; Inoue and Tsujimoto 2017; Tiwana, 2015; van Alstyne et al. 2016). For example, the variety of innovative offerings attracts numerous demand-side users, but the increased diversification may lead to less commitment from them (that is lack of adoption) due to inability to comprehend which of the offerings suit their needs best (Hagiu, 2006). As the main purpose of digital platform ecosystems is to enable interactions between the affiliated to them actors (Hagiu and Wright, 2011; Parker et al., 2016), a decrease in such interactions stalls the performance of the ecosystem.

Increased growth of actors also creates tension with an ecosystem's existing architecture and governance. For example, the existing architecture may not be able to support the growing number of interactions between demand-side and supply-side users (Kohler, 2018; Parker et al., 2016), leading to slow down and irresponsiveness when actors engage (Tiwana, 2014). While the growing number of actors unlocks new revenue streams, it also imposes additional governance costs (costs for coordination, support, monitoring, and more) on the platform owner, which limits the overall profitability and future investments (Evans, 2012; Huber et al., 2017; Parker and van Alstyne, 2008; Svahn et al., 2017; Wareham et al., 2014; West, 2003).

New actors allow platform owners to establish new collaborations (Parker et al., 2017). However, increased heterogeneity of interests between the platform owner and third-party complementors can often turn collaborators into competitors (Cusumano and Gawer, 2002; Hagiu, 2014; Hagiu and Spulber, 2013; Parker and van Alstyne, 2008; Wareham et al., 2014). Due to diverging interests, platform owners can enter into markets dominated by some of their complementors (Gawer and Hendersson, 2007). Similarly, third-party complementors may decide to join the ecosystem and subsequently create similar offerings to those provided by the platform owner, in attempts to disintermediate the owner (Baldwin and Woodward, 2009).

The inclusion of heterogeneous actors also intensifies competition for access to the platform owner's assets (e.g., development and maintenance resources). Due to the scarcity of these resources, the owner may therefore face challenges distributing resources to ecosystem actors (Eaton et al., 2015), leading to dissatisfied actors that may choose to leave the ecosystem.

Salient Tensions from Architecture Contradiction. The architecture of digital platform ecosystems consists of platform core, boundary resources and periphery, all of which evolve over time (Boudreau, 2012; Eaton et al., 2015; Tiwana, 2014). Over the course of ecosystem evolution, the inherent contradiction between reliability and evolvability of the architecture strengthens and when triggered, manifests into several salient tensions, including partitioning that requires integration, provisioning of stable, yet versatile boundary resources, and growing complexity that challenges reliability (Table 3).

When designing and developing the architecture of a digital platform ecosystem, the platform owner has to decide how much to innovate based on own efforts and how much to rely on third-party complementors (Olleros, 2008; Tiwana, 2014). While evolving the platform core based on own efforts prevents the disruption of the ecosystem by lowering the risk of competitive imitation (Eisenmann et al., 2009), it also challenges platform maintenance and the speed, with which the owner can deliver innovation (Eisenmann et al., 2009; Tiwana, 2014). Similarly, while developing platform periphery with external complementors fosters innovation, it also increases the risk of platform disintermediation (Baldwin and Woodward, 2009; Eisenmann et al., 2009; Olleros, 2008; Tiwana, 2014).

This choice entails that the platform owner partitions the ecosystem architecture between a stable, lean platform core, provided by the platform owner, and a periphery of complements, provided by third-party developers (Baldwin and Woddward, 2009; Olleros, 2008; Tiwana, 2014). Such partitioning allows for division of labour between platform owner and complementors, with each of them building upon their strengths to innovate (Tiwana, 2014). While their autonomy is encouraged, third-party complements also need to integrate properly into the platform core to ensure the stability of the ecosystem (ibid). At the same time, if integration is cumbersome, the evolvability of the platform core may come under threat with third-party complementors abandoning the ecosystem for rival ones (Tiwana et al., 2010).

Finding the balance between integration and partitioning is challenging (Baldwin and Woodward, 2009; Tiwana et al., 2010; Tiwana, 2014; Yoo et al., 2012; Wareham et al., 2014). Tight coupling between core and periphery, for example, promotes reliability and optimizes performance (i.e., stability), but restricts variety and innovation (i.e., evolvability) (Baldiwn and Woodward, 2009; Tiwana, 2014; Yoo et al., 2012). Loose coupling, on the other hand, spurs innovation (evolvability), but, while it also ensures resilience due to the low interdependencies (Tiwana et al., 2010), it also leads to fragmentation and high coordination costs (stability) (Boudreau, 2010; Tiwana, 2014; Wareham et al., 2014). Furthermore, the level of integration (or degree of coupling) alters over time with internal or external changes in the ecosystem (Yoo et al., 2012). For example, an internal change in the platform core or periphery may challenge the existing level of integration as well as the established partitioning (Tiwana et al., 2010). Thus, changes in the architecture due to its evolvability can trigger tensions between the existing arrangements around the ecosystem architecture when it comes to integration and partitioning.

The platform core and the periphery around it connect through boundary resources, also referred to as interfaces and design rules (Baldwin and Woodward, 2009; Tiwana et al., 2010; Ghazawneh and Henfridsson, 2013; Eaton et al., 2015). To ensure proper connectivity, on one hand, boundary resources need to be stable to enable interoperability between complements and platform core, and, on the other, they must be versatile to incorporate subsequent innovative complements (Baldwin and Woodward, 2009; Tiwana et al., 2010). By providing standardized boundary resources, the platform owner ensures that third-party complementors follow uniform rules about access to and integration with the platform core (Tiwana et al., 2010; Yoo et al., 2012). High degree of standardization, which implies strict rules, however, decreases the flexibility of the architecture, which can subsequently constrain the innovative efforts of third-party complementors (Baldwin and Woodward, 2009; Tiwana et al., 2010; Wareham et al., 2014). On the other hand, too versatile boundary resources support new innovative complements, but lead to fragmentation among them (Tiwana, 2014; Wareham et al., 2014).

While the platform owner should encourage the evolvability of the architecture to benefit from external innovation, the growing variety of complements results in increased complexity, which, if unaddressed, can impede future ability to evolve (Tiwana, 2014). The plurality of heterogeneous complements, often facilitated by versatile boundary resources, makes interconnections between complements and platform core, on one hand, and among complements themselves, on the other, difficult to comprehend due to the high degree of interdependencies (Gawer and Cusumano, 2002; Tiwana, 2014). If not reduced in due time, these interdependencies can magnify the detrimental effects of a failure within one part of the architecture by spreading the damage to other parts (also called "ripple effect"; see Tiwana, 2014), thus destabilizing the overall architecture.

Salient Tensions from Governance Contradictions. Inherent contradictions between control and openness within the digital platform ecosystem manifest in three main salient tensions, namely centralization that restricts decentralization, divergence that requires conformity, and aggregation that balances sharing (Table 3).

Digital platform ecosystems usually evolve from relatively closed to open and back to being closed (Eisenmann et al., 2009; Gawer, 2009, 2015; Parker et al., 2017; Ondrus et al., 2015; West, 2003). Thus, upon the initial formation of the ecosystem, the platform owner often exercises tight control over the ecosystem actors and architecture (Cusumano and Gawer, 2002). With the increase in the degree of openness, however, the high level of control retained by the platform owner may clash with the demand from ecosystem actors (e.g., third-party complementors, platform providers, platform owners; see Ondrus et al., 2015) for making decentralized decisions over their participation in the ecosystem (Cusumano and Gawer, 2002; Eaton et al., 2015; Tiwana et al., 2010; Svahn et al., 2017). When seeking to foster variety of complements (Tiwana, 2014) or to spur adoption (Ondrus et al., 2015), the owner can accommodate their request and grant them autonomy (Parker and van Altyne, 2008).

While high level of centralization discourages third-party complementors from joining a platform ecosystem (Ceccagnoli et al., 2012), increased decentralization, however, magnifies the heterogeneity among ecosystem actors, who often have conflicting interests. Because of the increased plurality of interests, which ecosystem actors can pursue freely in an autonomous governance regime, the instances of actors misbehaving also may surge (Boudreau and Hagiu, 2009; Evans, 2012). Such bad behaviour (e.g., such as non-delivery of goods (eBay), damaging property (Airbnb)) diverges from the existing governance rules, which promote efficiency, and as a result, the platform owner can require the ecosystem actors to conform to existing rules, or, often to newly introduced, which curb the level of autonomy (Evans, 2012; Parker et al., 2016).

The increased level of openness within the ecosystem also leads to tensions between the desire of the platform owner to aggregate and control resources (e.g., intellectual property rights (IPR), revenue, access to demand-side users) with the need to allocate them in fair manner in order to keep other actors part of the ecosystem (Gawer and Henfridsson, 2009; Parker et al., 2017; Svahn et al., 2017; West, 2003). For example, while by opening the ecosystem, the owner can accumulate additional resources (e.g., revenue, IPRs, innovation, etc.), the continuous flow of resources is dependent upon its ability to share them with other ecosystem actors, which, in fact, reduces the accumulated resources for the platform owner (Gawer and Henderson, 2007; West, 2003).

Salient Tensions from Development Contradiction. The development contradiction refers to the struggle between consolidating the existing ecosystem trajectory and the need to adapt it to emerging challenges and opportunities. When triggered, this contradiction renders into three salient tensions, namely, ensuring growth that requires adoption, expansion that fosters inter-platform competition, and innovation that challenges legitimation (Table 3).

While digital platform ecosystems evolve constantly (Gawer, 2015), the platform owner needs to ensure that changes within the existing structure of actors, architecture and governance are absorbed within the ecosystem. As a result, the owner redirects some efforts to consolidate the existing evolutionary trajectory. For example, the growth of the ecosystem in terms of attracting new types of actors and offering new functionalities increases the value of the platform to existing participants, but if a platform owner directs all resources to further development by investing in attracting new types of actors and neglects ensuring continuous adoption, actors may abandon the platform ecosystem (Hagiu, 2006).

While consolidation forces seek to reinforce the existing structure of an ecosystem's actors, architecture and governance, internal and external events can challenge its existing development trajectory, leading to its adaptation. The emergence of new competitors may require the platform owner to shift the existing evolutionary path by, for example, entering into new markets (Eisenmann et al., 2011). This expansion, however, increases further the inter-platform competition, creating tensions with existing and new competitors alike (Armstrong, 2006; Eisenmann et al., 2011).

The novelty of the services offered by a digital platform ecosystem (e.g., Uber and Airbnb) can create a misfit with existing regulation, which challenges the overall legitimacy of the ecosystem and requires further adaptation (Evans, 2012; Hagiu and Rothmans, 2016). For example, the value creation within the digital platform ecosystem, which orchestrates the interactions between affiliated to it actors (Hagiu and Wright, 2011), may diminish the welfare of certain actors outside the ecosystem (e.g., Uber and Airbnb) (Hagiu, 2006). Further, regulators can interpret measures implemented by the platform owner to maintain the value creation in the ecosystem (such as restricting access or appropriating external complements) as anti-competitive behaviour (Parker et al., 2017). Collaborating with external contributors in the form of mergers or in the form of agreements preventing participants to partner with other ecosystem actors can also constitute a restriction to competition (Evans, 2012). As a result, regulators may require changes in the digital platform ecosystem, which alter its existing development trajectory.

In addition, internal challenges, such as lack of resources, can propel a platform owner to open the ecosystem so that third-party actors can access and use it (e.g., supply-side users and platform providers) (Gawer and Cusumano, 2002; Tiwana, 2014), thus changing the existing development trajectory. The inclusion of new actors, however, may require changes in ownership, which can also impact the future development of the evolutionary path (Eisenmann et al., 2009; Ondrus et al., 2015).

Table 3. Inherent Contradictions and Corresponding Salient Tensions		
Contradiction	**Opposites**	**Salient Tensions**
Performance	• Growth • Efficiency	• Decrease in quality of offerings that leads to inefficient interactions

		• Architecture and governance that misfit growth • Collaborations that turn into competition over resources
Architecture	• Reliability • Evolvability	• Partitioning that requires integration • Stable, yet versatile boundary resources, • Growing complexity, which challenges reliability
Governance	• Control • Openness	• Centralization that restricts decentralization • Divergence that requires conformity • Aggregation that balances sharing
Development	• Consolidation • Adaptation	• Growth that requires adoption • Expansion that fosters inter-platform competition • Innovation that challenges legitimation

6. Responses to Tensions in the Praxis of Reconstructing Digital Platform Ecosystems

Once an inherent contradiction escalates and becomes salient (Benson, 1977; Smith and Lewis, 2011), it draws the attention of the platform owner and other ecosystem actors (Smith and Lewis, 2011), who then can reject or accept it (Smith and Lewis, 2011). By not addressing the tension, the ecosystem enters a vicious cycle, which can be detrimental to its future evolution (Smith and Lewis, 2011; Poole and Van de Ven, 1989). Some tensions, however, are of such intensity that they do not allow the platform owner and other ecosystem actors to ignore them (Benson, 1977; Van de Ven and Poole, 1995). When attending to a salient tension, platform owners and other ecosystem actors engage in activities (praxis), spanning from the moment a tension becomes salient until its resolution (Seo and Creed, 2002; Smith and Lewis, 2011). When actors become aware of a tension (Benson, 1977; Seo and Creed, 2002), they may mobilize resources and interact to reconstruct the existing structure, which does not fit their interests any longer (Benson, 1977; Carlo et al., 2012; Van de Ven and Poole, 1995).

By assuming the role of an orchestrator with responsibility to maintain and develop the digital platform ecosystem, platform owners seek to resolve salient tensions to ensure the sustainability of the ecosystem. While platform owners may rely on three responses, namely accommodating, splitting and synthetizing (Poole and Van de Ven, 1989; Smith and Lewis, 2011) to manage salient tensions, other ecosystem actors may participate in this process depending on their resources, interests and support from other actors (Eaton et al., 2015).

Accommodating a salient tension involves providing opportunity for the two constituting opposites of an inherent contradiction to develop towards a joint outcome through emergent or deliberate actions (Poole and Van de Ven, 1989). Splitting involves seeking to prevent the opposites from interacting by separating them in

time or space (Poole and Van de Ven, 1989; Smith and Lewis, 2011). Transforming involves negotiation and innovation by synthetizing the two opposites into a response, typically in situations when the two opposites cannot co-exist (Benson, 1977; Poole and Van de Ven, 1989).

Managerial Responses to Performance Tensions. Attending to the salient tensions between growth and efficiency as manifestation of the performance contradiction, the owner engages in splitting when it comes to managing plurality of conflicting interests, accommodating for addressing the inefficiency stemming from congestion, and synthesis for resolving the misfit between architecture and growth.

To solve the salient tensions between growth and efficiency, the platform owner usually relies on splitting strategy by separating the two opposites in time. For example, during the initial formation of the platform ecosystem, the owner focuses on achieving sustainable growth (critical mass of users; see Evans, 2009; Ondrus et al., 2015; Ruutu et al., 2017) rather than on investing in efficiency. With the growth of actors, which challenges the ecosystem performance (see above), the owner shifts its attention towards ensuring efficiency, thus slowing down the growth rate (Hagiu, 2006; Parker et al., 2017; Rolland et al., 2018).

The platform owner also relies on splitting to solve the tensions among heterogeneous actors who compete for limited resources. For example, the owner can maintain differentiation between the distinct types of ecosystem actors (e.g., demand-side and supply-side users) (Hagiu, 2006; 2014) and make sequential investments in them (Bakos and Katsamakas, 2008). Furthermore, it can altogether avoid including too many distinct types of actors (Hagiu, 2014), which decreases the plurality of interests, and puts emphasis on efficiency over growth.

When addressing the decrease in the quality of offerings, which leads to inefficient interactions as a manifestation of the performance contradiction, the platform owner accommodates the tension between growth and efficiency. To foster growth, while also ensuring efficiency, the owner adjusts the existing governance regime by, for example, installing curation mechanisms to cultivate desired behaviour (e.g., ratings, insurance policy, dispute resolution mechanisms) (Evans, 2012; Hagiu and Rothman, 2016; Kohler, 2018; Parker et al., 2016). It can further penalize or exclude actors who engage in an inappropriate behaviour (Casadesus-Masanell and Halaburda, 2011; Evans, 2013; van Alstyne et al., 2016). In some cases, the owner can engage in splitting, giving temporal preference to efficiency over growth by reducing the number of actors to improve quality of interactions (Casadesus-Masanell and Halaburda, 2011; Halaburda and Piskorski, 2010).

The growth of actors also creates misfit with the existing architecture, thus prompting the platform owner to improve its capabilities (Kohler, 2018; Tiwana, 2014). For example, to improve scalability, the platform owner can enhance the technical quality of the architecture (Hartigh et al., 2016). Such architectural innovation constitutes a synthesis response as the owner transforms the existing architecture to support the growth of actors.

Managerial Responses to Architecture Tensions. To resolve the inherent contradiction between reliability of the architecture and its evolvability, the platform owner adopts accommodating, splitting and synthesis responses. The owner engages in splitting and synthesis when dealing with tensions around partitioning and integration between the platform core and platform periphery, in accommodating when offering stable and versatile boundary resources and, in synthesis when managing the growing complexity as to ensure reliability of the architecture.

When addressing the tension between partitioning of the innovative efforts between itself and external complementors, the owner usually relies on synthesis. In cases where there is no conflict, the owner and external developers collaborate (Gawer and Cusumano, 2002; Tiwana, 2014). When tensions between them become salient (see above), the owner can absorb competing and crucial complements, thus transforming the platform core and closing partially the access to it (Boudreau, 2017; Eisenmann et al., 2009; Parker et al., 2017).

However, to encourage collaboration rather than competition, platform owners can close down their own complements that compete directly with third-party complements (Gawer and Cusumano, 2007). Then, tensions arise between partition and integration (see above) as external complements needs to integrate to the platform core through loose or tight coupling (Baldwin and Woodward, 2009; Tiwana, 2014; Wareham et al., 2014). As discussed above, the level of integration (tight or loose) varies over time as the platform owner tries to encourage variety of complements or decrease it (see Wareham et al., 2014).

Throughout the course of the ecosystem evolution, the platform owner adopts a splitting response to manage the tension between tight and loose coupling as manifestation of the reliability and evolvability opposites of the architecture contradiction. Initially, the owner may give prevalence to loose coupling, which encourages external complements to join the ecosystem easily, thus fostering evolvability (Tiwana, 2014; Wareham et al., 2014). Subsequently, seeking to reduce competition and securing profitability (Parker et al., 2017), the platform owner may adopt a tight coupling, which ensures reliability, but also restricts evolvability as it reduces the number of external complements (see also, variety decreasing mechanism; Wareham et al., 2014). Thus, by giving prevalence to tight or loose coupling over time, the owner relies on a splitting strategy to manage the tensions between partitioning and integration.

To ensure connectivity between platform core and platform periphery, the boundary resources, which connect them, need to be stable and versatile at the same time (Baldwin and Woodward, 2009; Tiwana, 2014). Solving this tension, the platform owner tends to accommodate stability and versatility of the boundary resources by offering, in most cases, general rules, which, while ensuring a sufficient level of standardization, also support newly emerging innovative complements (Tiwana, 2014).

Finally, when managing the growing complexity, resulting from the evolvability of the architecture, which also challenges its reliability, the owner engages in synthesis. To decrease the overall complexity, the owner aims at increasing the modularity of the architecture, which allows for reducing the interdependencies across its various sub-systems (Baldwin and Woodward, 2009; Olleros, 2008; Tiwana, 2014). At the same time, the increased modularity strengthens the overall evolvability of the architecture (Tiwana, 2014).

Managerial Responses to Governance Tensions. When addressing the contradiction between control and openness, which manifests in several salient tensions (Table 3), the platform owner adopts accommodating and splitting responses.

To address the tensions between centralization and decentralization, where actors struggle for control and autonomy respectively, the owner relies on splitting. As a result, the level of control and autonomy within the ecosystem changes over time depending on the salience of the tension. Initially, the platform owner enjoys high level of control, as the ecosystem tends to be relatively closed (Eisenmann et al., 2009). With the opening of the ecosystem to incorporate more actors, such as third-party developers, platform providers, and more, the tight grip of the owner over the ecosystem comes under threat by some of the newly introduced actors, leading to tensions becoming salient in some cases (Gawer and Cusumano, 2002). As a result, the owner can try to relax the strict rules and increase their transparency, granting more autonomy to developers (Eaton et al., 2015).

The balance between decentralization and centralization, however, can also alter over time (Eisenmann et al., 2009). For example, a platform owner can attempt to increase its level of control over new and existing boundary resources, which curbs the autonomy of third-party developers (Ghazawneh and Henfridsson, 2013; Wareham et al., 2014). Furthermore, the owner can close the access to the platform to reinforce control again, leading to exclusion of certain actors (Parker et al., 2016). Thus, by engaging in splitting, throughout the course of the ecosystem evolution, the platform owner manages the tension between centralization and decentralization by giving prevalence to one over the other at certain points in time.

Managing the tension between divergence interests and the need to ensure conformity requires the adoption of accommodating. For example, Eaton et al. (2015) investigate how third-party developers, part of the Apple ecosystem, tried to circumvent the strict rules for access to the Apple iPhone by engaging in jailbreaking, which creates tensions with the platform owner. As a result, Apple introduced new boundary resources to increase the control over the architecture, thus restricting the autonomy of third-party developers (Eaton et al., 2015; Ghazawneh and Henfridsson, 2013). This led to third-party developers resisting the change and entering into a new conflict with the platform owner, who then tried to adjust the control level to satisfy the demands of the former (Eaton et al., 2015).

The platform owner also tends to accommodate the tension between actors with diverse interests who need to conform to established rules by allowing for flexible governance regime. For example, Huber et al. (2017),

when investigating the governance of third-party developers found that platform owner engages in both high level of governance regime consisting of general rules, to which all actors need to conform to, while also allowing for the emergence of specific rules tailored towards different collaborators.

To resolve the tension between aggregation of resources and the need to allocate them proportionally, the owner engages in accommodating. For example, when tensions between the owner and external contributors appear as result of low return on partnership (see Gawer and Henderson, 2007), the owner should engage in fair, proportionate distribution of the accumulated resources (e.g., revenue, IPRs, and more) (Ceccagnoli et al., 2012; Gawer and Henderson, 2007; Eisenmann et al., 2006; Kohler, 2018; van Alstyne et al., 2016).

Managerial Responses to Development Tensions. Throughout the evolution of the digital platform ecosystem, platform owners face the contradiction between reinforcing the current development trajectory, while also transforming it when faced with internal and external challenges. To manage this general contradiction, the owner engages in splitting by emphasizing on either one of the two opposites in sequential manner over time (Evans, 2009; Gawer, 2009; Hagiu, 2006; Kohler, 2018). Further, to address the specific salient tensions, stemming from this inherent contradiction, the owner relies on accommodating, splitting and synthesis.

To manage the tension between growth and subsequent adoption, the owner engages in a splitting strategy. While growth of actors spurs the evolution of the ecosystems and transforms it with the introduction of new actors (Evans, 2009; Hagiu, 2006), it also requires dedicated efforts in securing the continuous adoption of the introduced actors (Hagiu, 2006). Researchers recommend owners to first focus on achieving depth that is to ensure that the newly introduced actors have adopted the provided services, before the inclusion of other types of actors (breadth) (Hagiu, 2006), thus splitting the two opposites in time.

When expanding the digital platform ecosystem, the inter-platform competition intensifies (Eisenman et al., 2011; Gawer, 2009). To resolve this tension, the owner engages in accommodating by trying to manage the growing competition while continuing expanding. In particular, the owner can engage in entry deterrence practices (Eisenmann et al., 2009) through scaling of the ecosystem (Kohler, 2018) or through requiring exclusivity, such as exclusive dealing, tying, bundling, from ecosystem actors (Evans, 2012). In addition, it can also increase switching costs (Bakos, 1991), invest in R&D (Eisenmann et al., 2006), decrease prices (Eisenmann et al., 2006) and increase product differentiation (Evans, 2012). In some cases, the owner can also exclude competitors' services from own channels (e.g., Apple excluded Google Voice app in its App Store) (Eaton et al., 2015). To accommodate the competition, the owner can also increase the level of cooperation by allowing co-ownership of the platform (Eisenmann et al., 2009), licensing platform technology to competitors (Gawer and Cusumano, 2007) and ensuring interoperability to competing ecosystems (Eisenmann et al., 2009).

Due to the innovativeness of their offerings, digital platform ecosystems often challenge existing regulatory regimes leading to tensions with regulators and other interested parties, such as trade unions (e.g., Uber, Airbnb). To resolve this tension, the owner usually adopts a synthesis response by entering into a dialogue with the regulators to develop a mutually acceptable solution (Hagiu and Rothman, 2016), which allows the digital platform ecosystem to continue operating while meeting regulatory requirements. In addition, the owner can also change investigated practices before the regulators required such actions (Eaton et al., 2015; Evans, 2012), which also constitutes a form of synthesis.

By actively attending and solving the salient tensions occurring with regards to performance, architecture, governance and development contradictions within the digital platform ecosystem, the owner, in combination with the actions (praxis) performed by other ecosystem actors, reconstructs the digital platform ecosystems as interconnected totality. Depending on the introduced changes as result of the adopted managerial responses, the reconstruction can constitute either incremental changes, which reinforce the existing ecosystem structure, or significant changes, which transform the structure. Although salient tensions can be resolved through engaging in accommodating, splitting and synthesis, their resolution can serve as a source of additional inherent contradictions (Benson, 1977; Seo and Creed, 2002), which become part of the reconstructed ecosystem configuration of actors, architecture and governance. Thus, while some tensions disappear, others appear over time, underlying the dialectical nature of digital platform ecosystems.

7. Summary, Limitations and Future Research

Although digital platform ecosystems are ripe with contradictions (Boudreau and Hagiu, 2009; Gawer and Cusumano, 2002; Tiwana, 2014), researchers have paid limited attention to tensions as drivers of ecosystem evolution (see Eaton et al., 2015; Tiwana, 2014; Wareham et al., 2014 as exceptions). To address this gap, we embark on Review and Theory Development study, which allows us to theorize about digital platform ecosystem evolution. Specifically, we combine Dialectics as a theoretical framework (Benson, 1977) with insights from extant platform literature to conceptualize the inherent contradictions, their manifestation into salient tensions, and the responses adopted for their resolution as part of the evolutionary process of digital platform ecosystems.

As a result, we propose a Dialectical theory of digital platform ecosystem evolution (Figure 1), which presents digital platform ecosystems as socially constructed interconnected totality, characterized by four inherent contradictions with regards to performance, architecture, governance and development. Contextual factors of plurality, change, and scarcity can render these latent contradictions salient and prompt ecosystem actors to react. By adopting three response strategies, accommodating, splitting and synthesis, the platform owner, together with other ecosystems actors, resolves the tensions and subsequently reconstructs the digital platform ecosystem.

Our efforts are not without limitations. First, while we propose a Dialectical theory of digital platform ecosystem evolution building upon empirical insights from various dispersed studies, we do not demonstrate the utility of this model on a single case where we can investigate how the emergence and resolution of conflicts drive the evolution from end to end. Second, although we aim to provide a detailed summary of the relevant literature, due to the adopted sampling strategy (see Appendix), we might have omitted relevant studies, which point to relevant contradictions or managerial responses.

To overcome these limitations, we urge researchers to adopt the Dialectical theory of digital platform ecosystem evolution and apply it to investigate empirical cases in order to extend and improve our propositions. In addition, as context appears to be an important factor in determining the nature and operation of inherent contradictions (see Section 4), we welcome studies investigating this particular aspect of the evolutionary process in order to determine with more accuracy when salient tensions are more likely to appear. We further advocate for studies investigating digital platform ecosystem evolution from other theoretical perspectives. Thus, for example, researchers can combine insights about the ecosystem evolution from dialectical perspective with the insights from studies providing other theoretical perspectives of the evolutionary process (e.g., competition (Ojala and Lyytinen, 2018); Information System capabilities (Tan et al., 2015); strategy (Gawer, 2009)).

References

Armstrong, M. 2006. "Competition in two-sided markets," *RAND Journal of Economics* (37:3), pp. 668–691.

Atkinson, R. and Flint, J. 2001. "Accessing Hidden and Hard-to-reach Populations: Snowball Research Strategies," Social Research Update, 33.

Baldwin, C. Y., and Woodard, J. C. 2009. "The Architecture of Platforms: A Unified View". In A. Gawer (ed.) Platforms, Markets and Innovation, pp. 19-44.

Bakos, Y. 1998. "The emerging role of electronic marketplaces on the Internet," *Communications of the ACM*, (41:8), pp. 35-42.

Bakos, Y., and Katsamakas, E., 2008. "Design and ownership of two-sided networks: Implications for Internet platforms," *Journal of Management Information Systems*, (25:2), pp. 171-202.

Benson, J.K. 1977. "Organizations: A Dialectical View," *Administrative Science Quarterly*, 22, pp. 1-21.

Bjerknes, G. 1991. "Dialectical reflection in information systems development," *Scandinavian Journal of Information Systems*, (3:1), pp. 55–77.

Boudreau, K. 2017. "Platform-Based Organization and Boundary Choices: 'Opening-Up' While Still Coordinating and Orchestrating". Available at SSRN: https://ssrn.com/abstract=2929725

Boudreau, K. J. 2012. "Let a Thousand Flowers Bloom? An Early Look at Large Numbers of Software App Developers and Patterns of Innovation," Organization Science (23:5), pp. 1409–1427

Boudreau, K. and Hagiu, A. 2009. "Platforms Rules: Multi-sided Platforms as Regulators." In A. Gawer (ed.) Platforms, Markets and Innovation. London: Edward Elgar.

Boudreau, K., and Jeppesen, L. B. 2015. "Unpaid crowd complementors: The platform network effect mirage," Strategic Management Journal, (36:12), pp. 1761–1777.

Casadesus-Masanell R, and Halaburda, H. 2011. "When does a platform create value by limiting choice?" *Journal of Economics Management Strategy*.

Carlo, J. L., Lyytinen, K. and Boland, R. J. 2012. "Dialectics of Collective Minding: Contradictory Appropriations of Information Technology in High-Risk Projects" *MIS Quarterly*, (36:4), pp. 1081-1108.

Casey. T. R., and Töyli, J. 2012. "Dynamics of two-sided platform success and failure: an analysis of public wireless local area access". *Technovation* (32), pp.703–716.

Ceccagnoli, M., Forman, C., Huang, P., Smith, R. H., and Wu, D. J. (2012). Co-creation of Value in a Platform Ecosystem: The Case of Enterprise Software. MIS Quarterly, 36 (1), pp. 263-290.

Cho S., Mathiassen, L., and Robey, D. 2007. "Dialectics of resilience: A multilevel analysis of a telehealth innovation," *Journal of Information Technology*, (22:1), pp. 24–35.

Constantinides, P., Henfridsson, O., G. and Parker, G. 2018. "Introduction—Platforms and Infrastructures in the Digital Age," *Information Systems Research*, (29:2), pp. 381-400.

Datee, B., Alexy, O. and Autio, E. 2017. "Maneuvering in Poor Visibility: How Firms Play the Ecosystem Game when Uncertainty is High," *The Academy of Management Journal*, (61:2).

Den Hartigh, E., Ortt, J. R., Van de Kaa, G., and Stolwijk, C. M. 2016. "Platform Control during Battles for Market Dominance: The Case of Apple versus IBM in the Early Personal Computer Industry," *Technovation* 48–49, pp. 4–12.

de Reuver, M., Sørensen, C., and Basole, R. C. 2017. "The digital platform: a research agenda*." Journal of Information Technology*. ISSN 0268-3962.

de Rond, M. and Bouchikhi, H. 2004. "On the Dialectics of Strategic Alliances," *Organization Science*, (15:1), pp. 56-69.

Eaton, B., Elaluf-Calderwood, S., Sorensen, C., and Yoo, Y. 2015. "Distributed Tuning of Boundary Resources: The Case of Apple's iOS Service System," *MIS Quarterly*, (39: 1) pp. 217-243.

Eisenmann, T., Parker, G., and van Alstyne, M. 2011. "Platform envelopment," *Strategic Management Journal*, (32:12), pp. 1270-1285.

Eisenmann, T., Parker, G., and van Alstyne, M. 2009. "Opening platforms: How, when and why?" In A. Gawer (Ed.), *Platforms, Markets and Innovation*. Cheltenham, UK: Edward Elgar Publishing Limited.

Eisenmann T, Parker G, and van Alstyne M. 2006. Strategies for two-sided markets. Harvard Business Review, (84:10), pp. 92–101.

Evans, D. S. 2012. "Governing Bad Behavior By Users of Multi-Sided Platforms", *Berkeley Technology Law Journal*, 27:2.

Evans, D. S. 2009. "How Catalysts Ignite: The Economics of Platform-Based Start-Ups," in *Platform, markets and innovation*, A. Gawer (Ed.), London, UK: Edward Elgar.

Evans, D. S. and Schmalensee, R. 2016. *Matchmakers: The New Economics of Multisided Platforms*, Harvard Business Publishing: Boston, Massachusetts, USA.

Evans, D. S., and Schmalensee, R. 2010. "*Failure to Launch: Critical Mass in Platform Businesses*," Review of Network Economics, (9:4).

Gawer, A. 2015. "*What Drives Shifts in Platform Boundaries: An Organizational Perspective,*" Conference Paper, DRUID Summer Conference, Copenhagen, Copenhagen Business School, Denmark.

Gawer, A. 2014. "Bridging differing perspectives on technological platforms: Toward an integrative framework," *Research Policy*, (43:7), pp. 1239–1249.

Gawer, A. 2009. "Platform Dynamics and Strategies; from products to services", In Platforms, Markets and Innovation; Gawer, A., Ed.; Edward Elgar Publishing: Northampton, MA, USA; Northampton, MA, USA, 2009, pp. 45-77.

Gawer, A., and Cusumano, M. A. 2014. "Industry platforms and ecosystem innovation," *Journal of Product Innovation Management*, (31:3), pp. 417-433.

Gawer, A., and Cusumano, M. A. 2007. "*A strategy toolkit for platform leader wannabes*," Conference Paper, DRUID Summer Conference on Appropriability, Proximity, Routines and Innovation, Copenhagen, Copenhagen Business School, Denmark.

Gawer, A. and Cusumano M. A. 2002. *Platform Leadership: How Intel, Microsoft, and Cisco Drive Industry Innovation*, Boston, MA, US: Harvard Business School Press.

Gawer, A. and Henderson, R. 2007. "Platform owner entry and innovation in complementary markets: Evidence from Intel', Journal of Economics and Management Strategy," (16:1), pp. 1-34.

Ghazawneh, A. and Henfridsson, O. 2013. "Balancing platform control and external contribution in third-party development: the boundary resources model," Information Systems Journal, (23:2), pp. 173–192.

Hagiu, A. 2014. "Strategic Decisions for Multi-sided Platforms." *MIT Sloan Management Review*, (55:2).

Hagiu, A. 2006. "Multi-Sided Platforms: From Microfoundations to Design and Expansion Strategies," Working Paper 07-094. Harvard Business School.

Hagiu, A., and Spulber, D. 2013. "First-Party Content and Coordination in Two-Sided Markets," *Management Science*, (59:4), pp. 933–949.

Hagiu, A. and Wright, J. 2011. "Multi-Sided Platforms," Harvard Business School Working Paper 12-024.

Hagiu, A. and Rothman, S. 2016. "Network Effects Aren't Enough," Harvard Business Review, April 2016.

Halaburda, H., and Piskorski, M. 2010. "When should a platform give people fewer choices and charge more for them?," *Antitrust Chronicle*, 7.

Hargrave, T.J. and Van de Ven, A.H. 2016. "Integrating dialectical and paradox perspectives on managing contradictions in organizations," *Organization Studies* (38:3-4), pp. 319-339.

Huber T, T. Kude, and Dibbern, J. 2017. "Governance Practices in Platform Ecosystems: Navigating Tensions Between Co-Created Value and Governance Costs". Information Systems Research.

Inoue, Y. and Tsujimoto, M. 2017. "New market development of platform ecosystems: A case study of the Nintendo Wii," *Technological Forecasting and Social Change*, In Press, Available online from January 2017.

Jacobides, M., C. Cennamo, and Gawer, A. 2018. Towards a Theory of Ecosystems. Strategic Management Journal.

Kallinikos, J., Aaltonen, A., and Marton, A. 2013. "The Ambivalent Ontology of Digital Artifacts". *MIS Quaterly*, (37: 2), pp. 357-370.

Kohler, T. 2018 "How to Scale Crowdsourcing Platforms," *California Management Review*, (60:2), pp. 98 – 121.

Leidner, D. E. 2018. "Review and Theory Symbiosis: An Introspective Retrospective," *Journal of the Association for Information Systems*, (19:6).

Lewis, M. W. 2000. "Exploring paradox: Toward a more comprehensive guide," *Academy of Management Review*, (25:4), pp. 760-776.

McGuire, J. 1988. "A dialectical analysis of interorganisational networks," *Journal of Management*, 14, pp. 109–124.

Ojala, A., and Lyytinen, K. 2018. "Competition Logics during Digital Platform Evolution," In Proceedings of the 51st Hawaii International Conference on System Sciences (HICSS 2018) (pp. 1026-1035). University of Hawai'i at Manoa.

Olleros, F. X. 2008. "The Lean Core in Digital Platforms," *Technovation*, (28:5), pp. 266-276.

Ondrus, J., Gannamaneni, J., and Lyytinen, K. 2015. "The impact of openness on the market potential of multi-sided platforms: a case study of mobile payment platforms", *Journal of Information Technology*, (30:3), pp 260–275.

Parker, G. and van Alstyne, M. 2008. "*Managing Platform Ecosystems*". International Conference on Information Systems, 2008, Proceedings. 53.

Parker, G., van Alstyne, M. and Choudary, S.P. 2016. Platform Revolution: How Networked Markets Are Transforming the Economy and How to Make Them Work for You. NY: WW Norton Company, Inc.

Parker, G., van Alstyne, M. and Jiang, X. 2017. "Platform Ecosystems: How Developers Invert the Firm," *MIS Quarterly*, (41:1) pp. 255-266.

Poole, M. S., and Van de Ven, A.H., 1989. "Using Paradox to build management and organization theories," *Academy of Management Review*, (14:4), pp. 562-578.

Rolland, K., Mathiassen, L. and Rai, A. 2018. "Managing Digital Platforms in User Organizations: The Interactions between Digital Options and Digital Debt," *Information Systems Research*, (29:2), pp. 419–443.

Ruutu, S., Casey, T., and Kotovirta, V. 2017. "Development and competition of digital service platforms: A system dynamics approach," *Technological Forecasting and Social Change*, 117, pp. 119–130.

Seo, M. and Creed, W.E. 2002. "Institutional contradictions, praxis and institutional change: A dialectical perspective," *Academy of Management Review*, (27:2), pp. 222-247.

Smith, W. K. and Lewis, M. W. 2011. "Toward a Theory of Paradox: A Dynamic Equilibrium Model of Organizing," *Academy of Management Review*, (36:2), pp. 381-403.

Svahn, F.; Mathiassen, L., and Lindgren, R. 2017. "Embracing Digital Innovation in Incumbent Firms: How Volvo Cars Managed Competing Concerns," *MIS Quarterly*, (41: 1) pp.239-253.

Tan, B.; Pan, S. L.; Lu, X., and Huang, L. 2015. "The Role of IS Capabilities in the Development of Multi-Sided Platforms: The Digital Ecosystem Strategy of Alibaba.com", *Journal of the Association for Information Systems*, (16:4).

Tan, F. T. C., Tan, B. and Pan, S. L. 2016. "Developing a Leading Digital Multi-sided Platform: Examining IT Affordances and Competitive Actions in Alibaba.com," *Communications of the Association for Information Systems*, (38:36).

Tilson, D., Lyytinen, K., and Sorensen, C. 2010. "Digital Infrastructures: The Missing IS Research Agenda," *Information Systems Research,* (21:4), pp. 748-759.

Tiwana, A. 2015. "Evolutionary Competition in Platform Ecosystems," *Information Systems Research*, (26:2).

Tiwana, A. 2014. Platform ecosystems, Aligning architecture, governance, and strategy. Amsterdam: Morgan Kaufmann.

Tiwana, A., Konsynski, B. and Bush, A. 2010. "Platform Evolution: Coevolution of Platform Architecture, Governance, and Environmental Dynamics," *Information Systems Research*, (21:4).

van Alstyne, M. G. G. Parker, and Choudary, S. P. 2016. "Pipelines, Platforms, and the New Rules of Strategy," Harvard Business Review, April 2016.

van de Ven. A., and Poole, M.S. 1995. "Explaining Development and Change in Organizations," *Academy of Management Review*, (20: 3), pp. 510-540.

von Krogh, G., Nonaka, I., Rechsteiner, L., 2012. "Leadership in Organizational Knowledge Creation: A Review and Framework," Journal of Management Studies, (49:1), pp. 240-277.

Wareham, J., P. B. Fox, and Giner, J. L. C. 2014. "Technology Ecosystem Governance," *Organization Science*, (25:4), pp.1195-1215.

Wessel, M., Thies, F., and Benlian, A. 2017. "Opening the Floodgates: The Implications of Increasing Platform Openness in Crowdfunding". *Journal of Information Technology*. 10.1057/s41265-017-0040-z.

West, J. 2003. "How open is open enough? Melding proprietary and open source platform strategies," Research Policy, 32, pp. 1259-1285.

Wiener, M., Mähring, M., Remus, U., and Saunders, C. 2016. "Control Configuration and Control Enactment in Information Systems Projects: Review and Expanded Theoretical Framework," *MIS Quarterly*, (40:3), pp. 741-774.

Yoo, Y., Boland, R. J., Lyytinen, K., and Majchrzak, A. 2012. "Organizing for Innovation in the Digitized World," *Organization Science*, (23:5), pp. 1398–1408.

Yoo, Y., Henfridsson, O., and Lyytinen, K. 2010. "The New Organizing Logics of Digital Innovation: An Agenda for Information Systems Research," *Information Systems Research*, (4), pp. 724-735.

Appendix: Research Method

To develop a Dialectical theory of digital platform ecosystem evolution, we conduct a Review and Theory Development study. Our goal was to provide an overview of the relevant literature to inspire and support subsequent theorizing (Krogh et al., 2012; Leidner, 2018; Wiener et al., 2016). We first identified a research gap within the existing platform literature (the lack of theories on tensions in digital platform ecosystem evolution) and selected a theoretical framework (Dialectics) to address it. Subsequently, we reviewed relevant studies within the platform literature and synthetized them based on the selected theoretical framework to theorize about the evolution of a digital platform ecosystem from a dialectical perspective. As a result, we propose a theory, which fills the identified research gap (Leidner, 2018).

To review the relevant literature, we first identified relevant studies on digital platform ecosystems by relying on snowballing sampling strategy, which prescribes the selection of a key article whose references are then used to identify additional relevant studies (Atkinson and Flint, 2001). We selected the article by Gawer (2014) on bridging the economic and engineering streams in the platform literature, as a starting point of the search process. We choose this article as it provides an overview of key studies from the two main streams in the platform literature, which have developed separately.

Out of the 91 references included in the article by Gawer (2014), we selected 29 studies, which refer to tensions or conflicts in relation to digital platform ecosystems, based on reading their abstracts. Subsequently, to identify relevant articles after 2014, we identified studies citing Gawer (2014) in their references through Scopus. The initial list consisted of 90 articles as of January 2018, when we performed the search. After reviewing their abstracts, we ended up with 9 relevant articles after excluding studies, which do not refer to the main phenomenon of investigation and which are not published in journals. Thus, the initial sampling pool consisted of 38 articles. Next, we went through the references of the 38 articles, identified during the first search round, to discover additional relevant articles for the final sampling. We further analysed their respective references until we could not identify any new relevant articles. As a result, our final sampling consists of 65 articles from across various research domains.

To analyse the articles, we developed a coding scheme incorporating the main concepts from Dialectics theory—contradiction, salient tension, triggers and managerial responses. Thus, for each article, we identified the tensions authors referred to, how they became salient (trigger), and how the platform owner and other actors addressed them (responses). We then looked for commonalities between the identified tensions and, as a result, grouped them in four different categories. Reflecting upon their similarities, we then abstracted the four different types of inherent contradictions and identified their identity and opposites. For each of these contradictions, we then drew on the reviewed literature to identify related salient tensions and responses.

Paper IV Adoption of Mobile Payment Platforms: Managing Reach and Range

Authors: Staykova, K., S., and Damsgaard, J.

Adoption of Mobile Payment Platforms: Managing Reach and Range

Kalina S. Staykova

Copenhagen Business School, Department of IT Management, Copenhagen, Denmark, kss.itm@cbs.dk

Jan Damsgaard

Copenhagen Business School, Department of IT Management, Copenhagen, Denmark, jd.itm@cbs.dk

Abstract

Numerous mobile payment solutions, which rely on new disruptive technologies, have been launched on the payment market in recent years. Despite the growing number of mobile payment apps, very few solutions have turned to be successful as the majority fail to gain a critical mass of users. This paper investigates successful platform adoption strategies by using the Reach and Range Framework for Multi-Sided Platforms as a strategic tool to which mobile payment providers can adhere in order to tackle some of the main challenges they face throughout the evolution of their platforms. The analysis indicates that successful mobile payment solutions tend to be launched as one-sided platforms and then gradually expand into being two-sided. Our study showcases that the success of mobile payment platforms lies with the ability of the platform to balance the reach (number of participants) and the range (features and functionalities) of the platform.

Keywords: Mobile payments, Multi-sided platforms, Platform adoption, Platform Strategy, Case studies

Introduction

The rapid proliferation of Ubiquitous Information Systems has tremendous potential to transform our day-to-day activities due to the ability of such systems to interact with their surrounding environment [46]. The smartphone, which is heralded as the 'first pervasive computer' [5] p.1, is an example of such a ubiquitous information system. Smartphone's portability, high degree of connectivity and its capability of incorporating numerous functionalities offered by device manufacturers and third-party developers alike significantly enhance the smartphone's use anytime, anywhere and in any context. Consider that the smartphone is in the midst of absorbing navigation devices (GPS), mp3 players and cameras, not only as separate physical objects,

but also as separate business sectors [23]. The annexation quest of this digital device is advancing and it has already set its target on payments [23]. While the smartphone has managed to triumph over the portable camera as the preferred method to record memorable occasions under the form of photos and videos [37], the adoption rates of mobile payments continue to remain low in spite of the fact that the first mobile payment having been executed more than 20 years ago [29].

Despite the rapid spread and adoption of smartphones and the emergence of a huge array of mobile payment solutions, the much proclaimed mobile payment revolution still has not taken place as most consumers still prefer to pay with plastic cards and cash [14]. Indeed, the majority of the launched mobile payment apps have failed to gain a sufficient number of users as consumers are hesitant to adopt digital payment services [29]. Most of these solutions try to attract both users and merchants on board simultaneously, which proves to be a cumbersome task. In reality, the adoption of mobile payments is a complex process characterized by numerous strategic challenges which a payment provider needs to address [23], [35]. In this paper, we investigate mobile payments as digital multi-sided platforms that facilitate the recurring interactions between various constituencies [20]. We argue that instead of just focusing on reaching a critical mass of users, a mobile payment provider should pay more attention to nurturing platform interactions in order to spur the adoption of mobile payment platforms. Thus, we formulate the following research question:

What strategies can a mobile payment platform provider adhere to in order to drive the adoption of its solution?

The main obective of this paper is to outline the strategies to which mobile payment platforms can adhere to in order to ensure their adoption. In order to do so, we further investigate and expand the Reach and Range framework for multi-sided platforms (MSPs) which we initially introduced in a paper presented at the 14th International Conference on Mobile Business. We then demonstrate the usefulness of the Reach and Range framework for MSPs as a strategic tool for tackling some of the main challenges a mobile payment platform faces throughout its evolution. To this end, we apply the Reach and Range framework to three selected cases and use the findings of our case analysis to prescribe several strategic approaches to which mobile payment providers can adhere in order to spur the adoption of their solutions. Our analysis reveals that the success of digital payment platforms is determined by the ability of the platform owner to balance the *reach* and *range* of each of the affiliated with the platform sides and to manage the interside *reach* and *range* which characterizes the interaction across the platform sides.

This paper proceeds as follows: First, we outline the theoretical foundations of this paper. We, then, present the Reach and Range Framework for MSPs as a mechanism that can be used to address the most pressing

strategic issues a platform faces. As a next step we briefly introduce the three investigated cases and analyze them using the Reach and Range Framework for MSPs. In the final sections of the paper, we discuss our findings, offer some conclusions and suggest promising areas for further research.

Mobile Payments as Multi-Sided Platforms

We draw on the literature on multi-sided platforms, which is rooted in the field of industrial economics, as theoretical lens to investigate mobile payment solutions. Despite the growing literature on MSPs, there is often confusion as to the exact difference between one-sided, two-sided and multi-sided platforms. The problem stems from the lack of a clear definition [20], which leads to an overlapping in the way that two-sided and multi-sided platforms are defined [12], [20]. In this paper, we view platforms as systems that create and facilitate interactions between one or multiple customer groups connected to them [20]. We also adopt a clear distinction between one-sided (enabling interactions between participants of one distinct group), two-sided (enabling interactions between participants of two distinct groups) and multi-sided (interactions between participants of more than two distinct groups) platforms [36].

Mobile payment solutions function as digital platforms that facilitate the direct interaction between various customers affiliated to them [11], [20], [23], [28], [35]. More often than not they are launched as one-sided platforms and gradually evolve to being two-sided, and eventually, multi-sided [36]. This is in contrast to payment cards which are traditionally launched and function as two-sided platforms that enable the interaction between merchants and consumers and remain two-sided so far [12]. Unlike traditional payment platforms, such as credit and debit cards, digital payment platforms are extremely scalable with high development costs and low marginal costs. As costs remain fixed throughout the platform's evolution, the extensive adoption of a platform affects positively the value of the platform to all affiliated constituencies [8]. This means that once the payment platform is developed, it costs very little to add and service additional users. Thus, payment platforms exhibit significant economies of scale as the initial development costs remain fixed and are gradually distributed across the growing number of platform participants. This observation, however, is valid only when the mobile payment solutions are software-based, that is they function as payment apps enabling P2P transactions. When such solutions are used to execute consumer-to-business (C2B) transactions, they require a merchant to be equipped with a compatible hardware (e.g., dongles).

The research on digital payment platforms mainly encompasses studies on payment platform design [23], business models [7], factors leading to platform failure [16], transformation of the digital payment ecosystem [21], and payment platforms' evolutionary models [36]. Significantly less emphasis, however, is placed on investigating strategies for successful entry into and expansion of digital payment platforms [35]. We address

this research gap by determining the strategies that platform providers can adopt in order to address the strategic challenges they face during entry, as well as subsequent expansion of their platforms.

MSPs value generation ability lies in the platform's capability to enable multiple interactions that occur with high frequency among the affiliated to the platform participants [20]. In order to do so, platform providers need to create and manage network effects that occur when users perceive an increase in the value of a product or a service as a result of the groiwng number of participants [33]. The concept of same-side network effects presupposes that consumers may find a product or a service more useful if similar consumers use that product as well. An example of this is the fax machine which has no value of its own, as it requires the presence of other fax machines. At the same time, the usefulness of the fax machine for a user grows as the number of fax machines increases, since the user can communicate with a larger number of other users. Cross-side network effects exist when users value the presence of other distinct groups of platform participants. For example, most credit cards function as two-sided platforms because they facilitate the interaction between two distinct groups of participants – buyers and merchants [11]. As the number of payment card holders increases, more merchants begin to accept this form of payment in order to attract buyers to their shops and vice versa. Platforms are also characterized by homing costs, which are related to the adoption and/or any form of affiliation with the platform [3], and by switching costs, or the costs which consumers incur when shifting platforms [33].

Digital platforms prove to be complex systems that evolve gradually over time [42]. Platform's evolvability, however, has remained an elusive topic in the research on MSPs, with only few models and prescriptions guiding the platform throughout its evolution. Evans [11], for example, proposes a two-stage model to explain a platform's market entry and growth, anchored around platform's ability to achieve a critical mass of users. A key threshold for every platform is swiftly gaining a critical mass of users, which is defined as a sufficient number of users who have joined the platform and are transacting within the platform with high frequency [17], [33]. Evan's model presupposes that during the first ignition stage, customers are affiliated with the platform in order to evaluate its main value proposition [11]. In the second "growth" phase, after the platform has managed to attract a substantial number of participants, the platform can rely on the already achieved network effects to spur further growth and to ensure its endurance. In order to achieve critical mass, Evans [11] recommends a zig-zag strategy where a platform owner gradually attracts and facilitate simultaneously the participation on both sides of the platform. The platform usually launches with a limited number of participants on both sides and grows over time. Another model, which provides an insights into the platform's evolvability, is proposed by Hagiu [19], who emphasises on the platform's gradual transition from being one-sided to two - (or multiple) sided platform. Before a platform can embark on an expansion quest, it should first achieve platform depth by designing and deploying value-creating functionalities that will bring benefits to the tjose affiliated with the platform participants [19]. The achievement of platform depth serves as a prerequisite

for the subsequent platform expansion when new constituencies join the platform, thus extending the platform's breadth. Tiwana [42] points out that a platform's evolution requires constant adjustment of the platform's architecture and governance as the platform matures over time. Tiwana [42] p.162 also proposes various "evolutionary metrics", which measure platform performance over the span of its evolution. In particular, he states that in the short term, platform owners should focus on measuring platform resilience, scalability, and composability, and then move on to tracking platform stickiness, synergy, and plasticity; and concentrating on envelopment, durability, and duration in the long term. While Evans [11] and Hagiu [19] discuss stage models in order to structure platform evolvability, Tiwana [42] focuses on concrete measurements to estimate the speed and effectiveness of platform evolution (that is evolutionary metrics). There is, however, a lack of an analytical model that brings the three views together (a stage model with concrete strategic thresholds for each stage) serving as a strategic tool to guide platform evolution by helping a platform solve some of its main strategic challenges.

The Reach and Range Framework for Multi-Sided Platforms

In this section, we briefly identify some of the most pressing strategic issues which platform providers face throughput the evolution of their platforms. Most of the research literature on multi-sided platforms focuses on pinpointing some of the strategic issues as well as prescribing certain rules that need to be taken into consideration when a platform owner designs and launches its offerings (e.g., pricing mechanisms, governance rules and design rules). There is, however, a lack of an overall principle or framework to guide the platform owner when addressing successfully and in a holistic manner the main strategic challenges throughout the platform's evolutionary path. To address this gap in the literature on MSPs, we develop the Reach and Range Framework for MSPs as a strategic tool that platform owners can use when designing their launch and expansion strategies.

Strategic Issues of Multi-Sided Platforms

As multi-sided platforms are characterized as being highly evolvable systems, they tend to evolve over time by introducing various modifications to their initial platform design (i.e. additional features, or more participants) [42]. As platforms pass through different stages throughout their evolutionary path, however, they face new strategic challenges and considerations that need to be addressed in a prompt and timely manner [35]. In this paper, we argue that the challenges which a platform owner faces are pre-determined by the specific design of the platform upon its launch. Thus, the challenges that a one-sided platform needs to solve differ to a certain degree from the challenges which the platform needs to tackle as it transforms into being two-sided [42]. This evolutionary approach allows for a platform owner not having to face all the strategic challenges at once, but instead can address them step by step [19].

Although the strategic challenges, which a platform faces, have been rightfully identified in the existing literature on multi-sided platforms, we try to identify some of the main specific strategic considerations associated with the separate stages of a platform's evolutionary path. We use the overview of these challenges as a useful vehicle for guiding the application of the Reach and Range Framework for multi-sided platforms for solving some of these considerations. We will address this issue more thoroughly in the Discussion section. In order to synthesize the existing strategic considerations, we adopt a two-step approach. First, we summarize the existing literature on MSPs in order to single out the existing strategic challenges and strategic goals, which need to be attained. In the second stage, we consult the data we gathered from conducting interviews with various payment experts over the span of two years in order to pinpoint the challenges that payment platforms tackle during the different stages of their evolution.

The main strategic challenge of a one-sided platform is to gain a critical mass of users after its launch; hence, the platform owner has only one distinct group of participants to cater to at this stage. However, a platform owner should be aware that one-sided platforms tend to offer a limited number of functionalities [35]. Thus, due to their relatively weak value proposition, one-sided platforms can easily be attacked by other players, who can easily imitate their offerings. This poses a significant threat to the durability of one-sided platforms, as the platform cannot generate enough lock-in effects in order to ensure that its platform's users will not multi-home to other platforms or even switch entirely to other solutions. In order to address this shortcoming, which is intrinsic to the design of the one-sided platforms, a platform has to strengthen its value proposition by adding a second distinct group of participants, thus transforming into being two-sided. As a one-sided platform achieves a critical mass of users, it becomes attractive to other actors wanting to gain access to the participants already affiliated to the platform [11].

As the complexity of the platform design increases, a platform faces several strategic challenges [41]. The platform owner thus needs to develop and deploy various mechanisms so as to ensure that the size of the second group of participants grows continuously. Another critical issue is achieving platform stickiness by creating strong lock-in effects for the first affiliated group of participants [33]. Apart from catering to each of those affiliated to the platform group of participants, a platform also needs to put efforts into creating and sustaining platform recurrence, which we define as the ability of the platform to achieve significant cross-side network effects by stimulating high volumes of transactions between the affiliated sides [30]. The presence of a second group of participants allows a platform owner to try to devise a viable business model by determining a platform's subsidy and revenue side [19]. The next step of the platform's evolutionary path is to achieve a platform variety of offerings in order to ensure even greater platform stickiness and strengthening of the platform's value proposition [42]. To do so, a platform can benefit from the innovative potential of numerous external complementors who can become affiliated to the platform, thus transforming it into being multi-sided

[19]. A key issue at this stage of the platform's evolution is for a platform owner to bolster the platform's defence, thus preventing a possible envelopment attack [9].

Reach and Range Framework for Multi-Sided Platforms

The Reach and Range Framework for MSPs is based on Keen's Reach and Range Framework for IT platforms [24] where he introduces the concepts of *reach* and *range* to study the business features of an IT platform. For Keen [24] reach determines the IT platform's ability to connect people, while range, as defined by Weil and Broadbent [44] who extend Keen's initial definition of range, detects the different functionalities of certain business activities on the IT platform. The Reach and Range Framework as proposed by Keen [24], [25] constitutes a useful tool for planning and guiding the expansion of an IT platform. As we are seeking to investigate the entry and expansion strategies of MSPs, we view Keen's framework as a useful theoretical underpinning to develop an analytical tool in order to study further the MSPs expansion. To this end, we adapt Keen's Reach and Range framework to reflect the main characteristics of MSPs in an attempt to map out the participants affiliated to the platform and the various functionalities in which they can take part.

There are several differences between Keen's framework and the Reach and Range framework for MSPs. First, the domain of application of the two frameworks is different. Keen's framework is anchored around the IT infrastructure of a firm, while the MSP framework is applied to digital platforms. Second, while we borrow Keen's terminology of *reach* and *range,* we provide new definitions of these terms in order to reflect the logic of MSPs. For example, Keen's definition of *reach* comprises business units, suppliers, geographical locations, customers etc. While, we adopt the main assumption behind the term *reach* (people connected through infrastructure, or platform in our case) [24], [25], we do not identify platform *reach* with business units or geographical locations (see below). Finally, by applying the MSPs logic to Keen's Reach and Range framework, we introduce a new conceptual layer to the initial framework (e.g. network effects, multi-homing, direct interaction between affiliated platform sides etc.).

The main purpose of MSPs is to enable cross-side interactions between distinct groups of participants affiliated to a platform in order to create, capture and distribute value [18]. Thus, the main goal of a platform is to increase not only the frequency of the interactions among the different participants affiliated to the platform but also the type of interactions within each of the platform sides and across several sides. In order to achieve this, a platform provider faces a number of strategic challenges, which require that certain strategic choices need to be made regarding the affiliation of the different sides to the platform as well as the features and functionalities offered on the platform throughout its evolutionary path. In this paper, we argue that the Reach and Range framework for MSPs can serve as a useful strategic tool to guide platform owners in tackling the key strategic challenges, indentified above (see section 3.1.).

At the core of the Reach and Range framework for MSPs is the assumption that every platform side can be characterized by its *reach* and *range*. When *reach* refers to a platform's side, it represents the number of participants of one distinct group affiliated to the platform. *Reach* can also refer to the overall platform's *reach*, which is a sum of the *reach* of each distinct group of participants affiliated to the platform. *Range*, on the other hand, encompasses the features and functionalities associated with a particular side or several sides. Thus, by combining all the features offered by the various sides and across the sides, we can estimate the overall platform's *range*. The concepts of *reach* and *range* are interconnected and the success of both depends on the right timing within which they are executed. A platform provider usually designs and offers a specific set of features (*range*) in order to attract more participants (*reach*) or to lock-in existing customers. In this way, a platform expands its *range* in order to increase its *reach*. On the other hand, if the number of participants increases (*reach*), but the platform has a limited number of features (*range*), a platform provider needs to guarantee further entrenchment of the already joined participants by offering new features and functionalities (*range*), resulting in more reoccurring interactions. Thus, a platform provider needs to strike a balance between the *reach* and *range* in order to create and manage multiple reoccurring interactions, which are the main generators of value for the platform.

Figure 1: Overview of Reach and Range for One-Sided Platforms
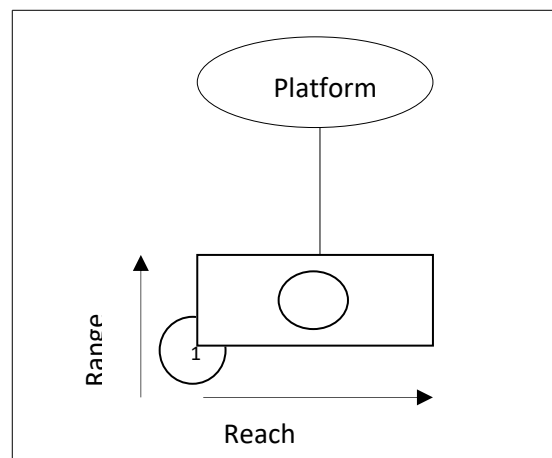
Upon their launch one-sided platforms (Figure 1), cater to one distinct group of participants (I), exhibiting same-side network effects (1). Initially, a one-sided platform offer a limited number of features (i.e., it is characterized by a limited platform *range*) in order to attract potential users. As a platform needs to gain a critical mass of users or a certain number of participants in order to become viable, a platform provider adds features that will attract more users, thus expanding the platform's *range* in order to increase the platform's *reach* (see Figure 1). As a one-sided platform gains a critical mass of participants, it comes to a point of saturation, which slows down the growth of a platform. A platform provider may then decide to stay in such a

position, as the one-sided platform has already become viable in terms of achieving same-side network effects (but not necessarily being economically viable) after it reaches critical mass. However, as one-sided platforms are particularly vulnerable (see section 3.1.), a platform provider may decide to expand the platform by adding a new distinct group of participants to its early value proposition, thus transforming the platform into two-sided one.

Two-sided platforms (see Figure 2) facilitate the interactions between two distinct group of participants (I and II) [16], which are characterized by cross-side network effects (3+4) [33]. Just as for the first group of participants (I), the second distinct group of participants (II) is also characterized by its own *reach* and *range*. Each of the platform sides is also characterized by same-side network effects (1+2). A platform provider needs to manage the *reach* and *range* of each side in order to increase the number of participants and functionalities associated with a particular platform constituency. The transformation from a one-sided to two-sided platform also implies that the overall *reach* and *range* of the platform now consists of the *reach* and *range* of both sides of the platform (I+II) (see Figure 2).

At the same time as a two-sided platform creates and nurtures cross-side interactions, a platform provider also needs to balance the *reach* and *range* across the different distinct groups of participants (Interside reach and range, see Figure 2). For example, the more credit card holders that join a payment platform, the more merchants will participate. Thus, the change in the *reach* in one of the platform's sides results in expansion of the *reach* on the other side and vice versa. A platform's interside reach is associated with the functionalities and features which enable cross-side interactions (e.g., functionalities to execute C2B transactions – QR code scanner, receipts, loyalty, etc.). A platform may also expand its interside *reach* by launching a platform envelopment attack, that is a platform can imitate functionalities offered by other platforms and add them to its existing offering [9], [10].

The leveraging of the platform's *reach* and *range* can also indirectly help determine the platform pricing strategy (i.e. platform's subsidy and revenue side, see [12], [13], [18]). One-sided platforms usually do not possess a viable business model (e.g., Facebook, LinkedIn and Youtube struggled initially to generate revenue before expanding their services) as platform providers aim to stimulate users' adoption by making the platform's value proposition optimally attractive. As part of its evolutionary path, a one-sided platform adds a second distinct group of participants that values the access to the already established platform's user base, thus constituting a potential source of revenue for the platform. In order to provide such access, a platform owner needs to design features that support interactions between the two affiliated groups of participants [18]. By

designing new features that enable the execution of such cross-side interactions, the platform extends its interside range.

Figure 2: Overview of Reach and Range for Two-Sided Platforms
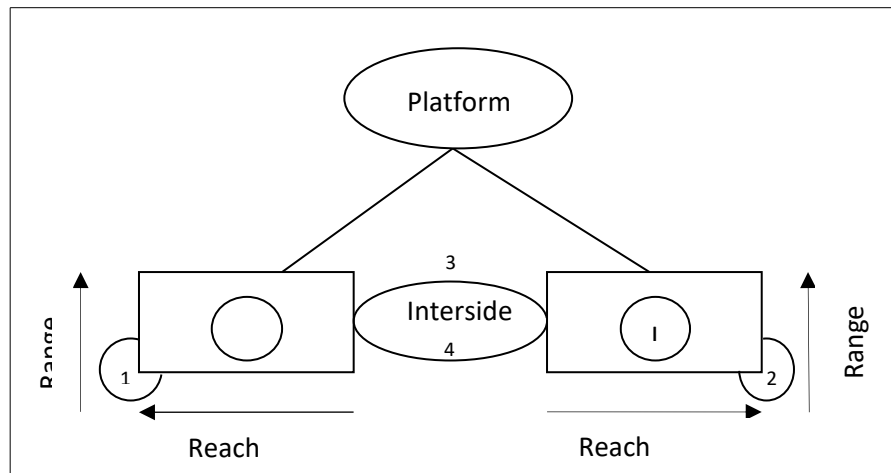
Even though a two-sided platform manages to optimally balance its reach and range, and eventually succeeding in defining a viable business model, it should further reconsider its current design in order to prevent potential envelopment attacks from other players [9], [23]. A platform can find itself under the threat of being enveloped by rival platforms if it cannot achieve platform stickiness and fails to ensure significant platform reach (enough number of participants affiliated to the platform). This can be attributed to the mismanagement of platform reach if a platform owner has designed functionalities that are not recurring with high frequency. To prevent the threat, a platform owner needs to reinforce its defence by further diversifying its value proposition. Such a diversification can be achieved through attracting numerous external complementors [42] who can offer innovative services to the platform's users, thus expanding the platform's reach (number of affiliated distinct group of participants) and range (the platform's functionalities). At this stage of its evolution, a platform consists of multiple sides, each of which has its own *reach* and *range*, thus making the management of the platform extremely complex.

Method

In order to provide an answer to our research question, we use a qualitative research method utilizing case study analysis. Thus, our study adopts an explorative research approach of digital payment platforms with three cases of successful mobile payment solutions. Case studies aim at providing in-depth understanding of complex phenomena by allowing researchers to analyze them within their context of emergence and existence [6], based on collection and detailed analysis of various data sources [45].

Case Selection

In this paper, we aim to define strategies that platforms can use in order to spur their adoption. To this end, we investigate the usefulness of our framework to address the main challenges that platforms face throughout their evolution. Thus, we concentrate on studying mature digital payment platforms with a well-established evolutionary path. The platform's ability to advance successfully on its evolutionary path is a vital indicator for the platform's endurance, which ultimately is what distinguishes successful from non-successful digital payment platforms. Selecting such successful digital payment platforms for the purposes of our study, however, proves to be a challenging task, as most of the launched mobile payment apps have failed to reach critical mass of users and, as a result of this, have been discarded. Nonetheless, in the last few years, a few solutions have been successfully launched and have managed to establish a clear-cut evolutionary path. Digital payment platforms, such as Pingit offered by Barclays bank in UK and MobilePay offered by Danske Bank in Denmark, have acquired a large number of participants and have continued to evolve at a stable pace, diversifying their functionality portfolio and affiliating more constituencies. Thus, we choose to investigate them as examples of mature digital payment platforms.

Pettigrew [31] does not recommend relying exclusively on similar cases to investigate a phenomenon, and we also include a unique case study – Swish, a solution jointly developed by some of the largest financial institutions in Sweden, which is dissimilar to the initially selected Pingit and MobilePay. As Swish has different design from the two other solutions, as it is offered jointly by several banks in Sweden, which all need to achieve consensus about the entry and expansion design of the solution, it is an interesting case to investigate as it is in contrast to the other selected cases. We undertake this approach in order to test the robustness of our framework by investigating whether the model can be replicated across various types of cases (different characteristics of the solutions across three different markets) and to study whether the framework can be expanded further by incorporating new insights. In the Discussion section, we briefly present two unsuccessful solutions, Paii in Denmark and Bart in Sweden, which no longer exist. The two solutions serve as further illustration of the explanatory power of the framework and are not part of the analysis, which leads to the formulation of the different strategies in the Discussion section.

Data Collection and Analysis

The research in question in this paper is of a process nature, as it focuses on understanding the evolution of various concepts over time [26]. Thus, the data we gathered are comprised primarily of separate stories which describe events ocurring over a span of time [43]. The data we gathered took place in the span of eight months and were coded in order to identify the specific evolutionary path of the three selected platforms.

Our research is informed by both primary and secondary data. We collected primary data for MobilePay by conducting interviews with senior managers in the period April – May 2014. One of the senior managers was in charge of the initial launch of MobilePay and its future development. The second senior manager was responsible for consulting the future development of the mobile payment solution in terms of overcoming strategic challenges and taking into account existing strategic opportunities. The duration of each of the interviews was one hour. The interviews were conducted based on semi-structured questionnaire and contain insights about the rationale behind the specific design choice of MobilePay upon launch and during its subsequent evolution as well as insights about some of the strategic challenges that the solution needed to overcome over time. It was possible to collect primary data only about MobilePay as we managed to get access to senior managers only in this case. In order to construct the exact evolution of MobilePay, we further consulted secondary data, such as press releases and news articles.

A significant amount of secondary data was also collected. The data we gathered for Pingit and Swish were exclusively secondary. We consulted publicly available sources: press releases, annual reports, online news and interviews. The collected data contained information about the launch of both solutions as well as information about their subsequent evolution, namely introduction of new features, user base, promotional campaigns and business models. The gathered data allow us to map out the evolution of each of the solutions. Two of the apps (MobilePay and Pingit) were also installed on the researchers' phones so that better insights into the apps' functionalities could be obtained.

To analyse the gathered data about the three selected cases (MobilePay, Pingit, and Swish), we applied a qualitative content analysis based on developing coding schemes and analysing the gathered text [22]. The coding scheme we developed is informed by previously defined theory, namely the Reach and Range Framework for MSPs. The coding scheme consists of two main codes (one-sided and two-sided platforms) and three sub-codes *reach*, *range* and *interside reach and range*. We coded the data by first identifying the stage of the platform evolution (one-sided or two-sided) and then we identified the *reach* and *range* for each of the identified platform sides as well as the interside *reach* and *range*. *Reach* encompases all the information with regards to user base on each side of the platforms as well as the overall number of users on the platform. *Reach* was also identified as different types of platform participants (e.g., different types of merchants). *Range* was coded as features and functionalities introduced to the platform's initial value proposition. Small app releases, introducing security updates or bug fixes, were omitted from the coding as they refer to app maintainance and do not reflect the platform evolution (see [42]). Thus, any change in the platform was coded as *reach* or *range* if it was part of the evolutionary path of a platform.

MobilePay

Danske Bank's MobilePay app is a bank-operated, card-based mobile payment solution allowing users to transfer money from a card to a bank account via a mobile phone number and a PIN code. The app was launched in May 2013 and has proved to be extremely popular among the Danes as more than 50 per cent of the adult population has downloaded it since its launch. Currently the app has three million registered users. Initially, the solution was launched as a one-sided platform catering to the needs of one distinct group of participants (that is, users). After MobilePay managed to attract a critical mass of users, it added a second group of participants by opening up to small merchants in October 2013.

MobilePay as One-Sided Platform

MobilePay was launched as an one-sided platform facilitating the interaction between a sender and a receiver, thus forming one distinctive group of users with interchangeable roles (user A can send money to receiver B; the next day B becomes the sender by sending money to A).

Range

The MobilePay app allows a user to transfer money to another user by relying only on the recipient's phone number, thus eliminating the need to exchange complicated bank details. Initially, users could send no more than 201 EUR per day to other users (Site 1). A new version of the app was released in September 2013, just five months after the initial launch. The updated app introduced new features such as 'split the bill' and allowed for higher amounts per transaction. The introduction of these new features is a concrete step to increase the *range* of the app in order to increase the frequency of the interactions (i.e. by enabling the new use of 'split the bill') and achieve lock-in effects. The increase of the *range* is also aimed at attracting more users, thus strengthening the same-side effects.

Reach

The app targets both Danske bank customers and non-Danske bank customers that contributed to its high adoption rate, with almost 300.000 people installing the app on their devices during the first two months after launch. The non-Danske Bank customers, who use the solution, constitute approximately 70 % of the overall user base of MobilePay. Danske Bank put considerable effort into attracting new consumers and growing its user base. The app was initially developed only for iPhone and Android devices. Users were also able to send money to receivers who initially had not downloaded the app, and, who in order to claim the money, had to sign up for the app. Getting a critical mass upon launch and reaching as many users as possible were critical for the success of the solution. Thus, during the first few months after the launch of the solution, efforts were focused on gaining a significant user base with strong same-sided network effects.

MobilePay as Two-Sided Platform

As MobilePay managed to attract a significant number of users by expanding its *range*, it gradually became attractive to small businesses that form another distinctive group of participants who wanted access to the large user base of the app. Thus, by adding first small merchants and later big retail chains, MobilePay transformed from being a one-sided platform to being a two-sided platform, thereby creating cross-side effects.

Interside Reach and Range

In October 2013, Danske Bank started a trial period with selected small merchants (coffee shop owners, hot dog stand owners, and taxis) that could accept payments from customers. Small merchants had already been using MobilePay to execute transactions at flea markets, as the solution was perceived to be cheaper and easier to use as opposite to existing payment options. After the successful pilot, MobilePay solution for businesses was launched in February 2014. As most of the MobilePay users used the service to transfer small amounts, it was considered logical to first test low-value consumer-to-business (C2B) payments. The solution uses the businesses' phone number to execute the transaction with shop owners being equipped with a smartphone with a MobilePay app. After the money is transferred from the consumer's bank account, he or she gets a receipt with the company's name, logo and time of payment on it (Site 1). At the same time businesses can easily verify the transactions and the overall amount of money sent to them, display their logo on the receipt, export transaction data, and point out to consumers the location of their shops. Thus, with the introduction of new platform interactions (between users and business), a platform needs to design features that support these interactions on both sides (interside range).

In June 2014, a coffee shop in Denmark incorporated MobilePay as a payment method in its own app [1], thus expanding MobilePay's *range* by enabling new ways of using the app. In July 2014, MobilePay entered the e-commerce sphere by partnering with five online stores which now use MobilePay as a payment method. Danske Bank continued to bring more merchants to the solution by enabling online shops to use MobilePay as a payment method. The expansion of the MobilePay's range was further reinforced in July 2015 when large retail chains introduced MobilePay in their stores, thus further expanding the *range* of the second platform side. Unlike the solutions for small merchants and online shops, payment transactions with MobilePay in large retail shops can be executed much faster and more conveniently with the help of Near Field Comminication (NFC) and Bluetooth technology. Thus, MobilePay's platform interchange range is supported by various solutions. In 2015, MobilePay also launched a pilot of a loyalty concept called Bonus, allowing users to collect and redeem loyalty points with selected merchants, thus enhancing a platform's interside range. Platform's interchange reach is determined by the adoption rate of C2B transactions (i.e. the number of users paying merchants with MobilePay). We could not obtain such numbers for MobilePay.

Merchant's Reach and Range

MobilePay gradually extended the *reach* of the second distinct group that was added to its initial value proposition. Initially, the solution for businesses targeted only small merchants and consisted of an app that needed to be installed on the merchant's smartphone. As of September 2014, approximately 1,975 small business places, such as coffee shops, clothing companies, hairdressers, bike repair shops, doctors etc., had adopted the solution. Later, MobilePay was incorporated as a method of payment on the websites of various online shops, and thus the *reach* of the business side was extended to encompass Internet retailers. Initially, big retailers were reluctant to use MobilePay in the same way that small merchants do mainly due to the high volume of transactions a larger retailer has to process in a quick and efficient way. Thus, MobilePay had to design different functionalities if it wanted to bring large retailers on board. After a few months of trial, the large retail chains in Denmark launched MobilePay. Thus, MobilePay's *reach* on the business side was gradually extended to encompass small merchants, online traders and large retail chains. The extension of the *reach* was facilitated by the introduction of new features for each of the business types, thus expanding the *range* of the platform's business side (see above).

Users' Reach and Range

As merchants were attracted to the sheer size of the MobilePay's installed user base, the platform owner needed to continue growing the number of active users (i.e. expanding the reach of the first platform constituency), while also focusing on growing the platform participants which form the second constituency. Although MobilePay put significant effort into attracting merchants to join its platform, it also continued growing its installed user base by managing both the *reach* and *range* of the user side (see Table 1). To cater to its user base, MobilePay increased on several occasions the daily payment limits, introduced photos and personal messages when users sent money, added profile photos (*range*) and also launched a MobilePay app for Windows Phones (*reach*) (see Table 1).

Table 1: Overview of MobilePay's Reach and Range

MobilePay			
One-Sided Platform	**Side 1 (Users)**	**Range**	P2P payments Increase payment per transaction limit Split the bill
		Reach	All banks customers 15-years old iOS, Android

Two-Sided Platform	Side 1 (Users)	Range	Increase daily payment limit Photos to receipts Messages to receipts Profile Pics
		Reach	Windows Phones
	Side 2 (Merchants)	Range	Mobile Business App with functionalities for merchants MobilePay Button in third-party apps NFC/Bluetooth device at check out
		Reach	Small merchants Online retailers Large Retailers
	Interside	Range	C2B transactions Bonus
		Reach	Number of C2B transactions (non-disclosed)

Pingit

In 2012, the UK-based Barclays bank launched its peer-to-peer transactions (P2P) app Pingit which allows one user to send money to another user fast, easily and efficient. The service is available for Barclays' customers and non-customers as long as they have a UK current bank account and a UK mobile phone number. Approximately 4.2 million people have signed-up for the service since its launch. Pingit has also managed to attract 67 000 businesses so far [27]. Initially, Pingit was launched as a one-sided platform and later expanded to become two-sided in May 2012.

Pingit as One-Sided Platform

Pingit was first launched as a payment app enabling P2P transactions between a receiver and a sender who are subject to same-side network effects. The more people use the app, the more valuable it becomes. As the sender and receiver of P2P payments can change their roles easily, they form one distinct group of users. Thus, upon its launch Pingit functioned as one-sided platform.

Range

Upon its launch, Pingit's main functionality was to enable P2P payments among Barclays' bank account holders who can select the recipient's phone number, enter the amount they wish to transfer and press the send button (Site 2). The app allowed users to split the bill, send a personal message and receive a SMS confirmation for each transaction. App users could also set up and customize their profile by adding a photo. In May 2012, Barclays extended its value proposition by introducing features which allow for better user account management (e.g., integration with current accounts, operation of joint accounts, adding several phone numbers to one user profile), thus expanding the *reach* of the platform. By increasing the number of features offered by the app, Barclays aimed at creating more interactions on the platform, thereby driving value for the

app users. At the same time, the introduction of new features is directed not only towards more interactions within current app users, but also towards attracting more users. Thus, by increasing the *range* of the app, Barclays also tried to increase its *reach*.

Reach

Upon its launch, Pingit was available only to Barclays' bank account holders who can use the app to send P2P payments. Payments, however, could be received by both Barclays and non-Barclays customers, with the latter having to log-in to a website to claim the transferred Money (Site 2). Initially, the app was available only to Barclays' customers over 18 years old who had iOS, Android or Blackberry devices. Just a week after its launch, approximately 120 000 people signed for the payment app [34]. Following the successful launch, with two subsequent updates in February and April 2012, the app was expanded beyond Barclays' customers and was made available to anyone in Britain over the age of 16 years with a current UK bank account. Furthermore, in July 2014, Pingit became available for Windows Phones devices. Thus, Barclays had extended the platform's *reach* by changing the rules of access to the platform and by making the app available across multiple devices.

Pingit as Two-Sided Platform

By adding new functionalities and easing the rules for platform access, Pingit's user base grew significantly and reached 1,8 million users within a year and a half. As Pingit's user base grew in size, it became attractive to small businesses that form a second distinctive group of users who paid to get access to the installed user base. As Barclays started to add various small and large businesses, the app was transformed from being one-sided to being two-sided. Thus, Pingit still needed to design strategies for managing two sides (users and sole traders) each of which would have its own *reach* and *range*.

Interside Reach and Range

In May 2012, Pingit enabled its users to pay to sole traders such as carpenters, plumbers and beauticians by scanning a QR code on their bills, thereby eliminating the need for exchange of bank account details. With the introduction of the "Pay Now with Pingit" button to third-party apps and the "Buy it" button in the Pingit app in September 2013, the app allowed users to connect to merchants, thus enabling the possibility for more types of platform interactions. In November 2013, Barclays retooled its Pingit app to enable large firms to send funds for insurance claims, utility refunds and other corporate payments directly to consumers. Even though Pingit was extended to cover B2C payments, the app still functions as a two-sided platform, as it facilitates the interactions between two platform constituencies (users and merchants).

Merchant's Reach and Range

By bringing sole traders on board and enabling the interactions between users and small businesses, Pingit became a two-sided platform and started building the *reach* of its second side. The management of the *reach* and *range* for businesses required strategies for attracting more business owners (*reach*) and introducing features that would attract various types of businesses to the platform (*range*). In 2013, Barclays announced that Pingit could be used for paying utilities bills, thus adding utility providers to its *reach* and enabling new uses. A few months later, in September 2013, when Pingit had 1,8 million users, the app enabled functionalities that extended the *reach* to encompass small and large merchants. In this way, Pingit expanded the *reach* of its second side by gradually absorbing different types of businesses. Pingit introduced different features (*range*) in order to affiliate particular business types (sole traders vs. merchants) such as QR codes, in-app switch, buy button, etc. Thus, Pingit partitioned the second (business) side of the platform by designing different features for each of the different business types.

User's Reach and Range

Despite adopting strategies to grow the number and types of the affiliated to the solution businesses, Pingit also continued to grow the size of its installed user base. In August 2012, Pingit enabled the possibility for users to send money outside UK free of charge, thereby broadening the *range* of the platform. This new feature also expanded the *reach* of the platform with new types of users, that is remittance senders and receivers. Pingit continued to introduce various new features (*range*), such as Twitter payments, easier homepage navigation, simplified registration process, as indicated by the last released app version of Pingit. Pingit also increased its *reach* on the user side by providing the solution to Windows Phone users (see Table 2).

Table 2: Overview of Pingit's Reach and Range

Pingit			
One-Sided Platform	Side 1 (Users)	Range	P2P payments Joint accounts Multiple phone numbers Send money abroad
		Reach	All banks customers 16-years old iOS, Android
	Side 1 (Users)	Range	Twitter payments Money remittance
		Reach	Windows Phones Remittance receivers
		Range	QR Codes on bills/increase Payment transaction limit

Two-Sided Platform	Side 2 (Merchants)		*Pay now with Pingit* button in third-party apps *Buy it* button in Pingit *Send payment* button
		Reach	Sole Traders Utility companies Small merchants Insurance companies
	Interside	**Range**	C2B transactions B2C transactions
		Reach	Number of C2B and B2C transactions (non-disclosed)

Swish

Swish is a mobile payment application jointly developed by some of the largest financial institutions in Sweden (Danske Bank, Handelsbanken, Länsförsäkringar Bank, Nordea, Sparbankerna, Swedbank and SEB). The solution was introduced in 2012 and quickly became popular. Approximately every third Swede uses the mobile payment app, as the solution has more than 3,7 million registered users as of the end of 2015 [40]. Unlike the previous two payment platforms (MobilePay and Pingit), Swish has a different set up, which makes the solution an interesting case to study due to the dissimilarities between the selected solutions. Although Swish functions as one app, users need to register for the solution through their respective online banking apps offered by the participating banks. Each of the participating banks has a discretion to determine its own rules with regards to fees, payment limits, customer and merchant onboarding, age limit of customers. Despite these variations, the design and the features within the Swish app are identical to all users regardless of which bank they are customers.

Swish as One-Sided Platform

Swish, which was launched in December 2012, allows its users to execute P2P transfers in real-time by using the sender and receiver's phone numbers which are connected to their respective bank accounts [32]. Thus, Swish initially functioned as a one-sided platform, which facilitates the interactions between one distinct group of participants, namely senders and receivers of P2P payment transfers.

Range

Upon its launch, Swish allowed its users to send money to peers, split the bill with friends, buy second hand goods at flea markets (see Table 3). To execute a P2P transaction, a user needs to enter the phone number of the recipient, and the due amount, after which the user must enter a PIN code to finalize the transaction. In the following years, the app was improved with a couple of new releases which addressed minor user requests. In April 2013, Swish allowed non-smartphone users to receive money on their phones even though they did not

have the Swish app installed. Such users, however, could not send money to their peers. Even though the functionality was limited, it allowed Swish to incorporate more constituencies to its platform, namely non-smartphone users.

Although users need to use their respective bank credentials to register for the app and the participating banks have a large discretion to determine the rules of platform affiliation, the features and functionalities are identical for all Swish users, regardless of which bank they are customers. Thus, Swish functionalities are negotiated and agreed upon by all participating banks and are released simultaneously to all users. The need for coordination among many actors makes the process of introducing new features (that is, expanding the platform's reach) more cumbersome and time-consuming. This may also pose various restrictions in the platform's ability to introduce new services on a frequent basis.

Reach

Swish is available only for customers of the banks participating in this payment initiative as they need to log-in through the online banking app of their respective bank. Initially, the solution was launched by the six of the largest financial institutions in Sweden, which limits the potential reach of the solution to the customers of the participating banks. In the following two years two other Swedish banks, Skandiabanken and ICA Bank, joined the Swish initiative by making the solution available to their customers. Thus, Swish's potential reach was expanded to the customer base of two other banks.

Swish users can send and receive money from all participants affiliated to the platform, regardless of their bank. This set up of the solution not only stimulates the creation and maintenance of same-side network effects between receivers and senders, which form one distinct group of participants, but also drives the adoption of the service. Swish managed to attract 420 000 active users in the first six months after its launch with the number of users amounting to 700 000 at the end of the first year after the app release (Site 3). Initially, Swish was available on iOS and Android devices. In October 2013, Swish app for Windows Phone was released (Site 3), which enabled users with such devices to gain access to the full range of Swish services. Apart from allowing users with different smart phones to join the solution, Swish's reach also expanded as to encompass non-smart phone users, to be able to receive P2P transfers.

Swish as Two-Sided Platform

After Swish managed to attract more than 1 million users, it enabled its users to send money to companies and organizations in June 2014. As Swish's user base was growing at a stable pace, it became attractive to another

group of constituencies that wanted to have access to the sheer size of Swish's users. Thus, by adding a second group of participants, Swish was transformed from being a one-sided to a two-sided platform.

Interside Reach and Range

Approximately two years after the initial release of the Swish app, the solution enabled the execution of C2B transactions (interside range) by allowing users to pay for products and services at various small- and médium-sized merchants and to donate money to selected charities and not-for-profit organizations. To send money to merchants, users enter the merchant's number, the due amount and enter their PIN to confirm the transaction. In January 2016, Swish was enabled as a payment method in various webshops and third-party apps. To use Swish as a payment method in online check-out, users enter their phone number and the web store then sends a payment request to the users' Swish app. The users can then see the payment request with the details of the payment and enter their PIN to execute the transaction. Although each of the participating banks enable all these cross-side interactions simultaneously, each bank can design its own specific rules according to which these interactions can take place (e.g., pricing per transaction, etc.).

Merchants' Reach and Range

By enabling C2B transactions, Swish affiliated a second distinct group of participants to its platform. To be able to accept Swish payments, businesses need to get a Swish number, which is directly linked to the businesses' bank account (range). Users send money to merchants by using the merchants' phone number. This set-up of the solution allows for small and medium-sized businesses (reach) to accept payments. However, it is not currently possible to pay with Swish at large merchants such as supermarkets. In July 2015, approximately one year after the launch of C2B transaction functionality, 24 700 businesses were affiliated to the solution, while the number of users amounted to three million people [39]. By the end of 2015, the number of participating businesses (merchants and charities) increased to 45 000 [40], which indicates for a strong adoption rate of the solution among merchants and charity organizations. Since January 2016, Swish users can use the solution as a payment method in online stores (reach) as well as for in-app purchases in selected third party apps that can integrate the solution by using Swish' Application Programming Interface (API) (range) [38]. As with the set up of cross-side interactions and defining the access rules of the first platform constituency (users), each of the participating banks can determine the rules for platform affiliation of the second constituency (i.e. who can access, how the process is conducted, pricing model).

User's Reach and Range

The sheer size of Swish's user base helped the solution to attract businesses that wanted to gain access to new potential customers. As the size of the Swish's installed user base is key competitive advantage for the solution, Swish also focused on attracting new users and locking-in its existing users. Swish has launched new versions of the app with incremental improvements. In July 2015, a new design of the Swish payment app was released, but it did not introduce new features and functionalities. Swish also aimed at expanding the reach on its user side by releasing an app version for Windows Phone' users.

Table 3. Overview of Swish's Reach and Range

Swish			
One-Sided Platform	**Side 1 (Users)**	**Range**	P2P payments Split the bill
		Reach	Customers of participating banks iOS, Android Non-smartphone users
Two-Sided Platform	**Side 1 (Users)**	**Range**	Minor app releases
		Reach	Windows Phones
	Side 2 (Merchants)	**Range**	Swish Merchants Number Swish API
		Reach	Small and medium companies Online shops Charities
	Interside	**Range**	C2B transactions
		Reach	Number of C2B transactions (non-disclosed)

Discussion

This paper proposes the Reach and Range Framework for multi-sided platforms as an analytical tool to address some of the main challenges that platform owners face. To this end, we have adapted Keen's Reach and Range Framework to study MSPs and synthesize some of the main strategic considerations that platform owners need to tackle at the different stages of the platform's evolution. We select three case studies (two similar and one dissimilar) to demonstrate the usefulness of the framework to guide platform owners when addressing and designing strategies for overcoming various hurdles.

We found that the key to successfully launch and manage digital payment platforms is to balance the *reach* and *range* on each of the platform's sides and across sides. Thus, a platform provider needs to design and execute strategies to grow the number of participants as well as the types and volumes of interactions on each side. It also needs to have in place a strategy that nurtures the interactions across sides. To do so, a platform provider leverages the *reach* and *range* of each of the affiliated to the platform distinct group of participants.

Furthermore, as platforms evolve over time, they face various strategic challenges throughout the different stages of their evolutionary path, which necessitates that platform owners adopt specific strategies to manage the reach and range of the platform (see Table 4).

Table 4. The use of Reach and Range Framework for multi-sided platforms for strategic challenges

Platform Type	Strategic Challenge	Reach and Range Framework	Examples of Mechanisms		
			MobilePay	*Pingit*	*Swish*
One-Sided	Achieve critical mass of users	Build *Reach*	All banks' customers	All above 16- years old	All participating banks' customers
		Limit *Range*	P2P	P2P	P2P
Two-Sided	Adoption on the second group of participants	Build *Reach*	SMEs Large merchants Webshops	Sole traders Large merchants	SMEs Charities Webshops
		Diversify *Range*	NFC Bluetooth Business Online	*Buy It* button *Pay now with Pingit* button	Swish number for merchants Swish API
	User Stickiness (lock-in effects on the user base)	Strengthen User *Range*	Increased daily payment limit	Twitter payments	New app design
		Grow User *Reach*	Windows Phone app	Windows Phone app	Windows Phone app
		Enable Interside *Range*	C2B transactions	C2B transactions B2C transactions	C2B transactions
	Recurrence (high volume of cross-side transactions between the affiliated sides)	Manage Interside *Range*	Bonus	*Buy It* button	*Pay with Swish* button
		Scale *Reach* on second group of participants	Third-party apps	Insurance companies	Third-party apps

One-Sided Platforms – Building Reach, Limiting Range

The key challenges that one-sided platforms have to solve is swiftly gaining a critical mass of participants in order for a platform to secure its endurance. We argue that in order for a platform to succeed in this task, the platform owner needs to focus on the platform's reach and limit its efforts with regards to expanding the platform's range. This strategy recommendation calls for a platform owner to initially offer a limited number of features that target one distinct group of platform participants. For example, all of the three analyzed cases (MobilePay, Pingit and Swish) offered identical functionality (P2P) upon their launch that specifically targeted one distinct group, namely users. Thus, initially a platform owner should focus on achieving a sheer number of users within one main functionality and should abstain from introducing too many features that target the platform's user base (i.e., a platform should not offer too many functionalities to too many users).

The suggestion to limit the platform's range, which we define as the platform's ability to introduce new functionalities, however, does not imply that a platform owner should not leverage the platform's reach. We stress that platform owners should focus on introducing limited number of functionalities that can further facilitate and speed up the platform adoption. For example, MobilePay modified the amount limits for daily payment transactions on several occasions, while Pingit lowered the age of its users (see Table 1 and Table 2). Thus, the two solutions concentrated on making already introduced functionalities more appealing to both existing and potential users. Platform owners can also choose to introduce features in order to extend the main functionality of the one-sided platform that constitutes its value proposition. The main value proposition of the three investigated digital payment platforms is built around executing fast and easy P2P money transfers. In order to enhance this functionality, all of the solutions introduced 'split the bill' functionality, which allows for executing P2P transaction within a specific context (e.g., restaurant visit with friends). In addition to this, Pingit enabled its user to conduct international money remittances, which is another form of P2P money transfers taking place when users want to send money across borders. Thus, by enhancing and expanding the main functionality of the one-sided platform (range), the platform owner indirectly targets new potential users, thus expanding the reach on the first distinct group of participants affiliated to the platform. The key strategy which a platform owner should adopt during the first stage of platform evolution is offering limited functionalities to an increasing number of users forming one distinct group of platform participants (i.e., offering little to many).

It is interesting to note that although Swish also leveraged its platform range as described above, it adopted a slightly different approach to managing its platform *reach* due to its specific set up as a collaboration between various financial institutions. Swish's platform *reach* expanded after two more Swedish banks joined the solution when they enabled their customers to gain access to the payment solution. Thus, Swish managed to extend its platform *reach* without leveraging its platform *range*. This, however, is due to the unique platform design of the solution and it does not impact the importance of balancing both platform *reach* and *range* throughout the first phase of platform's evolution.

Two-Sided Platforms – Adopt Multiple Strategies to tackle Multiple Challenges

As the platform affiliates with a second distinct group of participants, it becomes two-sided. This presupposes that the platform increases its complexity as it has to cater to two constituencies (the first constituency is the first affiliated group of participants, while the second constituency represents the newly affiliated second distinct group of participants) and to nurture the interactions between them. Thus, a platform owner has to tackle a series of strategic challenges.

Build Initial Reach, Diversify Range to spur adoption of the second platform constituency

One of the main challenges which a platform owner faces at this stage is to ensure that enough participants of the newly added second constituency join and transact on the platform. Initially attracted by the size of the installed platform base, the participants of the second distinct group affiliated to the platform tend to be eager to join the platform. Regardless of this initial enthusiasm, platform owners often find that they have to further design and adopt strategies in order to increase the number of participants that form the second distinct group affiliated to the platform. Thus, when a new constituency is added, the overall reach of the platform expands, but while the reach of the first group of participants is ensured, the reach of the second constituency has to be built from scratch. To solve this conundrum and build the reach of the second platform side, a platform owner needs to diversify the range associated with this platform side.

None of the investigated solutions (MobilePay, Pingit and Swish) added a second platform constituency (i.e., businesses) as one homogenous group (or one uniform constituency). Instead, they gradually added different types of businesses as a second distinct group of participants starting by first offering solutions to small merchants, and then expanding to online retailers, large retail chains, insurance companies (see Table 1, Table 2 and Table 3). Thus, the platform reach of the second constituency scales up gradually. The three solutions also deploy separate mechanisms to target the different business types, thus diversifying the range of the second distinct group of participants. MobilePay users, for example, rely on NFC or Bluetooth technology to pay in-store to large merchants, while they use a merchant's mobile number when shopping in small retail shops. The rationale behind this set-up is based on the differences in the payment needs of large retailers that process a large volume of transactions and require fast solution at check-out. Thus, different payment options (range) have to be offered to address more appropriately the needs of the different merchant types (SMEs, large retailers, online stores, apps) (reach). Subsequently, by partitioning the business side, the digital payment platforms take into account the heterogeneity of the different actors and design specific solutions in order to get them on board.

Strengthen Initial Range, Grow Initial Reach and Enable Interside Range to ensure User Stickiness

Even though a platform has managed to increase its *reach* (i.e., it has attracted a significant number of users, it also needs to deepen its value proposition in order to lock-in the existing participants that form the first distinct group of platform participants. In order to so do, platform providers can deploy three different mechanisms. A platform can strengthen the initial range of the first constituency by introducing new functionalities, and thus creating new types of same-side interactions that will drive user engagement. An example of this is Pingit which enabled Twitter payments to grow the *reach* of its first group of participants

after it added its second constituency, i. e. businesses. It is also interesting to note that a platform owner can introduce different types of features as part of its efforts to leverage its *range*. While features such as Twitter payments and money remittances focus on accommodating various payment scenarios, features, such as adding a profile photos and photos to receipts aim at improving the user payment experience.

Platform providers should also focus on growing further the initial reach of the first platform constituency by increasing the number of the affiliated participants. As more users join the platform, the existing users will benefit from strengthening the same-side network effects as they can now transact with a larger user base, which ultimately bolsters the platform's stickiness. For example, MobilePay, Pingit and Swish launched versions of their apps for Windows Phones, thus extending the reach of their first constituency (i.e. users). Despite the growing user base and increased same-side interactions, affiliated users exhibit low levels of engagement as P2P payment transactions usually occur on a sporadic basis (e.g., most people do not transfer money to their friends on a daily basis, but just on a couple of occasions). To solve this, MobilePay, Pingit and Swish enabled C2B interactions by allowing people to use their apps in various other contexts, thus enabling new uses and increasing the value of the platform to the first platform constituency.

Manage Interside Range and Scale Reach on Second Side to create Platform Recurrence

Apart from tackling issues with regards to the adoption of the second platform constituency and ensuring stickiness of the initial user base, a platform owner needs to design and enable reoccurring interactions between the two distinct groups of participants that are now affiliated to the platform. A platform owner needs to introduce new functionalities which enable the interaction between the platform sides, thus creating platform interside range. For example, MobilePay, Pingit and Swish allowed its users to execute C2B transactions. By enabling cross-side functionality, a platform could unlock new uses for its app and expand its overall *reach*. The establishment of Interside range increases the complexity of the overall platform's range as the platform owner needs to maintain and drive the adoption all of the existing functionalities, while at the same time spurring the adoption of the new features. The successful introduction of new functionalities requires the platform owner to gain a critical mass of users who adopt such cross-side interactions. Thus, platform interside reach indicates the number of users who actively use the new feature (in our cases, the number of users who adopt C2B transactions (Interside range), which differs from the adoption of P2P transactions, which refer to platform initial range of the first constituency. Platform Recurrence, which we define as the achievement of high volume of transactions between the two affiliated to the platform distinct group of participants, is also dependent upon the ability of the platform owner to scale the reach of the second constituency. As more merchants adopt Swish and the solution becomes widely accepted, more users are likely to use it in order to

pay for their goods. Thus, the expansion of the *reach* of a platform's side can also facilitate the adoption of the interside platform reach.

As all of the three analyzed cases (MobilePay, Pingit and Swish) function as two-sided platforms, we are not able to investigate the usefulness of the Reach and Range framework for solving some of the strategic challenges that multi-sided platforms face. In section 3.1, we identified platform variety and platform defence as the main issues that multi-sided platforms have to tackle, but we are not able to test these assumptions further due to lack of data.

To further demonstrate the usefulness of the Reach and Range Framework as a tool to overcome the main strategic challenges that a platform faces throughout its evolution, we applied the framework to explain the failure of two solutions that are considered to be competitors to two of our selected cases.

Approximately nine months after the release of MobilePay in Denmark, the online payment solution, Paii, was launched by 4T, a joint venture between all four major telecommunication operators in the Danish market [35]. The account-based solution enables users to make web and app purchases, transfer money to other Paii user's or pay via SMS without it showing up on their phone bill. Less than a year after its launch, Paii was discontinued and sold out to one of its competitors on the Danish digital payment market, Swipp. Paii was launched as a two-sided platform as it was trying to attract both users and merchants on board simultaneously. As a result of its initial platform design, Paii had to tackle multiple challenges. The solution had to achieve reach on both platform constituencies (users and merchants), while trying to create and manage interside reach and range (C2B transactions) (see Table 4). Paii also started by designing and offering wide platform range on the user side (one of the two platform constituencies), as it enabled its users to execute both P2P and C2B transactions (unlike the first strategy we have identified (see Table 4)). This presupposes that a platform owner has to achieve reach for both features, thus creating sufficient same-side network effects for the adoption of P2P functionality (platform's reach on one distinct group of participants, namely, users (see Figure 1)) and cross-side network effects for the adoption of the C2B functionality (platform's interside reach (see Figure 2)). Another major hurdle was that Paii managed to ensure only limited reach on the merchant side, which limited the number of potential cross-side interactions and reflected negatively on the platform interside reach. At the same time Paii, whose main target were online merchants, failed to diversify the range on the merchant side (i.e. offering different functionalities for different merchants), which impacted on the number of merchants joining the platform (reach). The merchant's reach was also hindered by the limited reach of the other distinct group of participants on the Paii platform, namely the users. Thus, one of the main mistakes that Paii made was trying to offer a wide variety of functionalities to more than one group of platform participants at an early stage of the platform's evolutionary path (i.e., being too much to too many too soon).

The same analysis can be applied to investigating the reasons behind the failure of Bart, a Swedish mobile payment solution offered by Swedbank, which was discarded in 2014 [15]. Bart is another example of a two-sided platform which tried to get two distinct groups of participants on board simultaneously. The account-based solution made use of QR codes to execute C2B in-store transactions and required merchants to be equipped with QR-readers. Bart managed to sign on one big retailer chain (Axfood) to use the service [4]. However, it failed to attract other major retailers, as its fees, which were the same as paying with cards, were higher than the fees offered by other payment services in Sweden. The interest from the consumer side was also very low with just 20 000 users signing up for the service [2]. As a result, the service was scrapped and Swedbank joined the Swish initiative. Bart failed to achieve a sufficient number of participants on both of its sides, as it mismanaged the platform's reach and range. The solution was available only to the customers of Swedbank, significantly limiting the platform's reach on the user side. Bart's platform reach on the user side was low, as the solution did not support any features that spurred users' adoption of the payment app such as P2P transactions. The platform's reach on the user side depended directly on the platform's reach on the merchants' side (that is, the number of merchants joining the platform). Thus, Bart was focusing on creating and managing interside platform reach by stimulating cross-side interactions. However, the platform's reach on the merchant side, which constituted the second platform constituency, was inhibited due to the lack of critical mass of users. Bart also tried to attract merchants by offering only one type of solution to businesses (QR code scanning). Thus, the solution failed to diversify its platform reach in order to appeal to wider types of merchants (see Table 4). Under the Reach and Range Framework for MSPs Bart's failure can be attributed to offering limited cross-side functionality such as C2B transactions (interside range) the adoption of which is subjected to the presence of strong platform's reach on each of the platform constituencies between which the cross-side interactions take place (i.e. being too little to too few as Bart could not manage to attract enough users and merchants).

The findings of this research further expand the literature on entry and expansion strategies for MSPs. As discussed in Secton 2, a couple of researchers have proposed stage models to guide the launch and subsequent evolution of MSPs. The models, however, only partially address some of the challenges which platform owners face throughout the platform's evolution, and thus they do not prescribe in-depth strategic recommendations in order to guarantee the platform's success.

Evans [11], for example, proposes a two-stage model to explain the market entry and growth of MSPs (ignition-growth model). According to him, the success of a platform depends on the ability of the MSPs to reach critical mass, that is, the number of users on both sides has to reach to a certain point. To this end, Evans [11] recommends a zig-zag strategy, where a platform launches with a limited number of participants on both sides

and grows over time. Evans' model, which presupposes that a platform is launched and managed as two-sided, does not take into account the different platform design possibilities upon entry (one-sided or two-sided) and the fact that different platform designs require different strategies. The platform evolution under Evans [11] is solely associated with changes in the number of platform participants and does not take into account other important elements of platform evolution such as the introduction of new features. Furthermore, the zig-zag strategy proposed by Evans only gives recommendations with regards to managing the number of participants on both sides affiliated to the platform. Thus, the model does not address one-sided platforms and how they can be transformed into being two-sided. In contrast to Evans' model [11], the Reach and Range framework for MSPs helps us view the platform evolution as a complex process that includes not only the attraction of a huge number of users (reach), but also the introduction of new features and functionalities (range) that serve a double purpose: first, to attract more users (reach), and second, to increase the platform stickiness in order to lock-in the already attracted users. Thus, we argue that there is an inderdependency between *reach* and *range*, and in particular that the increase in platform *range* can lead to the increase of platform *reach*. Unlike Evans' model, we also recognize that a platform faces various strategic challenges throughout the different stages of its evolution (see section 3.1.).

Hagiu's model [19] recognizes the gradual transition of a platform from one-sided to being two-sided and prescribes mechanisms (platform's breadth and depth) that a platform owner can leverage during this process. The Reach and Range framework for MSPs is anchored around the concepts of reach and range, which have some similarities and dissimilarities with the notions of breadth and depth. Although both sets of concepts focus on the number of participants as well as on the features and functionalities offered by a platform owner, Hagiu's depth and breadth are applied on a general platform level and do not address in details the interplay between the two concepts. For example, the notion of breadth implies adding separate constituencies (that is separate platform sides) and does not take into account the fact that the size of a particular platform side also grows over time (its reach). Hagiu's platform breadth comprises the number of the affiliated to the platform groups of participants (sides), while our notion of platform *reach* is associated with the size of a particular platform side and also with the interside reach, which measures the size of the interactions across platform sides. Although Hagiu's concepts of breadth and depth are important for the platform's evolution, we further extend these concepts by applying them on a more detailed level, which allows us to pinpoint the various interdependencies between the platform's reach and range. Furthermore, Hagiu's model [19] is based on a single strategy which a platform owner can adopt in its expansion quest. Hagiu recommends that before a platform adds an additional platform constituency (that is, it expands its breadth), a platform owner should offer new functionalities so to increase the platform depth. This is a valid strategy that is also part of the strategies we prescribe for successful platform expansion (see Discussion). The adoption of the Reach and Range framework for MSPs, however, allows us to deduct multiple strategies and strategic recommendations

for how to leverage the platform's reach and range (see Table 4), which can guide more precisely the platform owners' efforts to spur the platform adoption.

The Reach and Range framework for MSPs differs from the already existing models in the MSPs literature, as it recognizes the different strategic challenges that a platform owner needs to tackle throughout the platform evolution. Further, it provides the needed mechanisms (leveraging the reach and range) in order to address them (see Table 4). Such considerations are absent from Hagui's model [19], and while Evans [11] recognizes the importance of achieving critical mass of users, he does not provide more examples of present or future strategic challenges and how his model can help overcome them. Although Tiwana [42] recognizes the fact that platforms face different strategic challenges throughout the different stages of platform evolution, his work lists only some of them in the form of evolutionary metrics and does not offer a model that contains prescriptions of how to tackle them.

Although we recognize that the above mentioned models present important and relevant findings, we argue that they address only partial issues and do not provide coherent strategic recommendations to guide platform owners. Nonetheless, we draw upon some of the main assumptions of the three models (Evans' notion of critical mass as important threshold for platform's evolution [11], Hagiu's concept of depth and breadth as mechanisms for leveraging the platform's adoption [19] and Tiwana's notion of evolutionary metrics as foundation for determining some of the strategic challenges faced by platforms [42]) in order to apply MSPs logic to the Keen's Reach and Range Framework. Thus, we design the Reach and Range framework for MSP as an analytical tool that provides in-depth understanding of the platform's key mechanisms (reach and range) and how they can be leveraged to address the main strategic challenges that a platform owner faces during platform evolution.

Conclusion

The aim of this paper is to identify successful strategies to which mobile payment platforms can adhere in order to ensure their initial and subsequent adoption. To this end, we investigate the applicability of the Reach and Range Framework for MPSs for overcoming some of the main challenges associated with platform adoption and use this analysis to deduct strategies for successful platform entry and expansion. In order to do so, we first apply the framework to study three successful mobile payment platforms. After analyzing the selected cases, we prescribe several strategic recommendations that can assist platform owners in their quest to spur platform adoption. We further prove the explanatory power of the framework by illustrating its usefulness for explaining the failure of two mobile payment solutions. Our main finding is that successful mobile payment platforms tend to follow a particular evolutionary path that ensures a high adoption rate among the platform participants. We, thus, recommend that a mobile payment solution should be launched as a one-

sided platform in order to attract a sufficient number of users, and then gradually expand into being two (milti)-sided by adding more platform constituencies. The key to successfully managing this transformation is determined by the platform owner's ability to leverage a platform's *reach* (number of participants) and *range* (features and functionalities).

The contributions of this paper are several. First, we conceptualize a framework that can serve as a useful vehicle for understanding and mapping out a platform's evolution. Second, we demonstrate the usefulness of the Reach and Range Framework for MPSs to address key issues with regards to platform adoption. Third, we indentify several strategic recommendations for leveraging the platform's reach and range that a platform owner can consult when tackling the various strategic hurdles at different stages of platform evolution. Fourth, although we apply the framework to the cases of digital payment platforms, we demonstrate that the Reach and Range Framework can be used to guide the strategic planning of every business functioning as a platform. Finally, the proposed framework as well as the identified strategies that a platform owner can adopt in leveraging the platform's reach and range can serve as a useful guide for practitioners when designing and executing platform entry and expansion strategies.

We limit our analysis to investigating only a few strategic considerations that platform owners face. In reality, a platform owner has to address strategic issues such as platform governance, platform pricing and designing a viable business model, developing a platform-based ecosystem, etc. In our analysis, we also rely predominantly on secondary data (with the exception of MobilePay where we had access to primary data), which constitutes another limitation of this paper. Although the gathered data is representative enough, the analysis could be further extended by delving into further details, which can come from primary data. Future research may pinpoint how the Reach and Range Framework relates to broader topics such as platform governance, platform pricing and platform-based ecosystems. The framework can also be applied to MSPs other than digital payments.

Websites List

Site 1: MobilePay App
http://www.mobilepay.dk/da-dk/Pages/mobilepay.aspx

Site 2: Pingit Website
https://www.pingit.com/#!/

Site 3: Swish Official Facebook Page
https://www.facebook.com/getswish/

References

[1]   P. Andersen, Nu kan du betale med Mobilepay i andre apps, Politiken, 19. Jun. 2014. Available : http://politiken.dk/oekonomi/virksomheder/ECE2320556/nu-kan-du-betale-med mobilepay-i-andre-apps/.

[2]   T. Apanasevic, and J. Markendahl. Mobile payments for retailing – success or failure?Findings from Swedish market. Abstract submitted to the Third Cashless Society Roundtable, May 2014, Stockholm.

[3]   M. Armstrong, Competition in two-sided markets, RAND Journal of Economics, vol. 37, no. 3, pp. 668–691, 2006.

[4]   Axfood (2012). Mobile payment with Bart to Willys and Hemköp stores. Press release. Available: http://www.axfood.se/en/Press/Press-releases/Mobile-payment-with-Bart-to-Willys-and-Hemkop-stores/

[5]   R. Ballagas, J. Borchers, M. Rohs, and J. G. Sheridan, The Smart Phone: A Ubiquitous Input Device, IEEE Pervasive Computing, vol. 5, no. 1, pp. 70-77, 2006.

[6]   P. Baxter and S. Jack, Qualitative Case Study Methodology: Study Design and Implementation for Novice Researchers, The Qualitative Report, vol. 13, no. 4, pp. 544-559, 2008.

[7]   C. J. Chae, and J. Hedman, Business Models for NFC Based Mobile Payments, Journal of Business Models, vol. 3, no. 1, pp. 29-48, 2015.

[8]   T. R. Eisenmann (Ed.), Internet Business Models: Text and Cases. New York: McGraw-Hill/Irwin, 2002

[9]   T. R. Eisenmann, P. Geoffrey and M. van Alstyne, Platform envelopment, Strategic Management Journal, vol. 32, no. 12, pp. 1270-1285, 2011

[10] T. R. Eisenmann, G. Parker and M. van Alstyne, Strategies for Two-Sided Markets, Harvard Business Review, vol. 84, no. 10, pp. 92-101, 2006.

[11] D. S. Evans, How Catalysts Ignite: The Economics of Platform-Based Start-Ups. In: A. Gawer (ed.). Platform, markets and innovation. Cheltenham, UK and Northampton, MA, US: Edward Elgar, 2009.

[12] D. S. Evans and R. Schmalensee, The Antitrust Analysis of Multi-Sided Platform Businesses. In R. Blair and D. Sokol (Eds.) Oxford Handbook on International Antitrust Economics. Oxford University Press, 2013.

[13] D. S. Evans and R. Schmalensee, Markets with Two-Sided Platforms, Issues in Competition Law and Policy (ABA Section of Antitrust Law), vol. 1, no. 28, 2008.

[14] Finextra (2016). Mobile payments to overtake cash and cards within a decade - The Co-op. Available: https://www.finextra.com/newsarticle/28765/mobile-payments-to-overtake-cash-and-cards-within-a-decade---the-co-op.

[15] Finextra (2014). Swedbank scraps Bart mobile payments app. Available: https://www.finextra.com/news/fullstory.aspx?newsitemid=25635

[16] A. Gannamaneni, J. Ondrus and K. Lyytinen, A Post-failure Analysis of Mobile Payment Platforms, in Proceedings of the 48th Hawaii International Conference on System Sciences, 2015

[17] C. Geddes, Achieving critical mass in social networks, Journal of Database Marketing & Customer Strategy Management , no. 18, pp. 123 – 128, 2011.

[18] A. Hagiu, Strategic Decisions for Multi-sided Platforms, MIT Sloan Management Review, vol. 55, no. 2, 2014.

[19] A. Hagiu, Multi-Sided Platforms: From Microfoundations to Design and Expansion Strategies, Harvard Business School Strategy Unit Working Paper No. 09-115, Boston, MA, 2006.

[20] A. Hagiu and J. Wright, Multi-Sided Platforms, Harvard Business School Working Paper 12-024, Boston, MA, 2011.

[21] S. Henningsson and J. Hedman, The New Normal : Market Cooperation in the Mobile Payments Ecosystem, Electronic Commerce Research and Applications, vol. 15, no. 5, pp. 305-318, 2015.

[22] H.-F. Hsieh, and S. E. Shannon. Three approaches to qualitative content analysis. Qualitative health research, vol 15, no 9, pp 1277-1288. 2005.

[23] E. Kazan and J. Damsgaard, A Framework for Analyzing Digital Payment as a Multi-sided Platform: A Study of Three European NFC Solutions, in Proceedings ECIS 2013, Atlanta, GA : Association for Information Systems. AIS Electronic Library (AISeL), 2013.

[24] P. G. W. Keen, On-line Profits: A Manager's Guide to Electronic Commerce. Boston, MA: Harvard Business School Press, 1997.

[25] P. G. W. Keen, Shaping the Future: Business Design Through Information Technology. Boston, MA: Harvard Business School Press, 1991.

[26] A. Langley. Strategies for theorizing from process data**.** The Academy of Management Review*,* 24 (4), pp. 691-710, 1999.

[27] M. Moore (2015). Zapp Takes The Fight To Apple Pay With Barclays Pingit Deal. Tech Week Europe. Available: http://www.techweekeurope.co.uk/e-marketing/zapp-barclays-pingit-apple-pay-171962#7rXHDHxoeYYKjEX7.99.

[28] J. Ondrus, A. Gannamaneni, A. and K. Lyytinen, The impact of openness on the market potential of multi-sided platforms: a case study of mobile payment platforms, Journal of Information Technology, 30, pp. 260–275, 2015.

[29] J. Ondrus, K. Lyytinen, and Y. Pigneur. Why Mobile Payments Fail ? Towards a Dynamic and Multi perspective Explanation. In Proceedings of the 42nd Annual Hawaii International Conference on System Sciences (HICSS'09). IEEE Computer Society, 2009.

[30] G. Parker, van Alstyne, M. and S. P. Choudary. Platform Revolution: How Networked Markets Are Transforming the Economy and How to Make Them Work for You. NY: WW Norton Company, Inc., 2016.

[31] A. Pettigrew, Longitudinal field research on change: Theory and practice, in Proceedings National Science Foundation Conference on Longitudinal Research Methods in Organizations, Austin, 1988, pp. 91-125.

[32] SEB Press Release (2012). SEB launches new mobile payment service Swish. Available: http://sebgroup.com/press/press-releases/2012/seb-launches-new-mobile-payment-service-swish

[33] C. Shapiro and H. Varian, Information Rules. Boston: Harvard Business School Press, 1999.

[34] Shearman, S. (2012). Barclays Pingit app attracts 120,000 downloads in five days. Available: http://www.marketingmagazine.co.uk/article/1118578/barclays-pingit-app-attracts-120000-downloads-five-days.

[35] K. S. Staykova and J. Damsgaard, The race to dominate mobile payments: Entry and expansion strategies. Electronic commerce research and Appplications, vol 14, no 5, pp. 319-330, 2015.

[36] K. S. Staykova and J. Damsgaard, A Model Of Digital Payment Infrastructure Formation And Development : The EU Regulator's Perspective. In Proceedings of 13th International Conference on Mobile Business, 2014 ICMB 2014, London, UK.

[37] W-S. Sun, C-L. Tien, J-W. Pan, and K-C. Huang. Simulation of autofocus lens design for a cell phone camera with object distance from infinity to 9.754 mm. Applied Optics, 54(28), pp. 203-209, 10/2015.

[38] Swish Press Release (2016). Swish klart för e-handel. Available: https://www.getswish.se/content/uploads/2014/05/20160114_Swish_Pressrelease_Handel.pdf

[39] Swish Press Release (2015a). Var tredje svensk använder Swish. Available: https://www.getswish.se/content/uploads/2014/05/20150707_Swish_Pressrelease.pdf

[40] Swish Press release (2015b). Enkelt och snabbt – viktigaste anledningarna till att varannan svensk swishar. Available: https://www.getswish.se/content/uploads/2014/05/20151211_Swish_Pressrelease.pdf

[41] D. Tilson, C. I. Sorensen, and K. Lyytinen. Platform Complexity: Lessons from mobile wireless. *2012 International Conference on Mobile Business.* Paper 6, 2012.

[42] A. Tiwana, A. Platform ecosystems, Aligning architecture, governance, and strategy. Amsterdam: Morgan Kaufmann, 2014.

[43] A. Van de Ven, and G.P. Huber. Longitudinal field research methods for studying processes of organizational change. Organization Science, vol.1, no.3, pp.213-219. 1990.

[44] P. Weill and M. Broadbent, Managing IT Infrastructure: A Strategic Choice. In R.W. Zmud (ed.) Framing the Domains of IT Management: Projecting the Future Through the Past. Pinnaflex, Cincinnati, Ohio, 2000.

[45] R. K. Yin, Case study research: Design and methods, 3rd Edition. Thousand Oaks, CA: Sage, 2003.

[46] E. D. Zamani, P. Kourouthanassis, D.C. Karaiskos and G.M. Giaglis, Exploring the Adoption of Ubiquitous Information Systems within the museum context, in Proceedings, 6th Mediterranean Conference on Information Systems, Limassol, Cyprus, 2011.

Paper V Dual-track's strategy for incumbent's transformation: The case of Danske Bank adopting a platform business model

Authors: Staykova, K., S., and Damsgaard, J.

Dual-track's strategy for incumbent's transformation: The case of Danske Bank adopting a platform business model

Kalina S. Staykova

Copenhagen Business School, Department of Digitalization, Danske Bank, kss.digi@cbs.dk

Jan Damsgaard

Copenhagen Business School, Department of Digitalization, jd.digi@cbs.dk

Abstract

(a) Situation faced: The traditionally stable and conservative financial service industry is undergoing a process of transformation where contenders utiliz-ing new technologies and relying on novel business models challenge the role of incumbent financial organizations. The changing preferences of cus-tomers, who demand customized services at convenient for them time, and the shifting regulatory environment, which encourages the entry of fintech start-ups, threaten the dominant position of these traditional actors.

(b) Action taken: Instead of observing passively this ongoing trend, Danske Bank, one of the leading banks in Northern Europe, took a proactive ap-proach to digitalization by launching pre-emptively a number of disruptive digital initiatives in order to protect itself from disruption. Danske Bank cor-rectly read the market dynamics in Denmark in connection to consumer readiness, technology maturity and competitors' actions and decided to ven-ture into the mobile payment area in order to position itself as first mover. By launching its solution MobilePay, which functions as digital payment platform, Danske Bank also adopted a platform business model, which differs from the traditional banking products.

(c) Results achieved: Leveraging its first mover advantage, MobilePay gained momentum and has successfully defended its dominant position in the Dan-ish market, which other local and international mobile payment solutions tried to threaten. Four years after its launch, MobilePay is currently being used by more than 90 % of the Danes, has established a growing ecosystem of partners, and has expanded to other Nordic markets. MobilePay's success has helped Danske Bank improve its brand image and reduce customer churn. It has also demonstrated Danske Bank's ability to be at the forefront of digital innovation by proving the bank's capability to address the chang-ing preferences of its private customers and to deliver on the digitalization agenda of its corporate customers.

(d) Lessons learned: This case demonstrates how an incumbent financial organization can successfully protect its core services by venturing into disruptive digital initiatives, such as the launch of platform business model, which requires the adoption of different business thinking. The success of such initiative depends upon the timely launch of a customer-centric solution with focus on simplicity, ease of use and strong value proposition. Despite the short-term gains, the long-term sustainability and profitability of such a solution operating in constantly changing environment requires its continuous development. Its success also depends on achieving a certain level of organizational autonomy from the traditional business, while at the same time establishing synergy to it in order to gain access to the incumbents' core resources.

1. Introduction

In the recent years, the rapid advancement of digital technologies has led to the disruption of a number of traditional industries, such as music (e.g., iTunes), print media (e.g., Guardian), and transportation (e.g., Uber) (see, e.g., Karimi and Walter 2015). Similarly, the emergence of new actors who offer disruptive financial services by utilizing novel digital technologies (e.g., TransferWise, Square, LevelUP, Zopa, etc.) have recently challenged the traditionally stable and conservative finan-cial industry.

Observing closely this ongoing trend, Danske Bank, the leading bank in Denmark and one of the largest banks in Northern Europe, was contemplating the long-term consequences of this shift. Headquartered in Copenhagen, Denmark, Danske Bank operates in 16 markets and serves more than 2,7 million private customers, app. 240,000 small and medium-sized business customers and around 1,800 corpo-rate and institutional customers. With its history tracing back to late 19th century, Danske Bank has always been at the forefront of financial service innovation. For example, in 1881 the bank introduced for the first time in Europe safe deposits. It was also among the first in Europe to incorporate payment cards and online banking to its portfolio of financial products. In 1999, the bank launched the first mobile banking service in the world by utilizing the new Wireless Application Protocol (WAP) technology, which allowed its Finnish private customers to connect to their online banking accounts via mobile phone devices.

The present situation, however, was different. Novel digital technologies, such as smartphones, which had absorbed services offered previously by multiple phys-ical devices (e.g., camera, mP3 players, navigation devices), were rapidly adopted by significant part of the population in Northern Europe (e.g., 59 % of the Danes had a smartphone in 2013 (Statista 2016)). This led to a change in consumer pref-erences, with customers requiring on-demand services tailored to their individual needs. The traditionally strict regulatory environment was also altering as an after-math of the 2008 financial crisis with regulators demanding a transformation of the financial sector. Thus, Danske Bank, similarly to other incumbent banks, found it-self in a fast-paced changing environment, with its competitive advantages eroding significantly.

Instead of awaiting disruption, Danske Bank adopted a proactive approach to-wards digitalization by pursuing disruptive initiatives within its own business units, which challenged the current modus operandi of the bank. The venturing into a plat-form business model, which facilitate the interaction between distinct types of actors in a process of value creation and exchange (Hagiu and Wright 2011; Parker et al. 2016), constituted one of the most successful digital disruption initiatives. In particular, Danske Bank launched a mobile payment platform, MobilePay, around which an ecosystem of actors formed over time. MobilePay proved to be a huge success immediately after its release in May 2013. Four years after its launch, app. 90 % of the Danish population and app. 75 000 merchants use the platform, which facilitates peer-to-peer (P2P) and consumer-to-business (C2B) payment transac-tions. MobilePay also has a growing customer base in Finland and, until recently, in Norway.

Although Danske Bank managed to launch successfully a disruptive payment platform, it had to overcome various external and internal challenges, such as es-tablishing viable business model, improving platform resilience and scalability, and addressing increased competitive pressure, in order to ensure the long-term sustain-ability of the solution. As a result, MobilePay had to evolve constantly by adding new types of participants and by increasing its value proposition towards them. Thus, based on the evolutionary journey of MobilePay, we argue that the success of a digital payment platform requires not only identifying and launching appealing functionalities, but it also evokes its continuous managing and optimization.

In this case, we investigate how a traditional company can successfully launch and manage a digital platform business model and how such a disruptive initiative can help the incumbent protect itself from disruption. To this end, we draw upon first-hand observations, semi-structured interviews and archival documents, which we have collected since the launch of MobilePay – first, by acting as consultants on key strategic decisions, and later, by conducting a two-year fieldwork on site. We use an inductive approach to analyze the gathered data, based on which we synthe-tize several key learning points for practitioners and academics alike.

2. Situation faced

As an incumbent financial institution operating in rapidly changing environment, Danske Bank faced many uncertainties in 2012. The regulatory environment, in which financial institutions operated, altered as an aftermath of the financial crisis in 2008. The already strictly regulated financial industry was subjected to more reg-ulatory requirements in a bid to mitigate the consequences of the financial crisis (Danske Bank 2013). At the same time, the provisions of the new Payment Service Directive 2 (PSD2), with which the European Union (EU) aimed at transforming the payment area in the Single Market, required incumbent banks to open their in-frastructures in order to give non-discriminatory access to new actors (European Union 2013). Even though the PDS 2 is about to come into effect in late 2018, it already became a central topic for Danske Bank when it

was first proposed in 2013 mainly due to the uncertainty of the consequences, stemming from its implementation for the bank's business model.

The 2008 financial crisis also significantly eroded the consumers' trust in the financial institutions around the world. At the same time, the altering consumer preferences towards easy to use, innovative and real-time solutions also led to banks' customers substituting traditional financial products and services for novel, customer-centered offerings of fintech start-ups. In 2012, these new players, some of whom had managed to achieve significant global user base (e.g., Mint, Zopa, etc.), were about to enter the Danish market as well. For example, iZettle, which delivered innovative Point-of-Sale solutions to small and medium-sized businesses, announced its plans to enter the Danish market in 2012.

In 2012, Danske Bank also faced customer backlash due to the implementation of its new strategy "New Normal-New Standards", which, although emphasizing on introducing new standards for financial services by providing state-of-the-art digital solutions (Danske Bank 2012), failed to deliver optimal results. As result of an ill-planned new customer program, part of the new strategy, and the fiasco of the cor-responding marketing campaign, Danske Bank was rapidly losing its private cus-tomers, who decided to switch to other financial institutions.

Thus, Danske Bank found itself into a state of flux facing changing consumer preferences, new competitors, rapid spread of emerging technologies (e.g. NFC, dongles, real-time analytics, etc.) and stricter regulatory environment. To tackle these challenges, the financial institution had to undertake a new approach in order to protect its core services, restore its tainted image and remain relevant to the needs of its customers.

3. Action taken

Observing closely these ongoing trends, in 2012, Danske Bank decided to put focus on customer-centric solutions, digitalization, and increased transparency and trust (Danske Bank 2012). Although top managers perceived digitalization as an ongoing and overarching effort in the bank, they concluded that to protect Danske Bank from disruption, they should also focus on radical digital initiatives, which deviated from the traditional approaches towards innovation. Thus, Danske Bank adopted a dual-track strategy to digitalization – being a classical bank, which em-braces digitalization incrementally, while, at the same time, experimenting with disruptive initiatives. Radical, consumer-centric, utilizing novel technologies and re-lying on agile innovation processes, these disruptive digital initiatives aimed at turning upside down the modus operandi of the bank. To fulfil this vision, Danske Bank was on a quest to identify projects, which would disrupt the bank from within.

Developing and offering a mobile payment platform around which an ecosystem of actors emerges constituted one of these digital disruptive initiatives. Venturing into this new type of digital business models, however, required the adoption of different capabilities and thinking. Thus, instead of relying on traditional business

processes and strategies, building a digital platform business model called for the adoption of platform logic (Parker et al. 2016).

3.1 Launch of MobilePay

Situation

In 2013, mobile payments were gaining momentum. Due to increased consumer demand from its private customers, Danske Bank had already been exploring the opportunity to launch a joint sector solution for mobile payments together with other Danish banks. The assumption was that payments via smartphone were to become a fast growing financial channel with significant long-term opportunities for both private and business customers. The common efforts, however, progressed slowly due to various technical issues. In 2013, the major Danish telecom operators openly announced their intention to enter jointly the mobile payment area. At the same time, fintech start-ups (e.g., iZettle) also revealed their plans to enter the Danish market. Thus, with the shift in the competitive dynamics, various actors engaged in a race to dominate the untapped mobile payment market in Denmark.

Actions Taken

As the competitive environment changed and the talks for joint bank sector so-lution stalled, Danske Bank decided to leave the common initiative in order to en-sure that it launched the first mobile payment solution in the Danish market. Danske Bank's solo venture in this area begun with the set-up of a small, dedicated team of employees, whose task was to develop and launch a mobile payment solution within six months. The team had the freedom to explore different innovation methods than the ones usually applied in Danske Bank. Adopting agile principles, business ana-lysts worked closely together with IT specialists in conceptualizing, prototyping and testing the solution. During the development phase, the team considered multiple technologies enabling mobile payments – from Near Field Communication (NFC), QR codes and dongles to solutions utilizing the existing bank infrastructure through pre-paid accounts and even integration to the existing Danske Bank's mobile bank-ing app.

After six months of work, in May 2013, Danske Bank launched its mobile pay-ment app, MobilePay, which allowed users to transfer money to their friends and split the bill in various situations. The solution functioned as one-sided platform, enabling the interactions among one distinct group of platform participants, namely private customers, who wanted to send one another money (Hagiu and Wright 2011; Parker et al. 2016). Designing MobilePay as easy to use, simple and intuitive solu-tion, while still maintaining high level of security, reflected Danske Bank's new strategy, which focused on consumer centricity. Instead of developing a complex solution with multiple offerings, the team decided to solve one particular problem, which private customers faced, namely exchanging money with peers. The mobile payment platform utilized the existing card-based infrastructure by allowing users to add their cards to the app and transfer money to their friends via

mobile phone numbers. Thus, instead of adopting complex technology, which would have re-quired significant investment and longer development time, MobilePay took ad-vantage of the existing payment infrastructure by leveraging Danske Bank's key assets and expertise.

Results achieved

The initial strategy estimated that app. 250 000 users would adopt MobilePay within a year after its launch, but the digital payment platform proved to be hugely popular with the Danes. In just nine months, app. one million users (1/5 of the Dan-ish population), both Danske Bank and non-Danske Bank customers, used the plat-form, with the number of transactions amounting to more than 134 million EUR (MobilePay 2014). In fact, non-Danske bank customers accounted for app. 70 % of the total user base of MobilePay. Thus, instead of designing a bank-specific solu-tion, Danske Bank offered open to all users mobile payment platform in order to solidify its position in Denmark. The openness on user level strengthened Mo-bilePay's same-side network effects (that is, the value of MobilePay for existing users increased with the inclusion of new users and vice versa, see, Shapiro and Varian, 1999).

Due to the fast market entry, Danske Bank managed to secure a first mover ad-vantage by acquiring large number of private customers within a relatively short time span. This put the bank in advantageous position in comparison to its compet-itors (that is, other Danish banks, telecom operators and fintech start-ups) as the large and growing user base constituted a significant barrier to entry.

Key Learning Points from MobilePay's Launch Phase

Being a first-mover in a new and not yet defined market, such as mobile pay-ments, is important for ensuring the long-term success of a digital disruptive solu-tion. To share the risks and manage uncertainties, collaborating with other relevant actors is preferable, but in case, there is high consumer demand, intensified com-petitive environment and various coordination issues associated with a multi-part-ner initiative arise, developing and launching solo such a solution is advisable.

Instead of offering a complex digital payment platform targeting various partic-ipants (e.g., private customers, merchants, etc.) and offering multiple functionali-ties, managers should focus on initially addressing the needs of one distinct group of participants (e.g., private customers). This allows them to speed the entry to mar-ket as it reduces development time and to focus on solving efficiently an existing customer pain point. For example, instead of relying on complex technological set-up, managers can build upon existing technology, thus leveraging the key assets and strengths of an incumbent when developing disruptive solutions. MobilePay's dis-ruptive potential, for example, stems from offering a novel service, allowing private users to execute P2P transfers more efficiently than existing solutions (such as online banking) rather than adopting new technologies. The simplicity (in terms of design and functionalities), easiness of use and high level of

security of this digital payment platform, designed with a customer-centric mindset, are the main reasons for the fast adoption of the solution.

Instead of only focusing on catering to its own customer base, an incumbent launching a novel digital platform with disruptive potential should also try to incor-porate a large number of users outside its traditional customer base. Both Danske Bank and non-Danske Bank customers have free access to MobilePay, which al-lowed the incumbent bank to start building relationships with customers outside its own scope.

3.2. MobilePay Expansion

Situation

Despite its initial success in terms of rapid user adoption, MobilePay's first mover advantage could easily come under threat as other players also launched competitive mobile payment platforms in response to Danske Bank's move. Just few months after the launch of MobilePay, 81 Danish banks launched a common banking sector solution, Swipp, which functioned as an account-based P2P platform incorporated as a separate feature in the mobile banking apps of the participating banks. Approximately half a year after the launch of MobilePay, the four major telecom operators in Denmark introduced their own competing solution, Paii, which allowed users to execute web and app purchases and transfer money to their peers. The payment platforms developed by Swipp and Paii were similar to MobilePay's offerings, but differed significantly in terms of ease of use and simplicity. Thus, as the competitive environment continued to change, Danske Bank needed to solidify further MobilePay's dominant market position.

Apart from the challenges posed by other competitive solutions, MobilePay also faced a number of internal issues, which jeopardized the long-term sustainability of the solution. Despite its growing user base, the payment platform had not identified a viable business model as private customers used the solution free of charge. In addition, as it utilized the existing card payment infrastructure, MobilePay incurred cost per transaction, which Danske Bank decided to subsidize. As this initial deci-sion was not sustainable in long term, Danske Bank needed to identify stable reve-nue streams. In addition, MobilePay faced internal inefficiency with regards to the resilience of its own IT systems. Although the digital payment platform relied on the existing payment infrastructure in order to shorten time to market, the legacy of the bank's existing IT systems, built largely in silos, posed threats to the scalability and agility of the solution as well as to the speed with which MobilePay could in-novate.

Actions taken

The threat posed by competitive solutions prompted MobilePay to evolve further by incorporating novel functionalities in order to increase the value proposition to-wards its private customers (e.g., increased daily payment limits, introduced photos and personal messages when users sent money, etc.). MobilePay also

evolved by incorporating merchants through the launch of business version of the MobilePay app, which allowed small merchants, such as street vendors and coffee shop owners, to receive mobile payments from private customers (Danske Bank 2014a). Thus, by adding merchants as second distinct group of platform participants, MobilePay transformed into being a two-sided platform (that is, facilitating the interactions between two distinct groups of participants, namely users and merchants).

The opening to business customers proved to be successful move and MobilePay continued to launch novel functionalities with the aim to expand its base of mer-chants. To this end, MobilePay introduced a number of different payment methods (e.g., in-app payments, online payments, in-store payments) in order to address the various payment contexts, in which the different merchants operated. For example, unlike the solutions for small merchants and online shops, MobilePay transactions in large retail shops needed to be executed faster due to the specificity of this pay-ment context. To this end, MobilePay upgraded the platform architecture by intro-ducing NFC and Bluetooth technology. Apart from offering solely mobile pay-ments, MobilePay also included value-added services such as loyalty cards, discount-based loyalty programme, receipts, etc. Thus, by enabling the interactions between private and business customers and by introducing novel functionalities to both of them, MobilePay increased their level of engagement. Consequently, MobilePay managed to defend its dominant market position from the aspiration of new competitors.

The introduction of merchants as second distinct group of platform participants allowed MobilePay to establish stable revenue stream. Attracted by the large num-ber of private customers using MobilePay, business customers also wanted to gain access to the platform ecosystem and were willing to pay a fee for acquiring it. Thus, the fees, which merchants paid to participate in the platform ecosystem, constituted a stable revenue source for MobilePay.

With the growth of the platform ecosystem, the speed with which innovative of-ferings were released to various heterogeneous participants became of paramount importance for MobilePay. In order to guarantee the rapid launch of new function-alities, a business unit within Danske Bank was set up, with the sole purpose to guide the future development of MobilePay. The team could adopt significant level of independence from the bank's strategy, processes and approaches towards inno-vation. At the same time, the MobilePay team had access to key Danske Bank's resources such as IT development, customer support and marketing, which it uti-lized to develop and provide new offerings in the fastest and the most efficient manner.

The increasing number of functionalities incorporated in the platform architec-ture required the optimization and further development of the underlying IT archi-tecture. For this purpose, a special IT unit within Danske Bank was set up to support solely MobilePay. The new team also focused on ensuring the platform architec-ture's resilience and scalability and on supporting the development and maintenance of various platform functionalities. For example, a stand-in procedure, which al-lowed for reducing the downtime for processing a payment transaction, was intro-duced in order to allow the efficient execution of MobilePay transactions.

The op-timization of the platform architecture also included the gradual migration towards a more cost-efficient account-to-account infrastructure.

Results achieved

Less than a year after opening for business customers, app. 4000 small busi-nesses, such as coffee shops, clothing companies, hairdressers, bike repair shops, etc., had adopted MobilePay's business solution (Danske Bank, 2014b). With the release of more functionalities towards various types of merchants, MobilePay's base of business customers grew rapidly. By the end of 2015, 17 500 merchants enabled the use of MobilePay in their shops (MobilePay, 2015). In May 2016, app. three years since the launch of MobilePay, more than 25 000 small and medium-sized merchants and app. 3, 7000 online shops adopted the solution (Danske Bank 2016). In fact, the usage of MobilePay for C2B transactions continued to grow with double-digits since 2016. The incorporation of various merchants corresponded to the continuous growth of the private customers, which was influenced by the pres-ence of strong cross-side network effects (that is, the more merchants join Mo-bilePay, the more value private customers have from the solution and vice versa (see, Shapiro and Varian 1999)). In May 2016, app. 85 % of the Danish population used MobilePay to execute app 738,000 transactions on daily basis (Danske Bank 2016).

Learning Points from the MobilePay's Expansion Phase

In a rapidly shifting competitive environment, contenders can easily challenge the initial success of a digital platform. To prevent the erosion of the previously gained competitive advantages (e.g., huge user base) and to stay ahead of competi-tors, managers should constantly evolve the digital platform by incorporating new types of participants (e.g., business customers) and functionalities. However, as business customers, for example, operate in different contexts; managers should ca-ter to their specific needs by providing customized solutions instead of delivering one-size-fits-all functionality.

The inclusion of additional platform participants, who wish to gain access to the already existing user base on the platform, allows managers to identify a revenue source in order to cover operational and innovation costs (see also, e.g., Evans and Schmalensee 2016). However, the quest for identifying a viable business model is far from being over as more often than not the revenue streams are not enough to ensure profitability.

The openness of the digital platform leads to the establishment of a vibrant eco-system of multiple actors that challenge the optimal functioning of the digital plat-form. To amend for this, managers should invest in IT resilience and scalability. The explosive growth also calls for the establishment of different organizational set-up to better support the performance and future development of a digital platform.

3.3. Building a Nordic vision

Situation

Due to the rapid adoption from both private and business customers, MobilePay gained significant advantage over its competitors - the common bank sector solu-tion, Swipp, and Paii, operated by the major Danish telecom operators. Swipp, which was the biggest MobilePay's competitor in the Danish market, did not man-age to acquire significant customer base. In 2016, Swipp had only 900 000 regis-tered private customers and app. 16 000 business customers (Finans 2016; Skjær-lund 2016). Swipp could not erode significantly the competitive advantage of MobilePay due to its complicated sign-up process, consumer unawareness of the solution, and lack of coordinated actions between the participating banks as each of them set their own strategies, including different prices towards merchants for using Swipp. The other contender, Paii, operated as two-sided platform and aimed at get-ting both users and merchants on board simultaneously – a task, which proved to be challenging. After Paii struggled to ignite, Swipp acquired the solution in November 2014 in order to boost its online payment capabilities.

The competitive environment, however, shifted significantly since the launch of MobilePay. In particular, the team behind Swipp had been preparing new design of the solution and of its organizational set-up. Depending on their scale and nature, the planned changes could threaten MobilePay's leading position. At the same time, the global, regional and domestic competition from both financial and non-financial actors continued to build up. For example, on a regional level, Nets, a Nordic-based payment service provider, launched white-label wallet in Norway. On international level, tech giants such as Apple and Samsung introduced their own mobile payment platforms, Apple Pay and Samsung Pay, while the card company Visa collaborated with Facebook to enable P2P transactions. Thus, MobilePay needed to defend once again its position from new potential contenders with different business models and global reach.

Action taken

In order to solidify further its position, MobilePay expanded its reach by ventur-ing into several Nordic markets. The strong presence of Danske Bank in the region and the similarity between the consumer preferences across the Nordic countries, combined with the possibility to gain first mover advantage due to weak competi-tion, provided good foundation for the successful export of MobilePay to selected Nordic markets.

In December 2013, MobilePay entered the Finish market by launching a P2P mobile payment platform, which mimicked fully the design of the Danish version. The expectation was that the smooth registration flow, ease of use and overall sim-plicity of the solution would lead to its fast adoption among users. The initial uptake of MobilePay, however, proved to be not as expected as a key factor for the success of MobilePay in Denmark was not present in Finland. In particular, the easiness with which users could sign-up for MobilePay was not feasible in Finland, which resulted in cumbersome registration process. In Denmark, MobilePay's sign-up pro-cess required the input of bank account number, which is indicated on the users' payment cards. In Finland, however, this was not the case; thus, users needed first to find their bank account details, usually by accessing

their online banking, and then entered them as part of the MobilePay's registration flow. To mitigate this, MobilePay improved the registration process, but, despite these efforts, the adoption rate remained relative low (e.g., in 2015, MobilePay had 148 000 registered users in Finland). Despite the slow adoption rate, MobilePay became the leading mobile payment platform in the country as other competitors also struggled to ignite.

In Sweden, a banking sector solution, Swish, which launched in 2012, had al-ready earned a significant market share. Launching a standalone competitive solu-tion in this market was not considered a viable strategy, and thus, Danske Bank decided to join the other banks in the Swish initiative (note: Danske Bank was not part of common banking solution Swipp in Denmark).

The Norwegian market constituted the next potential option for expansion. Var-ious legal and technical constraints postponed the launch of MobilePay in Norway. One of the impeding issues turned out to be the rather low payment limit for receiv-ing payments, which, when reached, prevented users from receiving money unless they authenticated themselves with an ID. The integration of such ID authentication process slowed down the launch of the solution in the Norwegian market. While MobilePay contemplated on the different options and the potential risks associated with each of them, the largest Norwegian bank, DBN, launched a P2P mobile pay-ment platform, Vipps, in May 2015; thus, changing significantly the competitive environment in Norway. Although other mobile payment platforms had existed in Norway prior to the launch of Vipps, such as Valyou and mCash, their user adoption rates had been low due to their limited value propositions. Vipps, which is similar to MobilePay's design, however, managed to attract one million users in just five months after its launch. In response, MobilePay entered the Norwegian market in August 2015. Even though MobilePay supported both P2P and C2B transactions (Vipps initially enabled only P2P transactions), it could not overcome the strong first mover advantage, which Vipps had acquired. Thus, MobilePay needed to adopt a different strategy for conquering the Norwegian market.

In order to gain ground in Finland and Norway, individual country teams were established, which worked in close cooperation with the MobilePay team in Den-mark. While these local teams focused on designing and executing marketing cam-paigns and forging strong relations with local customers and partners, the team in Denmark was responsible for providing innovative features and rolling them out to all relevant markets.

Results achieved

MobilePay's fast adoption rate in Denmark could not be replicated in other Nor-dic markets. In 2016, 210 000 private consumers had MobilePay in Norway, while 180 000 private consumers utilized the digital payment platform in Finland (Mo-bilePay 2016). The initial struggles led to re-formulation of the strategies for each market, and even though the growth rates improved, there was strong competition from local players. In Finland, for example, Pivo, a mobile wallet operated by the largest Finnish bank OP-Pohjola, amassed more

that 500 000 users as of 2015 (OP-Pohjola, 2015). MobilePay's user base, however, is growing with 40 % in the sec-ond half of 2016 (MobilePay 2017) and it is largely expected to gain a market dom-inance. In Norway, the dominance of Vipps, which reported over 2,1 million private customers in 2016 (Vipps 2016), seemed to be difficult to overcome.

Learning Points from Building a Nordic Vision Phase

Despite the dominance of MobilePay in the Danish market, Danske Bank could not easily replicate this success story in other markets even if there are a number of similarities across the Nordics. In particular, when entering new geographical mar-kets, managers need to start building the platform's user base from scratch. Apply-ing similar adoption strategies across different markets, however, do not lead to replication of the initial success. At the same time, due to local characteristics, the technological set-up and customer journey of the Danish version of MobilePay, which largely contributed to the success of the solution, could not be replicated to all markets (e.g., MobilePay in the Finnish market), and instead, required adapta-tions. Furthermore, the lack of interoperability between the MobilePay-branded dig-ital payment platforms in the three markets (in Denmark, Finland and Norway) pre-vent any network effects between the three solutions, which could constitute a driver for further adoption. To govern successfully the entry and subsequent development of a digital payment platform in different markets, local teams should be set up with focus on distribution and marketing, while the innovation efforts remained in the central team.

3.4. Building an Ecosystem of Partners

Situation

In 2016, MobilePay continued to grow in size and scope by attracting more than 3,2 million private users and approximately 35 000 business customers (MobilePay 2016). To keep this large customer base active, MobilePay needed to increase their engagement rate by continuously launching novel functionalities, which required resources and the ability to read quickly the ever-changing consumer preferences and competitive environment. In addition, MobilePay had to balance the heteroge-neous interests of multiple stakeholders - from private customers to different types of business customers (e.g., small and medium sized to large retail groups), who also operated in different payment contexts – online, in-store, in-app, etc. As a result, the MobilePay team faced constant demands for delivering various functional-ities addressing the needs of specific merchants, which they needed to balance against the demand for innovative features by private customers.

MobilePay also struggled to ignite in Finland and Norway due to lack of clear vision how to win these markets and shortage of necessary resources to ensure rapid expansion. In 2016, MobilePay yet again operated in an increasingly disruptive pay-ment landscape with new international competitors closing in the Nordic markets (e.g, Apple Pay's indications to launch in the Nordics). As a result, MobilePay con-templated how to build up its capabilities in order to outpace the innovation speed of its main competitors. Ultimately, the team faced the

decision whether to continue MobilePay's journey as a sole quest or to establish a collaboration with other regional or international players in order to conquer the Nordics.

Action taken

As the Nordic expansion as standalone payment platform proved to be a difficult and fruitless endeavor, the MobilePay team decided to join forces with other incumbent banks across the Nordic region. Nordea was the first bank to join the new initiative, which led to its exit from the common sector solution Swipp. The majority of the other Danish banks also followed and left Swipp in order to enter into agree-ment with MobilePay. A number of banks in Finland and Norway also decided to participate in the new venture.

Under the terms of the collaboration, partner banks were to act as local distribu-tors of MobilePay towards their business customers. Danske Bank retained full ownership of MobilePay, but the existing business unit was to be carved out into a separate company operating under an E-Money license. Partner banks also agreed to invest in MobilePay in order to spur continuous innovation, which would be at MobilePay's discretion.

Apart from forging alliances with banks, MobilePay also entered in dialogue with numerous local and regional partners, most of which, such as the PoS vendor Veri-fone, operated across the Nordics and aimed at solidifying their market positions. Perceiving MobilePay as the most advanced and innovative mobile payment plat-form in the Nordics, various actors view potential partnership as a driver for their own digitalization agenda. For example, one of the largest retail groups in the Nor-dics, Rema 1000, cooperated with MobilePay on launching on-demand delivery app, Vigo, which utilized MobilePay as sole payment method.

Results achieved

The opening of MobilePay to external partners resulted in solidifying the posi-tion of the digital payment platform in the Danish market. Currently, more than 70 banks have joined MobilePay as distribution partners, which allowed MobilePay to expand its ecosystem by acquiring new business customers. The opening to external banks have also implications for the platform's architecture as this allows for mov-ing from the existing card-based infrastructure to more efficient and cheaper ac-count-to-account set-up. The stable revenue stream also gave MobilePay the oppor-tunity to innovate at increased speed. Multiple technology providers, independent app developers, and businesses from various sectors and industries also approached MobilePay seeking a potential collaboration.

Learning Points from the Building an Ecosystem of Partners Phase

As the dynamic competitive environment requires the continuous delivery of high quality innovative functionalities, this can puts serious constraints on the innovative capabilities of a digital platform. To secure more resources for development, a dig-ital platform should open up to various types of partners, who can boost its capabil-ities (e.g., distribution partners (banks); technology providers (Verifone as terminal provider), etc.)

(see also, Parker et al., 2016). Such co-innovation in particular with incumbent actors in industries, which also face digital disruption (e.g., retail, trans-portation, etc.), for example, helped MobilePay explore multiple innovation paths simultaneously and thus, increase its innovation potential. Working with various types of partners, however, requires the set-up of dedicated governance regimes for each type of platform partners (e.g., vendors, other banks, technology providers), which regulate issues with regards to revenue sharing, intellectual property rights protection, data ownership, etc. and serve as mechanisms for preventing and resolv-ing any potential conflicts (see also, Evans and Schmalensee, 2016).

4. Results achieved

In 2017, four years after its launch, MobilePay continues to dominate the Danish market, while also expanding its reach to selected Nordic markets. The user base of MobilePay continued to grow rapidly and by end of 2017, it amounted to 3,7 million users (more than 90 % of the Danish population) and more than 75 000 physical stores and app. 8000 Danish online shops (see Table 1 below for overview of the growth of MobilePay's private and business customers in Denmark). The total sum of the executed daily transactions via MobilePay amounts to app. 18 000 EUR. The collaboration between MobilePay and various business customers also turned to be successful. For example, 74 % of the tickets sold in the Danish State's railway app are purchased through MobilePay. As of beginning of 2018, more than 70 partner banks also have joined MobilePay as distribution partners. Despite this development and the presence of stable revenue streams, MobilePay is still in search of a viable business model.

Table 1. Overview of MobilePay's private and business customers in Denmark		
Phase	**Number of private customers (app.)**	**Number of business customers (app.)**
Launch of MobilePay	870 000 (2013)	Solution not offered
MobilePay Expansion	1,8 million (2014)	4000 (2014)
Nordic Expansion	2,7 million (2015)	17 500 (2015)
Building an ecosystem of partners	3,2 million (2016)	35 000 (2016)

MobilePay's popularity led to the closure of its main competitor in the Danish market, Swipp. New contenders, both local and international, however, have emerged, prompting MobilePay to continue evolving in order to stay ahead. In 2017, the Nordic payment service provider Nets, for example, launched its own mobile wallet in selected Danish stores in direct competition with MobilePay. Ap-plePay also entered the Danish market in 2017, but due to its technical set-up, merchants have to pay higher fees when using it in comparison to using MobilePay.

Across the Nordics, MobilePay is still trying to gain traction. In Finland, the popularity of MobilePay across both private and business customers increases, (e.g., 40 % user growth in Finland). Despite all the efforts to establish MobilePay in the Norwegian market, the digital payment platform was shut down in January 2018 as the competitor Vipps managed to attract the majority of the Norwegian banks as distribution partners. As a result, MobilePay's strategy for Norway changed from going solo to seeking collaboration with Vipps.

The success of MobilePay has helped Danske Bank achieve a number of non-financial benefits. In particular, the success of MobilePay contributed to Danske Bank's efforts to protect itself from disruption by gaining a first mover advantage in the mobile payment area, improving its brand image and reducing the churn among its customers. MobilePay is also a proof case demonstrating the innova-tion capabilities of Danske Bank, which various business and corporate customers of the bank can utilize in order to deliver on their own digitalization agenda. The success of Mobile Pay has also led to the emergence of several other disruptive initiatives within Danske Bank, which also adopt new approaches to innovation.

5. Lessons learned

Facing the possibility of disruption by the entry of various contenders (both fintech start-ups and established companies (e.g., Apple, Samsung) operating at local and global level), Danske Bank, an incumbent financial organization, decided to embrace digitalization. While digitalization is an ongoing and incremental process within the bank and permeates throughout all its business units and projects, Danske Bank also adopted a radical approach towards digitalization by launching initiatives with high disruptive potential. In particular, Danske Bank aimed at revolutionizing the way people pay by offering a mobile payment platform, MobilePay, which quickly gained dominance in Denmark and expanded to other Nordic markets.

In this case, we investigate how an incumbent financial institution succeeded at developing a digital payment platform - an endeavor, which required the adoption of platform thinking and different approach to innovation. Below, we summarize the main findings, which practitioners need to take into account when launching and further developing a digital platform.

Pursuing a platform business model deviates significantly from the business logic associated with traditional banking products (e.g., managing the interactions among various distinct groups of participants (see e.g. Hagiu and Wright, 2011; Parker et al., 2016, etc.)), identifying a subsidy and revenue side (Evans and Schmalensee, 2016), creating a robust ecosystem of external partners (Parker et al., 2016)). To succeed with this disruptive initiative, Danske Bank relied on different from usual approach when it comes to organizational set-up and innovation processes. In particular, a small, agile and cross-functional team of employees (e.g., IT developers, business analysts, legal experts, etc.) carried out the initial development of MobilePay as a six-month project. To ensure the continuous de-velopment of the digital payment platform in a fast, innovative and agile manner, Danske Bank established a separate business unit, characterized by high degree of autonomy in terms of

innovation processes, strategies and business models. In addition, an IT unit dedicated solely to the development and maintenance of MobilePay was established.

While the new organizational set-up fostered autonomy, MobilePay also established close synergies with other units in Danske Bank in order to benefit from bank's key resources (e.g., access to payment infrastructure, legal and technical expertise in the payment area, IT and marketing resources, etc.). The challenge, however, is to leverage the benefits stemming from being associated with an incumbent, while trying at the same time to reduce those dependencies, which can create inefficiencies and stifle innovation (e.g., slow decision-making process, being risk-averse, etc.). Thus, the development of MobilePay required a careful balance between autonomy and synergy when it comes to the relations with Danske Bank. The evolutionary journey of MobilePay also demonstrated that as the digital platform matures and its ecosystem grows, it bolsters higher degree of autonomy (e.g., the carving out of MobilePay as separate company in 2017) and less synergy due to the need to pursue new opportunities and establish collaborations with various heterogeneous actors.

The timing of digital platform's market entry is of importance as indicated by MobilePay's launch in Denmark and by the subsequent entries in Finland and Norway. Observing closely the market dynamics, Danske Bank decided to speed up its venturing into the area of mobile payments due to increased demand from private customers and the preparations from various contenders, both incumbents and fintech start-ups, to launch their own solutions. By identifying the window of opportunity for market entry, Danske Bank managed to attain a first mover advantage, which led to MobilePay's dominance in the Danish market and constituted high barriers to entry, which various contenders (e.g., Swipp, Paii, etc.) could not overcome. This Danish success story, however, could not be easily repli-cated to other markets, as the factors determining the popularity of MobilePay in Denmark were not present there.

MobilePay's strategy included first the launch of a customer-centric state-of-the-art digital payment platform, followed by efforts to build critical mass of private customers and later of various types of merchants and only then, seeking to make the solution financially sustainable for the bank. As part of its evolutionary journey, MobilePay also expanded its services from payment transactions to include value-added services such as receipts, loyalty cards and programs, and established a vast network of partners, which contributed to its expansion into selected Nordic markets. Thus, despite the initial high adoption rate, attributed to the simplicity, ease of use and strong value proposition of MobilePay, its continu-ous success and long-term sustainability remained elusive as the digital platform ecosystem faced many challenges (e.g., technology trends, consumer preferences, regulations, competitors, etc.). To address them, MobilePay needed to evolve constantly in search of new opportunities. This indicates that the success of a digital platform requires ongoing efforts, which stretch beyond the launch phase and consist of casting multiple bets on various innovation efforts. We recommend adopting an incremental approach to evolution, where the digital platform ecosystem starts small

(in terms of types of platform participants and value proposition) and scales later. The quest for finding a viable business model can take place at a later stage.

In this case, we trace Danske Bank's endeavors to develop and evolve MobilePay over time. As a result, we provide a number of practical recommendations how incumbent organizations can successfully venture into a digital platform business. By doing so, we contribute to the literature on Multi-Sided Platforms and on digitalization. In particular, we shed light into the execution of a dual-track strategy towards digitalization and prove its suitability for incumbent organizations. We also offer a number of advancements in the platform literature. First, we outline how a traditional business can adopt a digital platform business. Although researchers has previously dealt with this issue (see, Gawer and Cusumano 2014), they have mainly studied the transformation of physical products into digital platforms. In this case, we account for an incumbent launching and managing a digital platform from scratch. Second, we study the success of digital platform ecosystems beyond the initial launch phase. Third, we offer rare insights into the organizational set-up of successful digital platform, which is currently under re-searched area (Altman and Tripsas 2014). Finally, we also outline the endeavors of a digital platform to expand in geographic markets, of which currently few studies exists (see, e.g., Watanabe et al. 2017).

While Danske Bank aims to be at the forefront of digitalization, its core belief is that digital innovation should be first consumer-centric, even if this means slow-paced digitalization. 30 % of the private customers of Danske Bank, for example, have not yet used the bank's digital products, but as Jesper Nilsen, Head of Personal Banking in Danske Bank, states it is "ok not to be super digital" (Børsen 2017). Instead, the digitalization of these customers could be slow-paced and should occur when they found a strong value proposition for themselves to adopt digital solutions.

References

Altman, EJ, Tripsas, M (2014) Product to Platform Transitions: Organizational Identity Implications. Harvard Business School Research Paper No. 14-045. Available at SSRN: https://ssrn.com/abstract=2364523 or http://dx.doi.org/10.2139/ssrn.2364523.

Børsen (2017) Danske Bank: "De sidste kunder skal være digitale". Can be found here: https://www.pressreader.com/denmark/dagbladet-b%C3%B8rsen/20170803/281956017867315

Danske Bank Group (2012) Annual Report. Can be found here: https://www.danskebank.com/en-uk/ir/Documents/2012/Q4/Annualreport-2012.pdf.

Danske Bank Group (2013) Annual Report. Can be found here: https://danskebank.com/en-uk/ir/Documents/2013/Q4/Annualreport-2013-parent-company.pdf

Danske Bank (2014a) First Danish mobile payment solution for businesses. Press release. Can be found at: https://danskebank.com/en-uk/press/News/news-archives/Pages/mobile-payment-solution-for-businesses.aspx.

Danske Bank (2014b) Mobiltelefonen er fremtidens betalingsløsning. Can be found at: https://danskebank.dk/da-dk/erhverv/nyheder/pages/danske-business-december-2014.aspx

Danske Bank (2016) Three million people in Denmark are now using MobilePay. Can be found at: https://danskebank.com/en-uk/press/News/news-archives/Pages/3-million-use-mobilepay-in-denmark.aspx

European Commission (2013) Proposal for a Directive of the European Parliament and the Council on payment services in the internal market and amending Directives 2002/65/EC, 2013/36/EU and 2009/110/EC and repealing Directive 2007/64/E, COM.

Evans, DS, Schmalensee, R (2016) Matchmakers: The New Economics of Multisided Platforms. Watertown, MA: Harvard Business Review Press.

Finans (2016) Danskerne valgte MobilePay frem for Swipp. Can be found at: https://finans.dk/live/erhverv/ECE9149552/danskerne-valgte-mobilepay-frem-for-swipp/?ctxref=ext

Gawer, A, Cusumano, MA (2014) Industry platforms and ecosystem innovation. Journal of Product Innovation Management 3:417-433.

Hagiu, A (2014) Strategic Decisions for Multi-sided Platforms. MIT Sloan Management Review 55:2.

Hagiu, A, Wright, J (2011) Multi-Sided Platforms. Harvard Business School Working Paper 12- 024.

Karimi, J, Walter, Z (2015) The Role of Dynamic Capabilities in Responding to Digital Disruption: A Factor-Based Study of the Newspaper Industry. Journal of Management of Information Systems 1: 39-81.

MobilePay (2015) MobilePay 2015 - året i tal. Can be found at: https://www.mobilepay.dk/da-dk/Nyheder/artikler/Pages/MobilePay-2015-aaret-i-tal.aspx

MobilePay (2016) Nordea tilslutter sig MobilePay. Press release. Can be found at: https://www.mobilepay.dk/da-dk/PDF/Pressemeddelelser2016/20161013-pressemeddelelse-nordea-tilslutter-sig-mobilePay.pdf

MobilePay (2017) MobilePay is heading towards 1000 webshops in the Nordics. Press release. Can be found at: https://www.mobilepay.dk/da-dk/PDF/Pressemeddelelser/Checkout-MobilePay-PressRelease-20170419.pdf

OP-Pohjola (2015) OP brings easy contactless payment to the Pivo mobile wallet. Can be found at: https://www.pohjola.fi/pohjola?cid=-1691

Parker, G, van Alstyne, M, Choudary, SP (2016) Platform Revolution: How Networked Markets Are Transforming the Economy and How to Make Them Work for You. NY: WW Norton Company, Inc.

Shapiro, C, Varian, H (1999) *Information Rules*. Boston: Harvard Business School Press.

Skjærlund, S (2016) Swipp og MobilePay dukker op i flere og flere lokale butikker. Can be found at: https://frdb.dk/erhverv/Swipp-og-MobilePay-dukker-op-i-flere-og-flere-lokale-butikker/artikel/89864

Statista (2016) Percentage of people who use a smartphone in Denmark from 2012 to 2016. Can be found at: https://www.statista.com/statistics/488341/smartphone-penetration-denmark/

Vipps (2016) Over 100 norske banker satser sammen på Vipps. Press release. Can be found at: https://www.vipps.no/pressemelding.html.

Watanabe, C, Naveed, K, Neittaanmäki, P, Fox, B (2017) Consolidated challenge to social demand for resilient platforms-lessons from Uber's global expansion, Technology in Society, 48:33.

Paper VI Managing Platform Ecosystem Evolution through the Emergence of Micro-strategies and Microstructures

Author: Staykova, K., S.

Managing Platform Ecosystem Evolution through the Emergence of Micro-strategies and Microstructures

Short Paper

Kalina S. Staykova

Department of Digitalization, Copenhagen Business School
Howitzvej 60, 2000 Frederiksberg, Denmark
kss.digi@cbs.dk

Abstract

Digital platform ecosystems evolve rapidly in an attempt to address both internal inefficiencies and turbulent environment, where new opportunities and threats arise on ongoing basis. However, rather than being well planned and predictable, the evolution of a digital platform ecosystem resembles an uncharted path with frequent shifts in strategic direction. While recent studies have enriched our understanding about digital platform ecosystem evolution, researchers are yet to propose a comprehensive understanding of how platform owners manage the evolution of a digital platform ecosystem. Adopting emergence perspective, this research argues that platform owners manage the evolutionary process through engaging in multiple micro-strategies and microstructures, instead of relying on a long-term strategy and fixed organizational structure. Utilizing a longitudinal case study of a digital payment platform ecosystem, this study seeks to propose a process model for managing digital platform ecosystem evolution and a set of micro-strategies and microstructures, which practitioners can choose from when addressing various strategic challenges.

Keywords: Digital Platform Ecosystem; Platform Evolution; Strategy-as-Practice; Strategizing

Introduction

Today, some of the most successful companies, in terms of number of users, brand value and profitability, function as digital platform ecosystems (e.g., Airbnb, Alibaba, eBay, Uber, WeChat) (Hagiu, 2014; Parker et al., 2016). Despite their significant economic importance and rapid proliferation across various industries, successful digital platform ecosystems remain difficult to build and sustain over time (Evans, 2009; Hagiu, 2014). Operating in environment characterized by uncertainty, rapid shifts and unpredictability due to the innovative nature of their services, entry of new competitors and unstable revenue streams, digital platform ecosystems need to evolve constantly in order to ensure their long-term survival (Boudreau and Hagiu 2009; Hagiu 2014; Gawer 2014).

Their evolutionary path, however, does not constitute a stable and planned process; rather it meanders through a myriad of obstacles and new opportunities. Not surprisingly, there are far more examples of failed digital platform ecosystems rather than successful ones (Hagiu 2014; Parker et al. 2016). The lack of predictability and stability, which gives rise to unexpected threats and missed chances, challenges the ability of digital platform ecosystems to evolve over time. As a result, they often lag behind competitors, become irrelevant to its participants, or fail to become profitable (see e.g., Parker et al. 2016), all of which can jeopardize their sustainability.

To ensure the success of a digital platform ecosystem over time, platform owner(s) need to manage efficiently its evolution by identifying on time the potential pitfalls and opportunities and by designing relevant strategies and organizational structures in order to address them. In a dynamic, ever-changing and uncertain environment, however, traditionally fixed and macro level strategies and organizational structures are hardly suitable to deal with unexpected turbulences and emerging opportunities (see Tsoukas and Chia 2002). Instead, researchers advocate for moving towards micro processes of strategizing and organizational structuring (e.g. Tsoukas and Chia 2002).

Building upon this view, this research argues that platform owners can manage the process of ecosystem evolution through developing and implementing micro-strategies and corresponding microstructures rather than relying solely on macro strategies and macro organizational structures. For example, instead of designing a long-term, deliberate strategy around openness, which requires macro approach (Wan et al., 2017), platform owners can engage in short-term micro-strategies, such as resourcing (provision of boundary resources), securing (strengthening control) and monetizing (unlocking new revenue sources) , deployed as immediate response to emerging threats and opportunities(Ghazawneh and Henfridsson 2011). Further, instead of relying on rigid organizational structures, with hierarchical distribution of power and fixed division of labour, to execute micro-strategies, platform owners need to adopt flexible and fluid temporal organizational structures (Tsoukas and Chia 2002). For example, PayPal, which functions as a digital payment platform ecosystem facilitating the interactions between private users and merchants, (Evans and Schamalensee 2016), moved from

traditional organizational structure designed based on separation of functionalities (business development vs IT development) to flexible organizational structure by creating solely two dedicated teams to support private users and merchants respectively (Schulman 2016).

While researchers have started to investigate the evolution of digital platform ecosystems (see Gawer 2014; Tan et al. 2015), there is a lack of research analyzing how platform owners can manage the evolution of their ecosystems from micro perspective, with no deliberate, long-term strategy designed prior. Existing studies also black box the process of designing, implementing and modifying a platform strategy as they focus on its content rather than on the process of its emergence. Furthermore, while the focus of most studies is on platform owner(s) as designers, managers and owners of a digital platform ecosystem, researchers treat them as collective and faceless actor, without mentioning the organizational structure, which supports the work of the owner (e.g., units, division of labor, control systems, etc.). To address these research gaps, we formulate the following research question:

How do platform owners manage the process of digital platform ecosystem evolution from micro perspective?

Utilizing a longitudinal case study of a successful digital payment platform ecosystem, this research traces the daily activities of practitioners, who engage in various forms of strategizing and structuring. As a result, this study aims at identifying a number of micro-strategies and microstructures, which emerge from the activities of practitioners (that is, platform employees) in their attempt to ensure the survival of the ecosystem. An additional goal is to offer a model, which captures the process of managing the digital platform ecosystem evolution. Drawing upon first-hand observations, this research also seeks to provide a rare, inside glimpse into the organizational structuring, which supports the work of the platform owner(s).

Theoretical Background

Digital platform ecosystems function as complex socio-technical systems that enable and regulate the interactions between various affiliated actors through developing and managing an underlying technical architecture and a governance regime (Boudreau and Hagiu 2009; Hagiu 2014). One or several platform owners exercise ownership over the digital platform ecosystem and coordinate the activities of a myriad of participants, who encompass various actors such as platform providers (e.g., technology providers), demand-side users (or end-users) and supply-side users (e.g., third-party developers) (Eisenmann et al. 2009). Despite that the majority of the studies within the platform literature adopt a platform owner(s) perspective, the owner is often presented as a faceless, collective actor in contrast to the other actors participating in the ecosystem (e.g., third-party developers, end users, etc.).

The role of the platform owner(s) is to develop, manage and grow a robust ecosystem of actors around a stable and reliable digital platform (Parker et al. 2016; Tiwana 2014). To do so, a platform owner designs and

implements various strategies (see Wan et al. 2017). Although digital platform ecosystems evolve constantly (Gawer 2014; Tiwana 2014), few scholars investigate how a platform owner manages the evolutionary process. Evans (2009), for example, investigates the strategies, which platform owners can use to obtain a critical mass of users after the launch of their platforms. Similarly, Gawer and Cusumano (2007) discuss strategies for designing platforms upon market entry (coring) and for winning market dominance against other platform ecosystem (tipping). Hagiu (2006) also investigates design and expansion strategies and argues that platform owners need to focus first on managing platform depth (that is, the initial functionalities offered to actors) before expanding the platform breadth by including other distinct types of actors.

As platform ecosystem matures, however, it faces slow growth and potential stalemate, which platform owner needs to address accordingly by, for example, unlocking new sources of innovation through evolving its boundary resources (Eaton et al. 2015; Eisenmann et al. 2009) or by entering into other markets through envelopment attack (Eisenmann et al. 2011). To ensure the survival of the ecosystem, platform owners also need to develop the capabilities of the underlying IT architecture along with the overall ecosystem governance regime (Ghazawneh and Henfridsson 2011; Tiwana 2014). Tan et al. (2015), for example, propose a model, which traces the evolution of a platform ecosystem in terms of its Information System capabilities, and put forward relevant strategies for developing such capabilities in each evolutionary phase.

The majority of the studies outlined above, however, adopt a strategy as content perspective (e.g., what strategy contains) (see Wan et al. (2017) for overview of platform strategies). Thus, there is lack of research, which looks at strategy as process (with the exception of Ghazawneh and Henfridsson 2011), that is how platform owner(s) and other relevant practitioners strategize when faced with strategic challenges. In particular, most researchers assume that platform strategy is crafted by the platform owner (in terms of top management), but there is lack of research investigating how particular strategies emerge over time, who participates in the process of strategy making and whether there is internal consensus about them. Furthermore, there is lack of in-depth studies, which analyze how platform owner changes strategy over time to drive the further evolution of its digital platform ecosystem.

A number of researchers point out that the successful execution of platform strategies requires the presence of efficient organizational structure. Gawer and Cusumano (2007), for example, argue that in order to foster external collaborations, a platform owner needs to introduce an organizational structure that supports this goal by, for example, setting a separate unit, whose sole task is to grow the platform ecosystem. Gawer and Hendfridson (2007) further state that, in case of competition between a platform owner and complementors, the owner should create two separate units (one advancing the interests of the platform owner and one promoting the interests of the whole ecosystem) and limit the interactions between them. When discussing the success of an envelopment, Eisenmamm et al. (2011) argue that a platform owner needs to foster cross-unit cooperation in order for such strategy to succeed. Aiming to advance the overall development of the platform

ecosystem, Wan et al. (2017) advice that a platform owner should have two dedicated units to pursue exploration and exploitation respectively. Research investigating the organizational structure of digital platform ecosystems (in terms of division of labor, hierarchical structures, power distribution, etc.), however, remains scant and fragmented. In particular, there is lack of studies that provide comprehensive account of such organizational structure and how it changes over time in connection to the rapid alterations in the platform strategy.

Analytical Framing

This paper investigates how platform owner(s) manage the dynamic and unpredictable process of digital platform ecosystem evolution. To this end, this study builds upon the strategy-structure interplay as presented in the field of organization studies. In addition, it adopts a micro-perspective by arguing that rather than designed and imposed by the top management, strategies and the relevant organizational structures emerge from the micro-activities of various platform employees, especially when interacting with other ecosystem actors. Consequently, this research relies on Strategy-as-Practice perspective (e.g. Whittington 2006) and on micro approach to organizational structuring (e.g. Puranam 2014) as analytical lenses, and combines them in a preliminary research process model (see Figure 1).

Strategy-Structure Interplay

To survive turbulent times, an organization needs to ensure a fit between its strategy and structure, which guarantees its successful evolution over time (Simon 1993; Tushman et al. 1986). In particular, Miles et al. (1978) point out that managers have to adjust continuously their strategy to remain relevant in the market and, as a result, to re-evaluate and alter on ongoing basis the mechanisms, which support the strategy execution. Strategy and organizational structure are interdependent and develop in parallel. While strategy determines structure, which supports its execution, structure also affects the strategy itself (Chandler 1962; Hall and Sais 1980). The execution of specific strategy, for example, imprints on the overall organizational structure and leads to "structural evolution" (Chandler 1962). Organizational structure, however, also influences the introduction and further development of strategy (Hall and Sais 1980).

Adopting an Emergence Lens: From Macro to Micro Focus

The macro perspective for studying organizations, which puts emphasis on collectivism and discards individualism, has dominated the social science field (Barney and Felin 2013). Recognizing its limitations, a number of researchers have proposed the adoption of micro approach for studying various organizational issues (see, Tsoukas and Chia 2002). While this approach does not reject the importance of macro level, it gives prevalence to micro level in order to explain how social phenomena (at macro level) "emerge because of individual choices and social interaction" (Barney and Felin 2013, p. 144). In particular, micro-foundations put emphasis on the "unforeseen, surprising, and emergent" (ibid) outcomes as result of dynamic interactions

between individuals. Thus, emergence constitutes an important concept in the micro approach (Barney and Felin 2013). Rooted in the process philosophy of becoming, emergence is "being in continual process, never arriving, but always in transition" (Damsgaard and Truex 2000, p. 5) and presupposes that flux, change, unpredictability and ambiguity are inherent characteristics of reality (Tsoukas and Chia 2002). Thus, change is constant state for organizations, where its every aspect (e.g., business relations, strategy, organizational form, IT, etc.) co-evolve and emerge together, following no pre-established plan (Damsgaard and Truex 2000).

Emergence of Micro-Strategies and Microstructures

In opposition to deliberate and planned strategy, emergent strategy presents a pattern of unintended, context-specific strategic outcomes undertaken in reaction to changing environment dynamics (Mintzberg and Waters 1985). Thus, instead of relying on a fixed, long-term strategy, an organization tests various alternatives in order to establish which strategic approaches to retain and reinforce, and which to discard through a process of constant learning (Mintzberg and Waters 1985). Brown and Eisenhardt (1997), for example, found that successful managers do not elaborate on complicated plans for the future, but instead rely on low-cost probing techniques to sense the future and predict success.

The emergent patterns of strategic outcomes, which bring the organization closer to reality, are rooted in the praxis and practices of various actors who participate in the strategy making and execution (Mintzberg and Waters 1985). Thus, this study adopts a Strategy-as-Practice lens, which provides the necessary apparatus to investigate how the specific activities of practitioners on micro level lead to various strategic outcomes (Johnson et al. 2003; Whittington 2006). To understand this process of strategizing, Whittington (2006) proposes to study three concepts - praxis, practices and practitioners. Praxis encompasses diverse activities (e.g., formal meetings, informal conversations, etc.), related to the process of strategy design and realization performed by strategic practitioners from all organizational levels (Whittington 2006). Thus, practitioners engaged in strategizing need not to be top managers; in fact, they can assume either core strategic roles or auxiliary roles (Whittington 2006). Practices, which present common set of rules and understanding, guide the day-to-day activities of practitioners (ibid). As Whittington (2014) points out "in their praxis, practitioners enact practices in ways that affect outcomes" (p. 3). As result of this process, micro-strategies, which reflect the preferred strategic approach to tackling specific internal and external challenges, emerge (Ghazawneh and Henfridsson 2011; Johnson et al. 2003).

The successful execution of strategy emergence depends upon the existence of efficient organizational structure (see above). Reflecting an environment with increased dynamics and uncertainty, where managers need to sense their way (Brown and Eisenhardt 1997), organizations move from rigid structures towards a micro-approach to organizational design (Brown and Eisenhard 1997; Orlikowski and Yates 2002; Puranam 2014). This approach states that instead of being fixed, organization design emerges as a pattern of flexible and fluid temporal structures (Orlikowski and Yates 2002; Tsoukas and Chia 2002). Thus, microstructures,

who present "common patterns of interaction between members of an organization" (Puranam 2014, p. 2), form over time through the daily activities of various actors, who coordinate for the achievement of a common goal (Orlikowski and Yates 2002). Examples of such temporal structuring are semi-structures and "links in time" (Brown and Eisenhardt 1997). Semi-structures, which combine rigidity and flexibility, emerge during the duration of various projects and allow for fixed requirements (e.g., responsibilities, time frames, deliverables, etc.) to co-exist along with requirements, which are open and non-determined. "Links in time" allow managers to establish continuity and direction by connecting their work over time through "choreographed transition" (Brown and Eisenhardt 1997, p. 29).

Based on the above two theoretical lenses, this study proceeds with the development of a preliminary process model to guide the empirical analysis (see Figure 1). The model conceptualizes the emergence of overall platform strategy as a series of micro-strategies stemming from the micro-activities (praxis) of strategic practitioners (identified as A, B, C, D; see Figure 1), which are regulated by specific practices. Ghazawneh and Henfridsson (2011) argue that "platform strategy emerges through the enactment of different micro-strategies as the platform owner discover new opportunities or react as a response to strategic moves by ecosystem members" (p. 16). Thus, instead of relying on one deliberate strategy, a platform owner often implements multiple micro-strategies to address the unpredictability of the digital platform ecosystem evolution.
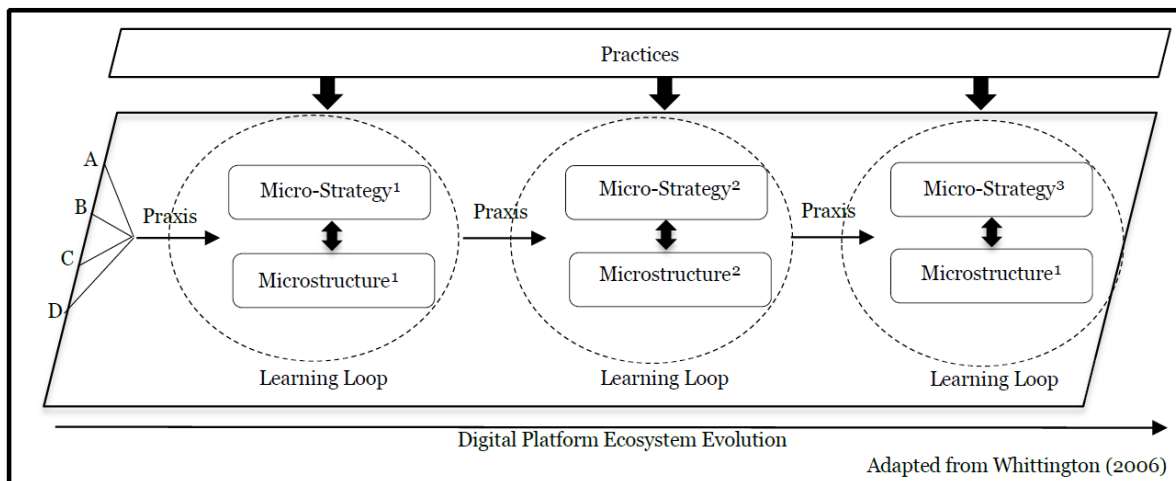
Figure 1. Model for Managing Digital Platform Ecosystem Evolution

In parallel with the emergence of micro-strategies, relevant microstructures also emerge from the praxis of the strategic practitioners (see, Figure 1). Thus, rather than relying on traditional organizational design set by top managers, platform employees create temporal micro-structures (e.g., working process, coordination mechanisms, division of labor) to support the execution of context-specific micro-strategies (Puranam 2014). Similar to micro-strategies, these microstructures form a certain pattern over time, which shapes the emergence of the organizational structure supporting the functioning of digital platform ecosystem.

The emergent micro-strategies and microstructures form a pattern over time. The proposed model conceptualizes that based on learning loops, practitioners can evaluate whether given micro-strategy and its corresponding microstructure address adequately and efficiently certain strategic challenge (see, Figure 1; see also Mintzberg and Waters 1985). Based on this evaluation, they can decide to create new micro-strategies and microstructures, which fit better the new strategic challenge, or to keep some of the existing ones (see e.g. last feedback loop in Figure 1, where the microstructure from the first episode is preserved). Thus, because of the learning process, practitioners can decide to keep, modify or altogether reject existing micro-strategies and microstructures or to introduce new ones. Consequently, as suggested by Ghazawneh and Henfridsson (2011), practitioners may compile a portfolio of micro-strategies and microstructures from which to choose when facing certain strategic challenge later on.

Research Design

As this study seeks to provide a process model tracing the emergence of micro-strategies and microstructures as part of the evolution of a digital platform ecosystem, qualitative longitudinal study constitutes a suitable research method (Plourde 2013). Since such studies provide temporal and holistic accounts, researchers select this approach when they need to study dynamic phenomena taking place across a certain span of time and in specific context (Yin 2003). In particular, this research relies on a single longitudinal case study in order to provide in-depth account of the studied phenomenon.

Case Selection and Empirical Context

This research investigates the evolution of a digital payment platform ecosystem based in Northern Europe from its formation back in 2013 until it gained market dominance in late 2017. Offered by an incumbent financial institution, the digital payment platform, which initially enabled peer-to-peer transfers and later consumer-to-business payments, grew rapidly in a short span of time. As a result, the platform owner managed to attract a significant number of demand-side users (e.g., private users), technology providers, external innovators and other supply-side users, thus forming a robust ecosystem of platform actors. Presently, the digital payment platform has become the dominant solution in the Danish market, with approximately 90 % of the Danes using it on daily basis, and has achieved a stable presence in the Finish market.

The four-year case study is set in unique context, which makes it suitable for the purposes of this research. Due to the nascence of the digital payment industry, the case company operates in a dynamic environment with rapid strategic shifts. Facing changing consumer preferences, strict regulation, the entry of new competitors (e.g., fintechs) and adoption of new technology, the evolution of this platform ecosystem does not follow a stable and predictable pattern of events and does not rely on explicit strategy. Throughout its evolutionary path, for example, the digital payment platform ecosystem went through a number of strategic shifts - launch of private app, expansion to include commercial customers, openness to third-party

complementors, inclusion of additional platform technology providers, expansion to Nordic markets, collaborating up with financial providers. In addition, this case is comprehensible as the researcher can achieve a relatively full overview of the emergence of micro-strategies and microstructures. In particular, while the case encompasses a myriad of ecosystem actors, the number of employees, who develop, manage and strategize around the ecosystem, remains relatively small (approximately 30-40 employees), which makes it easy to track activities. Lastly, the selection of this specific case study is also opportunity-driven due to the extensive level of access granted to the researcher (see below).

Data Collection

The collected data for this study comes from three different sources, which the researcher gathered during two-year fieldwork in the case company (October 2015-September 2017). During this time, the researcher had the chance to observe at first hand a wide range of activities, to discuss and record accounts of events, which occurred in the period before and during the fieldwork, and to examine all the relevant documentation kept in the company. As a result, the researcher collected a rich and detailed account of the evolution of this digital payment platform ecosystem, spanning over almost four and a half years (May 2013-September 2017).

When adopting a process perspective, researchers recommend immersing in the daily life of the organization (Whittington 2014) in order to "uncover strategic activities in their real rather than just their reported form" (Johnson et al. 2003, p. 17). Thus, the preferred approach for data collection is participant observation as "a process enabling researchers to learn about the activities of the people under study in the natural setting through observing and participating in those activities" (Kawulich 2005, p. 1). During the participant observation, the researcher observed a wide variety of activities – from weekly briefings, bi-weekly team meetings and department meetings to workshops, breakout sessions and multiple informal conversations. To record the findings, the researcher noted down all the observations under the form of research diary and minutes from meetings.

In addition, the researcher also conducted twelve interviews with various employees in order to obtain a retrospective account of events, which occurred prior to the fieldwork. To re-construct this initial period of the platform ecosystem evolution, the researcher also collected a number of archival documents such as presentations, reports, emails, minutes from meetings, contracts, press releases, etc.

Data Analysis

To analyze the data, the researcher is following a four-step procedure. Plourde (2013) states that at the end of the data collection, a researcher should have "long chronologies reporting every single action made by the organization in relation to its strategy, structure and processes, and divided into key strategic areas" (p. 99). Thus, the first step in the data analysis is to identify distinct periods of evolution during which micro-strategies and microstructures have emerged. To do so, this study engages in temporal bracketing to outline episodes,

which do not stem from any theory, but rather serve as a means of "structuring the description of events" (Langley 1999, p. 703). To distinct between periods, Langley (1999) recommends looking into certain discontinuities in the observed activities. Thus, the researcher seeks to outline distinct evolutionary episodes by identifying strategic outcomes, which signal for change in the previously established strategy (e.g., launch of new products, new partnerships, change in governance regime, etc. (see, Plourde 2013)). These strategic outcomes mark the beginning and end of each evolutionary episode.

The next step is to focus on each of the established evolutionary episodes and to trace the emergence of the micro-strategies and their microstructures in relation to the specific strategic outcome. To this end, within each identified episode, the researcher investigates the strategic challenges, which practitioners face, the strategic activities they use to address them (e.g., analyses, workshops, investigations, etc.), the practices, which they rely on to strategize, and the organizational structures which support their activities.

The following step is to label the relevant micro-strategies and microstructures, which emerge within each evolutionary period. To distinguish between strategic outcomes and micro-strategies, this study uses the terminology proposed by Ghazawneh and Henfridsson (2011). In their work, they, for example, present the launch of an API (from its launch to testing and modification) as a number of strategic moves, giving rise to certain micro-strategy, which they label resourcing and define as "provision of platform boundary resources for enriching a platform with new capabilities" (ibid, p. 15). Building upon this, for the purposes of this research, strategic outcome presents observable events (launch of new products, etc.), while micro-strategies refer to the act of strategizing which manifests in these observable strategic outcomes. To identify a correct label, Plourde (2013) advises researchers to write a short summary of the period and compare it with the period before and after in order to outline any distinct characteristics. By focusing on these distinct characteristics, the researcher can identify appropriate labels.

Lastly, the researcher compares the micro-strategies and microstructures within a given period with those, which characterize the period before and after. The purpose is to establish whether practitioners retain, reject or modify specific micro-strategies and microstructures as result of a learning process. In particular, of interest is to investigate whether practitioners develop a repository of micro-strategies and microstructures, as suggested by Ghazawneh and Henfridsson (2011), which they can use when faced with specific strategic challenges.

Initial Observations, Expected Findings and Future Work

Although the data analysis is still undergoing, few observations emerged in connection to the proposed model (see Figure 1). In particular, the initial conceptualization of strategizing as emergent on constant basis rather than deliberately planned found significant empirical support. For example, in the words of the CEO of the case company:

"The work in our company is work of uncertainty. There is no explicit strategy as the landscape is constantly changing. (...) Competition is changing. There's also changing regulation. Because of this uncertainty, it is difficult to have explicit strategy".

As result of this uncertainty, top managers and employees in the case company often rely on bottom up approaches to strategizing, where employees propose key strategic initiatives such as feature launch, partnerships, adoption of new technology, rather than these initiatives coming from top managers. At the same time, their practical execution followed different patterns of organizational structuring. For example, although employees belong to specific teams, they do not necessarily have clear job descriptions and instead can perform various activities across teams. Furthermore, the teams working on concrete strategic initiatives often emerge spontaneously initiated by the employees themselves, adopt ad hoc tools and last solely for the duration of the specific initiative. As noted by the CEO of the case company:

"We had a journey of flexibility. We started as a small team. If you have a job profile, in the end of the day, you most likely end up doing things which were not part of your job description".

Reflecting the expanding ecosystem of actors around the platform, the owner had to engage in active partnerships with a myriad of actors, which affected the strategy-making process as it revealed new opportunities for strategic initiatives:

"*As (case company) strengthens its user base, we have increasingly and continuously been presented with companies seeking cooperation, joint development, marketing, etc.* "(Strategy Document, 2015).

While these initial observations testify for the validity of the preliminary conceptualization, which adopts a micro and emergent perspective towards strategizing and organizational structuring, the next step is to conduct the empirical analysis and to adjust the initially proposed model based on the data analysis. The expected findings of this study is to propose a process model for managing the evolution of a digital platform ecosystem and to outline a number of micro-strategies and microstructures, which practitioners can rely on.

Conclusion

When completed, this research aims at contributing to the burgeoning literature on digital platform ecosystems in two ways. First, it offers a process model conceptualizing the management of digital platform ecosystem evolution through the emergence of a pattern of micro-strategies and microstructures. Thus, this study adopts a micro perspective towards platform strategizing and organizational structuring, which is currently absent from platform research. Second, it provides insights into the various practitioners (that is, employees), who support the work of the platform owner, and their activities; thus, moving away from treating the platform owner as collective, faceless actor. The goal of the study is also to provide practitioners from all organizational levels with a set of micro-strategies and their corresponding microstructures, from which they can select when addressing internal and external challenges as part of the evolution of their digital platform ecosystems.

References

Barney, J. B.. and Felin, T. 2013. "What Are Microfoundations*?" Academy of Management Perspectives*, (27:2), pp. 138–155.

Boudreau, K., and A. Hagiu 2009. "Platforms Rules: Multi-sided Platforms as Regulators." In *Platforms, Markets and Innovation*, A. Gawer (Ed.). Edward Elgar Publishing: Cheltenham, UK; Northampton, MA, USA, pp. 163-192.

Brown, S. L., and Eisenhardt, K. 1997. "The Art of Continuous Change Linking Complexity Theory and Time-Paced Evolution in Relentlessly Shifting Organizations," *Administrative Science Quarterly* (42), pp. 1-34.

Chandler, A. D. 1962. *Strategy and Structure: Chapters in the History of American Enterprise*. Boston, MA: MIT Press.

Damsgaard, J., and Truex, D. 2000. "Binary trading relations and the limits of EDI standards: The Procrustean bed of standards," *European Journal of Information Systems*, (9:3), pp. 173-188.

Eisenmann, T., Parker, G., and Van Alstyne, M. 2009. "Opening platforms: How, when and why?" In Platforms, Markets and Innovation; Gawer, A., Ed.; Edward Elgar Publishing: Cheltenham, UK; Northampton, MA, USA, 2009; pp. 131–162.

Eisenmann, T., Parker, G., and Van Alstyne, M. 2011. "Platform envelopment," *Strategic Management Journal*, (32:12), pp. 1270-1285.

Evans, D. S. 2009. "How Catalysts Ignite: The Economics of Platform-Based Start-Ups". In: *Platform, markets and innovation*, Gawer, A. (ed.) Cheltenham, UK and Northampton, MA, US: Edward Elgar.

Evans, D. S., and Schmalensee, R. 2016. *Matchmakers: The New Economics of Multisided Platforms*, Harvard Business School Publishing, Boston: Massachusetts, USA.

Hall, D.J., and Saias, M.A. 1980. "Strategy Follows Structure!," *Strategic Management Journal*, (1:2), pp. 149-163.

Gawer, A. 2009. "Platform Dynamics and Strategies; from products to services", In *Platforms, Markets and Innovation*; Gawer, A., Ed.; Edward Elgar Publishing: Northampton, MA, USA; Northampton, MA, USA, 2009, pp. 45-77.

Gawer, A. 2014. "Bridging differing perspectives on technological platforms: Toward an integrative framework," *Research Policy* (43:7), pp. 1239–1249.

Gawer, A., and Cusumano, M. 2007. "A strategy toolkit for platform leader wannabes," Conference Paper, DRUID Summer Conference on Appropriability, Proximity, Routines and Innovation, Copenhagen, Copenhagen Business School, Denmark.

Gawer, A., and Henderson, R. 2007. "Platform owner entry and innovation in complementary markets: Evidence from Intel," *Journal of Economic Management Strategy*, (16), pp. 1–34.

Ghazawneh, A., and Henfridsson, O. 2011. "Micro-Strategizing in Platform Ecosystems: A Multiple Case Study". In: Proceedings of the International Conference on Information Systems, ICIS 2011, Shanghai, China, December 4-7, 2011. Association for Information Systems 2011, Shanghai, China: AIS , 2011, p. 1-19.

Hagiu, A. 2014. "Strategic Decisions for Multi-sided Platforms," *MIT Sloan Management Review* (55:2).

Hagiu, A. 2006. "Multi-Sided Platforms: From Microfoundations to Design and Expansion Strategies." *Working Paper 07-094. Harvard Business School*.

Johnson, G., Melin, L., and Whittington, R. 2003. "Micro strategy and strategizing: Towards an activity-based view," Guest Editors' Introduction. *Journal of Management Studies*, (40:1), pp. 3–22.

Kawulich, B. B. 2005. "Participant observation as a data collection method". *Forum Qualitative Sozialforschung / Forum: Qualitative Social Research*, (6:2).

Langley, A. 1999. "Strategies For Theorizing From Process Data," *The Academy of Management Review* (24:4), pp. 691-710.

Mintzberg, H., and Waters, J.A. 1985. "Of Strategies Deliberate and Emergent," *Strategic Management Journal*, (6), pp. 257-272.

Orlikowski, W. J., and Yates, J. A. 2002. "It's about Time: Temporal Structuring in Organizations," *Organization Science*, (13), pp. 684-700.

Parker, G., van Alstyne, M., and Choudary, S.P. 2016. *Platform Revolution: How Networked Markets Are Transforming the Economy and How to Make Them Work for You*. NY: WW Norton Company, Inc.

Plourde, Y. 2013. "Studying strategy over time through the identification of patterns of actions: an illustrative case study of the strategies of Alcan and Alcoa from 1928 to 2007." In: *Handbook of Longitudinal Research Methods in Organisation and Business Studies*, Mélanie E. Hassett and Eriikka Paavilainen-Mäntymäki (Eds.). Elgar, pp. 95-118.

Puranam, P. 2014. "The Microstructure of Organizations". Available at SSRN: https://ssrn.com/abstract=2495909 or http://dx.doi.org/10.2139/ssrn.2495909.

Shulman, D. 2016. "PayPal's CEO on Creating Products for Underserved Markets," *Harvard Business Review*, December 2016.

Simon. H. A. 1993. "Strategy and organizational evolution", *Strategic Management Journal* (14), pp. 131-142.

Tan, F. T. C., Tan, B. and Pan, S. L. 2016. "Developing a Leading Digital Multi-sided Platform: Examining IT Affordances and Competitive Actions in Alibaba.com," *Communications of the Association for Information Systems*, (38:36).

Tiwana, A. 2014. *Platform ecosystems, Aligning architecture, governance, and strategy*. Amsterdam: Morgan Kaufmann.

Tsoukas, H., and Chia, R. 2002. "On Organizational Becoming: Rethinking Organizational Change." *Organization Science* (13:5), pp. 567-582.

Tushman, M.L., Newman, W.H., and Romanelli, E. 1986. "Convergence and Upheaval: Managing the unsteady pace of organizational evolution". *California Management Review* (29), pp. 29-44.

Yin, R. K. 2003. *Case study research: Design and methods*, 3rd Edition. Thousand Oaks, CA: Sage.

Wan, X., Cenamor, J., Parker, G., and Van Alstyne, M. 2017. "Unraveling Platform Strategies: A Review from an Organizational Ambidexterity Perspective." *Sustainability, (*9:5), pp. 734.

Whittington, R. 2006. "Completing the Practice Turn in Strategy Research," *Organization Studies*, (27:5), pp. 613- 634.

Whittington, R. 2014. "Information Systems Strategy and Strategy-as-Practice: A joint agenda," *Journal of Strategic Information Systems*, (23:1), pp 87-91.

19. Thomas Lyse Hansen
Six Essays on Pricing and Weather risk in Energy Markets

20. Sabine Madsen
Emerging Methods – An Interpretive Study of ISD Methods in Practice

21. Evis Sinani
The Impact of Foreign Direct Investment on Efficiency, Productivity Growth and Trade: An Empirical Investigation

22. Bent Meier Sørensen
Making Events Work Or, How to Multiply Your Crisis

23. Pernille Schnoor
Brand Ethos
Om troværdige brand- og virksomhedsidentiteter i et retorisk og diskursteoretisk perspektiv

24. Sidsel Fabech
Von welchem Österreich ist hier die Rede?
Diskursive forhandlinger og magtkampe mellem rivaliserende nationale identitetskonstruktioner i østrigske pressediskurser

25. Klavs Odgaard Christensen
Sprogpolitik og identitetsdannelse i flersprogede forbundsstater
Et komparativt studie af Schweiz og Canada

26. Dana B. Minbaeva
Human Resource Practices and Knowledge Transfer in Multinational Corporations

27. Holger Højlund
Markedets politiske fornuft
Et studie af velfærdens organisering i perioden 1990-2003

28. Christine Mølgaard Frandsen
A.s erfaring
Om mellemværendets praktik i en transformation af mennesket og subjektiviteten

29. Sine Nørholm Just
The Constitution of Meaning – A Meaningful Constitution? Legitimacy, identity, and public opinion in the debate on the future of Europe

2005
1. Claus J. Varnes
Managing product innovation through rules – The role of formal and structured methods in product development

2. Helle Hedegaard Hein
Mellem konflikt og konsensus – Dialogudvikling på hospitalsklinikker

3. Axel Rosenø
Customer Value Driven Product Innovation – A Study of Market Learning in New Product Development

4. Søren Buhl Pedersen
Making space
An outline of place branding

5. Camilla Funck Ellehave
Differences that Matter
An analysis of practices of gender and organizing in contemporary workplaces

6. Rigmor Madeleine Lond
Styring af kommunale forvaltninger

7. Mette Aagaard Andreassen
Supply Chain versus Supply Chain Benchmarking as a Means to Managing Supply Chains

8. Caroline Aggestam-Pontoppidan
From an idea to a standard
The UN and the global governance of accountants' competence

9. Norsk ph.d.

10. Vivienne Heng Ker-ni
An Experimental Field Study on the

Effectiveness of Grocer Media Advertising
Measuring Ad Recall and Recognition, Purchase Intentions and Short-Term Sales

11. Allan Mortensen
     Essays on the Pricing of Corporate Bonds and Credit Derivatives

12. Remo Stefano Chiari
     *Figure che fanno conoscere
     Itinerario sull'idea del valore cognitivo e espressivo della metafora e di altri tropi da Aristotele e da Vico fino al cognitivismo contemporaneo*

13. Anders McIlquham-Schmidt
     *Strategic Planning and Corporate Performance
     An integrative research review and a meta-analysis of the strategic planning and corporate performance literature from 1956 to 2003*

14. Jens Geersbro
     *The TDF – PMI Case
     Making Sense of the Dynamics of Business Relationships and Networks*

15   Mette Andersen
     *Corporate Social Responsibility in Global Supply Chains
     Understanding the uniqueness of firm behaviour*

16. Eva Boxenbaum
     Institutional Genesis: Micro – Dynamic Foundations of Institutional Change

17. Peter Lund-Thomsen
     Capacity Development, Environmental Justice NGOs, and Governance: The Case of South Africa

18. Signe Jarlov
     Konstruktioner af offentlig ledelse

19. Lars Stæhr Jensen
     Vocabulary Knowledge and Listening Comprehension in English as a Foreign Language

An empirical study employing data elicited from Danish EFL learners

20. Christian Nielsen
     *Essays on Business Reporting
     Production and consumption of strategic information in the market for information*

21. Marianne Thejls Fischer
     Egos and Ethics of Management Consultants

22. Annie Bekke Kjær
     *Performance management i Proces-innovation
     – belyst i et social-konstruktivistisk perspektiv*

23. Suzanne Dee Pedersen
     *GENTAGELSENS METAMORFOSE
     Om organisering af den kreative gøren i den kunstneriske arbejdspraksis*

24. Benedikte Dorte Rosenbrink
     *Revenue Management
     Økonomiske, konkurrencemæssige & organisatoriske konsekvenser*

25. Thomas Riise Johansen
     *Written Accounts and Verbal Accounts
     The Danish Case of Accounting and Accountability to Employees*

26. Ann Fogelgren-Pedersen
     The Mobile Internet: Pioneering Users' Adoption Decisions

27. Birgitte Rasmussen
     Ledelse i fællesskab – de tillidsvalgtes fornyende rolle

28. Gitte Thit Nielsen
     *Remerger
     – skabende ledelseskræfter i fusion og opkøb*

29. Carmine Gioia
     A MICROECONOMETRIC ANALYSIS OF MERGERS AND ACQUISITIONS

A case study of the Fashion and Design Branch of the Industrial District of Montebelluna, NE Italy

12. Mikkel Flyverbom
    Making the Global Information Society Governable
    On the Governmentality of Multi-Stakeholder Networks

13. Anette Grønning
    Personen bag
    Tilstedevær i e-mail som inter-aktionsform mellem kunde og med-arbejder i dansk forsikringskontekst

14. Jørn Helder
    One Company – One Language?
    The NN-case

15. Lars Bjerregaard Mikkelsen
    Differing perceptions of customer value
    Development and application of a tool for mapping perceptions of customer value at both ends of customer-suppli-er dyads in industrial markets

16. Lise Granerud
    Exploring Learning
    Technological learning within small manufacturers in South Africa

17. Esben Rahbek Pedersen
    Between Hopes and Realities: Reflections on the Promises and Practices of Corporate Social Responsibility (CSR)

18. Ramona Samson
    The Cultural Integration Model and European Transformation.
    The Case of Romania

2007
1. Jakob Vestergaard
    Discipline in The Global Economy Panopticism and the Post-Washington Consensus

2. Heidi Lund Hansen
    Spaces for learning and working
    A qualitative study of change of work, management, vehicles of power and social practices in open offices

3. Sudhanshu Rai
    Exploring the internal dynamics of software development teams during user analysis
    A tension enabled Institutionalization Model; "Where process becomes the objective"

4. Norsk ph.d.
    Ej til salg gennem Samfundslitteratur

5. Serden Ozcan
    EXPLORING HETEROGENEITY IN ORGANIZATIONAL ACTIONS AND OUTCOMES
    A Behavioural Perspective

6. Kim Sundtoft Hald
    Inter-organizational Performance Measurement and Management in Action
    – An Ethnography on the Construction of Management, Identity and Relationships

7. Tobias Lindeberg
    Evaluative Technologies
    Quality and the Multiplicity of Performance

8. Merete Wedell-Wedellsborg
    Den globale soldat
    Identitetsdannelse og identitetsledelse i multinationale militære organisatio-ner

9. Lars Frederiksen
    Open Innovation Business Models Innovation in firm-hosted online user communities and inter-firm project ventures in the music industry
    – A collection of essays

10. Jonas Gabrielsen
    Retorisk toposlære – fra statisk 'sted' til persuasiv aktivitet

2016

1. Signe Sofie Dyrby
Enterprise Social Media at Work

2. Dorte Boesby Dahl
The making of the public parking attendant
Dirt, aesthetics and inclusion in public service work

3. Verena Girschik
Realizing Corporate Responsibility Positioning and Framing in Nascent Institutional Change

4. Anders Ørding Olsen
IN SEARCH OF SOLUTIONS
Inertia, Knowledge Sources and Diversity in Collaborative Problem-solving

5. Pernille Steen Pedersen
Udkast til et nyt copingbegreb
En kvalifikation af ledelsesmuligheder for at forebygge sygefravær ved psykiske problemer.

6. Kerli Kant Hvass
Weaving a Path from Waste to Value: Exploring fashion industry business models and the circular economy

7. Kasper Lindskow
Exploring Digital News Publishing Business Models – a production network approach

8. Mikkel Mouritz Marfelt
The chameleon workforce:
Assembling and negotiating the content of a workforce

9. Marianne Bertelsen
Aesthetic encounters
Rethinking autonomy, space & time in today's world of art

10. Louise Hauberg Wilhelmsen
EU PERSPECTIVES ON INTERNATIONAL COMMERCIAL ARBITRATION

11. Abid Hussain
On the Design, Development and Use of the Social Data Analytics Tool (SODATO): Design Propositions, Patterns, and Principles for Big Social Data Analytics

12. Mark Bruun
Essays on Earnings Predictability

13. Tor Bøe-Lillegraven
BUSINESS PARADOXES, BLACK BOXES, AND BIG DATA: BEYOND ORGANIZATIONAL AMBIDEXTERITY

14. Hadis Khonsary-Atighi
ECONOMIC DETERMINANTS OF DOMESTIC INVESTMENT IN AN OIL-BASED ECONOMY: THE CASE OF IRAN (1965-2010)

15. Maj Lervad Grasten
Rule of Law or Rule by Lawyers?
On the Politics of Translation in Global Governance

16. Lene Granzau Juel-Jacobsen
SUPERMARKEDETS MODUS OPERANDI – en hverdagssociologisk undersøgelse af forholdet mellem rum og handlen og understøtte relationsopbygning?

17. Christine Thalsgård Henriques
In search of entrepreneurial learning – Towards a relational perspective on incubating practices?

18. Patrick Bennett
Essays in Education, Crime, and Job Displacement

19. Søren Korsgaard
Payments and Central Bank Policy

20. Marie Kruse Skibsted
Empirical Essays in Economics of Education and Labor

21. Elizabeth Benedict Christensen
The Constantly Contingent Sense of Belonging of the 1.5 Generation Undocumented Youth
An Everyday Perspective

33. Thomas Jensen
*Shipping Information Pipeline:
An information infrastructure to
improve international containerized
shipping*

34. Dzmitry Bartalevich
*Do economic theories inform policy?
Analysis of the influence of the Chicago
School on European Union competition
policy*

35. Kristian Roed Nielsen
*Crowdfunding for Sustainability: A
study on the potential of reward-based
crowdfunding in supporting sustainable
entrepreneurship*

36. Emil Husted
*There is always an alternative: A study
of control and commitment in political
organization*

37. Anders Ludvig Sevelsted
*Interpreting Bonds and Boundaries of
Obligation. A genealogy of the emer-
gence and development of Protestant
voluntary social work in Denmark as
shown through the cases of the Co-
penhagen Home Mission and the Blue
Cross (1850 – 1950)*

38. Niklas Kohl
Essays on Stock Issuance

39. Maya Christiane Flensborg Jensen
*BOUNDARIES OF
PROFESSIONALIZATION AT WORK
An ethnography-inspired study of care
workers' dilemmas at the margin*

40. Andreas Kamstrup
*Crowdsourcing and the Architectural
Competition as Organisational
Technologies*

41. Louise Lyngfeldt Gorm Hansen
*Triggering Earthquakes in Science,
Politics and Chinese Hydropower
- A Controversy Study*

2018

1. Vishv Priya Kohli
*Combatting Falsifi cation and Coun-
terfeiting of Medicinal Products in
the E uropean Union – A Legal
Analysis*

2. Helle Haurum
*Customer Engagement Behavior
in the context of Continuous Service
Relationships*

3. Nis Grünberg
*The Party -state order: Essays on
China's political organization and
political economic institutions*

4. Jesper Christensen
*A Behavioral Theory of Human
Capital Integration*

5. Poula Marie Helth
Learning in practice

6. Rasmus Vendler Toft-Kehler
*Entrepreneurship as a career? An
investigation of the relationship
between entrepreneurial experience
and entrepreneurial outcome*

7. Szymon Furtak
*Sensing the Future: Designing
sensor-based predictive information
systems for forecasting spare part
demand for diesel engines*

8. Mette Brehm Johansen
*Organizing patient involvement. An
ethnographic study*

9. Iwona Sulinska
*Complexities of Social Capital in
Boards of Directors*

10. Cecilie Fanøe Petersen
*Award of public contracts as a
means to conferring State aid: A
legal analysis of the interface
between public procurement law
and State aid law*

11. Ahmad Ahmad Barirani
*Three Experimental Studies on
Entrepreneurship*

2019

TITLER I ATV PH.D.-SERIEN

1992

1. Niels Kornum
Servicesamkørsel – organisation, øko-nomi og planlægningsmetode

1995

2. Verner Worm
*Nordiske virksomheder i Kina
Kulturspecifikke interaktionsrelationer
ved nordiske virksomhedsetableringer i
Kina*

1999

3. Mogens Bjerre
*Key Account Management of Complex
Strategic Relationships
An Empirical Study of the Fast Moving
Consumer Goods Industry*

2000

4. Lotte Darsø
*Innovation in the Making
Interaction Research with heteroge-neous Groups of Knowledge Workers
creating new Knowledge and new
Leads*

2001

5. Peter Hobolt Jensen
*Managing Strategic Design Identities
The case of the Lego Developer Net-work*

2002

6. Peter Lohmann
*The Deleuzian Other of Organizational
Change – Moving Perspectives of the
Human*

7. Anne Marie Jess Hansen
*To lead from a distance: The dynamic
interplay between strategy and strate-gizing – A case study of the strategic
management process*

2003

8. Lotte Henriksen
*Videndeling
– om organisatoriske og ledelsesmæs-sige udfordringer ved videndeling i
praksis*

9. Niels Christian Nickelsen
*Arrangements of Knowing: Coordi-nating Procedures Tools and Bodies in
Industrial Production – a case study of
the collective making of new products*

2005

10. Carsten Ørts Hansen
*Konstruktion af ledelsesteknologier og
effektivitet*

TITLER I DBA PH.D.-SERIEN

2007

1. Peter Kastrup-Misir
*Endeavoring to Understand Market
Orientation – and the concomitant
co-mutation of the researched, the
re searcher, the research itself and the
truth*

2009

1. Torkild Leo Thellefsen
*Fundamental Signs and Significance
effects
A Semeiotic outline of Fundamental
Signs, Significance-effects, Knowledge
Profiling and their use in Knowledge
Organization and Branding*

2. Daniel Ronzani
*When Bits Learn to Walk Don't Make
Them Trip. Technological Innovation
and the Role of Regulation by Law
in Information Systems Research: the
Case of Radio Frequency Identification
(RFID)*

2010

1. Alexander Carnera
*Magten over livet og livet som magt
Studier i den biopolitiske ambivalens*