An Inquiry into the Nature and Causes of Digital Platforms

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To Gunilla Saarikko and Olavi Saarikko who worked hard to provide their children with the world of opportunities that they never had.

Table of Contents

Abstract

While the shape and nature of platforms varies across different instances, they pursue common ambitions such as reduction of risk, complexity, or transaction costs. Although initially theorised in industrial contexts, subsequent theorising regarding platform development, platform ecosystems, and platform strategy has drawn upon studies of high-tech industries in general and IT-based platforms in particular. While the inherent malleability of digitised data and digital technology offers possibilities, they also make it difficult to pin down the locus of a low-variety platform core. As such, one of the fundamental properties of digital platforms is rather mundane: to provide stability. With that in mind, this thesis pursues the following research question: *How can a digital platform maintain stability for its stakeholders in the face of constant technical change?*

This thesis utilises *affordance theory* as a means to operationalise a relational view of digital platform, where stability is assessed in relation to stakeholders rather than technical persistence. This dissertation is based on an interpretive case study, primarily using qualitative data in the form of interviews gathered as part of two separate projects that varied both in scope and orientation.

The thesis offers two main contributions. First, the idea of platform stability as derived from low-variety components that are persistent over time is difficult to apply in relation to digital platforms. Rather, we need to approach *stability as a composite property*, based on the ability of the platform to satisfy technical, informational, and social expectations. Hence, stability should not be considered as a fixed or absolute property, but rather a moving target. Second, this thesis suggests that the existing notion of (technical) coring needs to be complemented with *information* coring and *social* coring when applied to digital platforms. The proposed concept of information coring expresses the ability to hide complexity and present bottom-line results to the user in a comprehensible manner. Social coring refers to the idea of aligning technical integration and social integration in a platform.

A relational perspective applied to digital platforms offers a possible avenue for theorising digital platforms as information systems artefacts rather than the dichotomous relationship between platform-as-architecture and platform-as-marketplace found in extant literature.

Acknowledgements

A wise man once said that a good thesis is a finished thesis. Right now, I'm inclined to agree. I've gradually come to realise is that writing a thesis is not the end of a journey. A more apt metaphor would be to describe a dissertation as a discarded chrysalis or a skin that has been shed. A tangible *thing* that is left behind as the erstwhile occupant is off in pursuit of new adventures. I guess this leaves me to conclude that a good thesis does not signify the *end* of a journey as much as a *beginning* of something else.

However, before I move on to whatever comes next, it is only fitting to briefly stop and take stock of the past four years. One of my most vivid memories is from an event that took place just two months after I moved to Umeå in October 2012. Around mid-December, the whole department visited a local restaurant as a prelude to the upcoming holidays. After an excellent meal, the guests at the restaurant were treated to a performance by a female stand-up comedian. As part of her performance, the comedian had a brief Q&A with the audience, asking where they were from and what that they did for a living. When she came around to our table, someone replied that we were from the department of informatics. Somewhat perplexed, the comedian shot back: "Informatics – what the hell is that?"

The response was dead silence. She then asked "Does it have anything to do with information?" A voice offered a wavering reply: "Yes…"

Although the whole exchange was improvised, the final comment could just as easily have been a well-rehearsed punchline as it drew thunderous laughter: "Well, then you're obviously not too good at it, are you?"

The pursuit of a Ph.D. can be a lonely endeavour – especially in a field that few people understand or even know exist. You do, however, meet people along the way who make the journey worth taking. First and foremost, I owe an immesurable debt of gratitiude to Katrin Jonsson who over the past four years has acted as my supervisor, co-author and spirit guide. Thank you for providing me with the tools and the piece of mind needed to get things done.

I need to confess something to my second supervisor, Jonny Holmström. When you first called to offer me the job back in late August 2012, I was fairly passive and uncommitted. I distinctly remember the voice on the other end of the line sounding a bit surprised and almost annoyed at my apparent lack of excitement. Well, it wasn't disinterest as much as *disbelief* as I honestly thought it was a mistake. (*Surely* he must have dialled the wrong

number on the list of applicants? There's no way that they want to take *me* on as a post-graduate student, right?) As I write these words (four years later) part of me still thinks his is all an elaborate prank. I guess time will tell.

I would like to thank my co-authors – Ulrika H. Westergren, Tomas Blomquist and Thommie Burström – for their patience and encouragement. I look forward to learning more from you in the future.

Mikael Wiberg, Lisen Selander, Johan Sandberg and Angelica Svelander all provided valuable input during my pre-seminar in June 2016. Thank you for taking the time, and double-thank you for reading between the lines and finding what I was *trying* to say rather than what I was actually *able* to say.

Then there's the motley crew of people from the Swedish Center for Digital Innovation: Lars Öbrand, Viktor Arvidsson, Daniel Nylén, Daniel Skog, Vasili Mankevich, Ofe Hosea Ayaba and Taline Jadaan. You guys are all deeply disturbed – and I love you for it. Oh, and Nils-Petter Augustsson – I'm looking forward to reading *your* thesis in the near future.

Fatemeh Moradi – *Sluta larva dig!*

Last, but not least, I owe a debt of gratitude to the people I met in Gothenburg who laid the foundation for where I am today: Aida Hadzic, who taught me that work requires focus and discipline, and Kalevi Pessi, who gave me a chance when I needed it most. Finally, I cannot possibly finish this long list of acknowledgements without mentioning Thanos Magoulas. Although you are no longer with us, your spirit of curiosity and passion for knowledge will stay with me for the rest of my life.

Ted Saarikko

Umeå, November 2016

Preface

This thesis is based on research described in the four appended research papers which are referred to in the text by the corresponding numbers. In addition to providing relevant insights in their own right, their results are also reinterpreted via a framework presented in chapter 3. Chapter 5 provides general summaries of each respective paper as well as descriptions of their contribution in relation to the overall thesis.

Paper 1: Saarikko, T. (2014). Here Today, Here Tomorrow: Considering Options Theory in Digital Platform Development. *Creating Value for All Through IT: IFIP WG 8.6 International Conference on Transfer and Diffusion of IT*, TDIT 2014, Aalborg, Denmark, June 2-4 2014.

Paper 2: Saarikko, T., Jonsson, K. & Burström, T. Platform establishment: A case study of entrepreneurial alertness. *Under review in an international journal (first round).*

Paper 3: Saarikko, T., Westergren, U. H. & Blomquist, T. (2016). The Inter-Organizational Dynamics of a Platform Ecosystem: Exploring Stakeholder Boundaries. In *2016 49th Hawaii International Conference on System Sciences (HICSS)* (pp. 5167-5176). IEEE.

Paper 4: Saarikko, T. (2016). Platform Provider by Accident: A Case Study of Digital Platform Coring. *Business & Information Systems Engineering*, 58(3), 177-191.

1. Introduction

Enterprises are increasingly faced with the challenge of leveraging efficient production to minimise costs whilst simultaneously appealing to discerning customers wanting both variety and responsiveness. The seemingly incongruent equation of large-scale output and customisation has brought about an increasing importance of platforms in many industries. Reviews and retrospectives by Cusumano (2012), Gawer (2014), Gawer and Cusumano (2014), and Thomas et al. (2015) have shown an increasing scholarly interest in platforms in terms of quantity (number of publications) as well as diversity (research context and theoretical perspective).

While the embodiment of platforms varies across different instances, each type of application[1] pursues common objectives such as reduction of risk, complexity, or transaction costs. Early efforts to theorise platforms are largely rooted in an industrial setting where firms seek to leverage common components across several different products, permitting "product families" that are either variants on a theme or entirely distinct offerings (Meyer & Utterback, 1993; Wheelwright & Clark, 1992). These platforms are intra-organisational structures that draw upon basic ideas of modularity (Baldwin & Clark, 1997; Ulrich, 1995) and decomposition of complex structures into manageable pieces (Simon, 1996) to provide a number of distinct values, including savings in fixed costs, reduced time-to-market for new products, and increased product variety, leading to an overall balance of economies of scale and scope (Gawer, 2014; Thomas et al., 2015). The application of internal platforms is most pervasive where they provide the greatest benefit – complex manufactured goods such as automobiles or consumer electronics (Nobeoka & Cusumano, 1997; Simpson, 2004). In addition to managing complexity, the use of product platforms is related to the practice of mass-customisation (Feitzinger & Lee, 1997; Simpson, 2004) where shared *core* components are mass-produced and paired with distinguishing *modules* to provide a limited form of customisation that still leverages the large-scale benefits of mass-production.[2]

As platforms have been used to enhance production processes, they have also served to further the differentiation of organisational units by function or expertise. When a product is comprised of distinct components – separated by clearly defined interfaces – it creates a natural basis for a

[1] I do not use the term application to denote software programs or "apps" used on mobile devices, but rather instances of applying (digital) technology for a specific purpose and/or in a specific context.

[2] I do not ascribe different meanings to the terms "complement" or "module", and they will be used interchangeably.

commensurate organisational division of function and expertise where each unit or section can focus on their specific task rather than address the full range of complexity. In addition to facilitating differentiation of tasks and expertise within organisations, platforms have also served to extend this approach beyond the confines of the single firm (Huang et al., 2005; Sako, 2009; Sturgeon, 2002). Gawer (2009) has offered a basic classification of three types of platforms based on the scope of stakeholder involvement*:* *internal platforms* that are specific to a single firm, *supply-chain platforms* that extend to external actors bound by basic supplier-consumer contracts, and *industry platforms* that are relatively open to different actors that abide by explicit rules and preconditions imbued in the platform. The latter have garnered much interest due to their ability to spawn ecosystems of loosely-coupled actors focused on business (Moore, 1996) or innovation (Adner & Kapoor, 2010) whereby such platforms provide a key technical function or serve to enable business interactions (Gawer & Cusumano, 2008; Iansiti & Levien, 2004; Tiwana, 2014).

From a business standpoint, platforms may be regarded as two-sided (or multi-sided) markets that enable interaction between different actors (Caillaud & Jullien, 2003; Eisenmann et al., 2006; Rochet & Tirole, 2003). The multi-sided market perspective has emerged from research on credit card providers (Tirole & Rochet, 2002) although it has subsequently been applied to other industries such as employment mediation, online retail, and social media (Evans, 2009; Hagiu, 2014). From a more technical perspective, Baldwin and Woodard (2009) have presented a general view, more in keeping with the industrial context whereby platforms are comprised of low-variety elements which are combined with high-variety elements to provide output variants. An alternate nomenclature designates the low-variety elements as a platform's *core* whereas the high-variety elements may be called *modules* or *complements* (Eisenmann et al., 2011; Gawer, 2009). This core-module dichotomy has been reaffirmed by subsequent theorising (e.g. Gawer, 2014; Thomas et al., 2015) and may be considered a mainstay of our current understanding of platforms.

External platforms in general, and industry platforms in particular, share certain properties with a dominant design (Abernathy & Utterback, 1978) in that they reduce the number of viable options and thus funnel business activity and creativity to a smaller (or maybe singular) set of options (Gawer & Cusumano, 2014). As a platform forms a relatively persistent basis on which to further innovate, the "best" platform may not primarily be determined by technical merits or design, but rather ability to attract interest. As the number of platform users increases, so does the perceived value of participation – a phenomenon commonly referred to as a network

effect (Katz & Shapiro, 1985; Parker & van Alstyne, 2005; Rysman, 2004). While there are many factors that determine the success of an industry platform or a platform's ability to attract an ecosystem, a key factor is the platform's ability to provide a solid foundation whilst permitting external actors the freedom to innovate in different ways and for different purposes. The tangible sign of finding the proverbial sweet spot is commonly manifested in a platform's generativity i.e. the ability to spawn derivative products or offerings that are not predetermined by the platform owner[3] (Zittrain, 2006). Hence, the value of external platforms is typically expressed in terms of lowered transaction costs, linkages between actors, and access to external innovation and entrepreneurship.

While platforms were initially theorised in industrial contexts focused on the physical manufacturing of products, the bulk of subsequent theorising regarding platform development (Eisenmann et al., 2011; Evans, 2009), platform ecosystems (Tiwana, 2014; West & Wood, 2013), and platform strategy (Eisenmann et al., 2006; Hagiu, 2014) has drawn upon studies of – and developments in – high-tech industries in general, and IT-based platforms in particular (Thomas et al., 2015). Digital technology is amenable to platform development in (at least) two distinct ways. First, digitised offerings do not require large production facilities, but are exceedingly cheap to reproduce and distribute. Second, when coupled with pervasive communications networks, digital technology also supports the coordination between different actors needed for collaborative innovation (Baldwin & von Hippel, 2011).

While the nebulous nature of digitised data and digital technology offers possibilities, it also makes IT-based platforms prone to change. Moore's law – which states that computer performance doubles every 18 months or so – has proved remarkably reliable over the past 50 years (Brynjolfsson & McAffee, 2014). Components, and indeed whole technologies, emerge, mature and grow obsolete at a blistering pace, making the idea of a consistent (or "low-variety") platform core difficult to enact in practice (Bresnahan & Greenstein, 1999; Wareham et al., 2014). It is in these contexts that platforms, with their ability to focus disparate actors into a shared technical baseline, are all the more potent, but also more difficult to establish. As Bresnahan and Greenstein put it: "Engineering only creates new kinds of computer *components* – hardware, software, and networks – but a *platform* is a more complex creature of engineering *and* buyer-seller interaction" (1999, p. 34, emphases in original). A significant factor in the overall appeal of digital technology in relation to platform research is the

[3] Please note that the terms "platform owner" and "platform provider" will be used interchangeably.

congruence between the promise of platforms – to facilitate connectivity and enable co-creation – and the disaggregated architecture – first through client-server models and then taken even further with the Internet and cloud computing – found in computer networks. However, the inherent flexibility found in digital technology (Yoo et al., 2010) also makes it difficult to pin down the locus of a core. Indeed, studies of computer platforms assert the overall insufficiency in ascribing stability to any specific architectural feature (Bresnahan & Greenstein, 1999; Wareham et al., 2014). In this context, one of the primary benefits for a platform is not to promote a modular approach or to reduce transaction costs, but more to curtail technical uncertainty and mitigate risk in the face of a seemingly endless sea of options for both providers and consumers (Tiwana et al., 2010).

1.1. Problem Statement

As an ever wider range of phenomena have come to be described as platforms, it follows that the term "platform" does not describe a homogeneous phenomenon. Quite to the contrary, as the term proliferates into a wider range of applications, it also runs the risk of losing any semblance of meaning or shared characteristics (Cusumano, 2012). While IT-oriented applications are by no means the sole sinners in this regard, the digital industries do provide us with multiple examples of how "platform" is used to describe highly disparate phenomena. Gillespie (2010) illustrated this point by describing how firms routinely apply the term "platform" to multimedia file-formats, Internet computing, services for commerce and advertising and last, but not least, various operating systems for personal computers as well as mobile devices.

Our understanding of platform architecture rests upon the notion of a persistent platform core and more dynamic, replaceable modules or complements (Baldwin & Woodard, 2009; Gawer, 2014). The core-module metaphor draws on research into modularity (Schilling, 2000) and decomposition of systems (Simon, 1996) whereby complex structures are deconstructed into smaller, manageable pieces. However, the past 20 years have seen an increasingly diverse set of phenomena framed as platforms – from physical structures or products to constructs that are either intangible or where the physical makeup is irrelevant (Cusumano, 2012). While extant literature has a relatively firm grasp on strategies regarding mature platforms (Eisenmann et al., 2006; Gawer, 2014; Tiwana, 2014) and the virtually inexhaustible potential of digital technology (Lyytinen et al., 2016; Tilson et al., 2010; Yoo et al., 2012), it is my view that our understanding of how a platform core is established and maintains stability for its stakeholders in spite of constant technical change is still lacking. While

platform theory has, of course, developed over the years, I see two lingering points of concern in relation to a more inclusive notion of platforms.

First, a platform once denoted a physical structure that permitted moderate recombination of parts for the purpose of production efficiency and mass-customisation (e.g. Simpson, 2004; Ulrich, 1995; Wheelwright & Clark, 1992). When applied to describe market structures, platforms describe a set of rules and incentives (such as reduced transaction costs or the promise of network effects) that encourage participation by different actors (Eisenmann et al., 2006; Rochet & Tirole, 2003). Digital technology has been applied to various types of platforms e.g. storefronts that link provider and customer (Ghazawneh & Henfridsson, 2013), websites and services for social media that gather users for non-commercial exchanges (Cusumano, 2011), and computer operating systems which permit simple use of exceedingly complex devices (Gillespie, 2010). While it is difficult to single out a sole purpose or function that is common to these varied types of application, we can characterise them as increasingly complex ventures that are not under the exclusive control of any one actor. As such, their pre-eminent property shifts from solving systemic problems for a variety of stakeholders (Iansiti & Levien, 2004), balancing efficiency against variety to yield mass-customisation (Simpson, 2004), or even to create marketplaces that support business activity and connect different actors (Eisenmann et al., 2006) to something considerably more mundane: the provision of *stability*.

Second, and partially as a result of the preceding point, it is questionable whether the existing notion of a platform core is relevant to the dynamic context of digital technology. Extant research (Wareham et al., 2014) has suggested that it is difficult to identify any stable elements in relation to technical platforms that pertain to digital technology. Yoo et al. (2010) have argued that digital (or digitised) products are comprised of a layered architecture where each and every layer is replaceable. In my own efforts to explore the issue (paper 4 in this thesis), I argue that the core of a digital platform[4] should be considered a verb ("coring") rather than a noun in order to denote the ongoing act of balancing platform stability against contextual *relevance* for different stakeholders in a constantly changing technical and economic landscape. Hence, the purpose of this thesis is to contribute to our understanding of strategies for digital platforms.

While the core-module metaphor may be applicable to IT-based platforms given the level of abstraction found in business studies (e.g. Eisenmann et

[4] Alternatively "digitally-enabled platform" (Lusch & Nambisan, 2015) or "digital technology platform" (Yoo et al., 2012).

al., 2011) and management studies (Thomas et al., 2015), it is unclear just how far we can push this perspective in information systems research without letting significant insights fall through the cracks. With that in mind, this thesis will pursue the following research question: *How can a digital platform maintain stability for its stakeholders in the face of constant technical change?*

In the interests of clarity and precision, there are a few points that need to be explained in relation to the research question. First, in order to answer the research question we need to reassess the notion of an "objective" platform core and consider it from the viewpoint of different stakeholders. While platforms are commonly presented as structures that are shared among multiple parties, it does not automatically follow that the platform is *perceived* in a similar fashion by all stakeholders. Platform literature describing failure to attract support (Evans, 2009), power imbalances (Bergvall-Kåreborn & Howcroft, 2014), and ongoing tension between platform providers and platform users (Ghazawneh & Henfridsson, 2013) suggests that the perception and interests in platforms can differ quite substantially. Hence, there is a need to study digital platforms from a *relational* perspective rather than consider it an objective structure, object or technology.

Second, while platforms have received a fair amount of attention in information systems research, the literature is somewhat scattered, using a varied nomenclature such as information technology platforms (Fichman, 2004), digital technology platforms (Yoo et al., 2012), software platforms (Tiwana et al., 2010), and digitally-enabled service platforms (Lusch & Nambisan, 2015) – all of which denote different interpretations and variations on the platform theme. The term *digital platform* in this dissertation will draw inspiration from Yoo et al. (2010) and their notion of the layered modular architecture, a composite structure consisting of both physical and digital materials[5] where all layers are necessary, but no layer is dependent upon one particular component. In other words, any device may accommodate several different types of digitised content just as any piece of content can be accommodated by any number of digital devices.

[5] "Physical materials" denote computer hardware and other tangible components whereas "digital materials" comprise computer software and other forms of digitised data.

1.2. Research Object and Approach

There are numerous ways in which stakeholders that make up an ecosystem may influence the focal platform and vice versa. Research into platform leadership (Gawer & Cusumano, 2002; 2008), platform-complementor relationships (Bergvall-Kåreborn & Howcroft, 2014; Ceccagnoli et al., 2012), platform governance (Baldwin & Woodard, 2009; Eisenmann et al., 2009), market entry (Eisenmann et al., 2011; Ghazawneh & Henfridsson , 2013), and platform strategy (Hagiu, 2014; Suarez & Cusumano, 2009) has identified a rich set of considerations, including power, market influence, provider resources, openness, value appropriation, network effects, pricing structures and protection of intellectual property. If one were to forego explicit attention to platforms and include inter-organisational dynamics (e.g. Mitchell et al., 1997; Santos & Eisenhardt, 2005), the range of concerns would also include legal authority, skill sets, identity and urgency.

As every last one of these factors is imbued with its own vast body of knowledge – each of which could form the basis of a doctoral thesis in their own right – a more pragmatic way to conceptualise platform influences is needed. In one of the constituent papers of this thesis, I argued that stakeholder influence on a platform could be expressed in terms of *value propositions* (see paper 4). This line of argumentation rested on one of the foundational principles in service-dominant logic (Lusch & Vargo, 2014), namely that value is not unilaterally created by supply-side actors (i.e. producers, providers et cetera). Rather, value is created when goods or products are put to productive, value-adding use. Hence, the value of any offering – platform or otherwise – is relative to the intentions and goals of different recipients. The need to address value as a subjective, *relational* property where interests differ between stakeholders is highlighted in platform literature (Ghazawneh & Henfridsson, 2013; Tiwana, 2014, p. 61-69) as well as the recent uptake of service-dominant logic in information systems literature (Barrett et al., 2015; Lusch & Nambisan, 2015).

Motivated by the need to apply a relational view to the study of digital platforms, this thesis utilises *affordance theory* (e.g. Markus & Silver, 2008; Robey et al., 2013) as a framework through which to aggregate, integrate, and discuss my previous forays into platform research. There are several reasons why I consider it useful to apply affordance theory as a theoretical lens.

First, the basic precepts of affordance theory have proven highly flexible and able to survive adaptations between disparate fields such as ecological psychology (Gibson, 1979), design theory (Norman, 1988) and sociology

(Hutchby, 2001b). The emerging body of work related to organisational benefits (Zammuto et al., 2007), organisational routines (Leonardi, 2011), and personal use of information technology (Jung & Lyytinen, 2014) hints at the applicability and, indeed, relevance for information systems research. Hence, affordance theory offers us an opportunity to stay within the nomological net (Benbasat & Zmud, 2003) of our field rather than drift too far into the economic and architectural theories that underpin much of platform research (Gawer, 2014; Thomas et al., 2015).

Second, digital artefacts, with their blend of physical and digital materiality, offer possibilities for action that simply do not exist for platforms based on decomposition of complex physical structures and are black-boxed in studies on platforms as multi-sided markets. The peculiar properties of digital technology was discussed by Yoo et al. (2012) who argued that its material properties provide unique affordances: "… because of its reprogrammable nature, pervasive digital technology exhibits a procrastinated binding of form and function […], meaning that new capabilities can be added after a product or a tool has been designed and produced" (p. 1399). The combination of physical and digital materiality permits a physically non-modular product such as a smartphone to be digitally modular and hence act as a platform for products and services. On the other hand, the user is also free to ignore the more advanced features and merely use it as a telephone. This marks a significant departure from traditional views on modularity (e.g. Schilling, 2000; Ulrich, 1995) where functional and architectural demarcations went hand-in-hand. Hence, any discourse on digital platforms necessitates a decoupling between what something *is* and what it *does*. In other words, the procrastinated binding of digital technology means that the ability to act as a platform may be construed as an affordance of an artefact rather than a predetermined role or purpose.

Third, and in relation to the previous point, the properties of objects and utility of objects are distinct entities. The former may be objectively ascertained (e.g. in quantifiable numbers or facts) whereas the latter is related to ability and context. This relational aspect has been at the core of affordance theory since the work of Gibson (1979) where he expressed the varying role different objects might take depending on one's ability and need. For instance, a tree affords climbing for a monkey, nest-building for a bird, or a hiding place for an insect. Subsequent work (e.g. by Norman, 1988 and Hutchby, 2001b) has outlined how affordances relate to humans, our use of tools, and how tools relate to different tasks. Hence, affordance theory explicitly addresses the abilities of an actor, the properties of the artefact, the goal which the actor seeks to achieve, and the context in which this all takes

place. As such, we can further explore the notion of value in relation to an actor as well as a goal or purpose.

1.3. Contributions

My intention with this cover-paper is to reinterpret the manuscripts that I have produced over the past years where I have looked at platform emergence and application using several different perspectives and frameworks. In my view, applying an affordance perspective to digital platform establishment and development can make at least two significant contributions.

First, the thesis contributes to our understanding of stability in relation to digital platforms. The common view in platform literature is that stability is derived from the combination or low-variety elements and high-variety elements. Applying this view to digital technology is problematic as given the rate with which "old" components grow obsolete. Rather than attribute stability solely to technical achitecture, we shold adopt a wider perspective that also considers application as well as varying trends and goals. We therefore need to stability in terms of technical, informational, and social expectations.

Second, the notion of platform "coring" as a strategy for creating a new platform is pervasive in platform literature. In this perspective, the platform provider identifies a technology/service/product that satisifies a common problem in the market, and develops (technical) interfaces that facilitate applicability and third-party complements. This thesis suggests that our existing understanding of a coring strategy for digital platforms should be complemented with two additional dimensions: information coring and social coring. The former refers to the ability to present information to a user in a suitable (understandable) manner, and the latter expresses that technical infrastructures should be complemented with commensurate organisational structures where needed.

Furthermore, while affordance theory is ostensibly gaining momentum as a theoretical lens for studying intra-organisational usage of information technology and information systems, it has yet to make any significant impression on platform research. Hence, the application of a relational perspective (in the form of affordance theory) to digital platforms and an inter-organisational context may be considered a contribution in its own right.

1.4. Thesis Outline and Structure

This dissertation consists of this cover paper and four appended research papers. Following this introductory chapter which outlines background, the research question and the research approach, chapter 2 describes and summarises platform literature before describing the peculiarities of digital platforms. Chapter 3 provides a review of affordance theory and describes the core concepts of technical object, functional affordances and symbolic expressions. The chapter concludes with an outline of assumptions regarding affordance theory in relation to digital platforms. Chapter 4 presents the research design of this thesis, including theoretical assumptions, research methodology and empirical context. Chapter 5 provides summaries of the appended research papers that form the basis for this thesis. This section also discusses the findings of each section in relation to the framework presented in this cover paper. Chapter 6 discusses the outcome of applying an affordance perspective to the study of digital platforms as well as overall implications, limitations and suggestions for future research. Chapter 7 presents the conclusions of this research.

2. Digital Platforms

Usage of the term *platform* to describe a pattern or design is by no means a novelty. The term has been widely applied in industrial manufacturing for several decades (Wheelright & Clark, 1992) and there are records of use of the term with this connotation going back to the 16th century (Baldwin & Woodard, 2009). In recent years, the platform concept has proliferated, gaining "...wide usage in management literature as a term meaning foundation of components around which an organization [sic] might create a related but differentiated set of products or services" (Cusumano, 2012, p. 36). However, a wider range of adoption has also brought about a term that is imbued with different meanings. Gillespie (2010) identified 15 different uses of the term "platform" distributed over four categories: computational, architectural, figurative and political. While the specifics differ greatly depending on the application and context, they share certain abstract properties, most notably facilitating an activity whilst remaining essentially neutral regarding the identity or objectives of its stakeholders.

Much of the integration of the domain-specific concepts into more general abstractions and what we may consider "mainstream" platform research is based on the work of Gawer (2009; 2014), as well as Gawer and Cusumano (2002; 2008; 2014). Their body of work has been highly influential in promoting a theoretical understanding of the nature, causes and application of platforms. This includes concepts of platform types, central components, stakeholder involvement and archetypal strategies. These generic concepts serve to influence subsequent research into digital platforms, and have been incorporated into conceptual research (Tiwana et al., 2010) as well as empirical work related to the relationship between platform owner and third-party complementors in mobile platforms (Bergvall-Kåreborn & Howcroft, 2014; Ghazawneh & Henfridsson, 2013), how platform components can merge over time (Eisenmann et al., 2011), and strategies for e-commerce platforms (Lin & Daim, 2009). Moreover, Thomas et al. (2015) noted that much of the current theorising in platform research is based on IT-oriented platforms, and Tiwana (2014) frequently used various types of digital platforms to illustrate the mechanics and governance of platform ecosystems. Hence, the aim of sections 2.1 – 2.4 is to introduce the core concepts of platform research and, where appropriate, exemplify their application in studies of – or pertaining to – digital platforms.

Following that, we then move on to focus more specifically on digital platforms by outlining the properties of digital technology and the

limitations of applying extant platform research in this context. These latter sections draw significant inspiration from the architectural view on digital technology described by Yoo et al. (2010).

2.1. Platform Typology

In addition to their perception as either architecture or marketplace, platforms may also vary significantly in their sphere of influence, affecting their potential for value creation as well as their scope of stakeholder involvement. Gawer (2009; 2014) offered a basic classification of three types of platforms based on the scope of stakeholder involvement: internal platforms, supply-chain platforms, and industry platforms.[6] Although this section will provide a brief introduction to all three types, subsequent sections (as well as the thesis as a whole) will primarily relate to industry platforms.

Internal platforms describe structures that are used by a specific firm to organise their internal processes or resources. Industrial applications largely conform to this type as they use platforms as a means to enhance efficiency through a modular approach to manufacturing, that is, the various parts of a product may be constructed separately, in different locations, and in different quantities. In doing so, the manufacturer is able to build large quantities of standardised *parts* that could be combined to form variations of the finished *product*. An illustrative example may be provided by the automotive industry and the Model T Ford. Although Henry Ford's use of an assembly line revolutionised the manufacturing industry and drove down production costs to the point where cars were affordable to the general consumer, it only permitted a single output: a black Model T Ford. The adoption of (internal) platforms in the automotive industry meant that retailers could offer a (limited) selection of different models, colours, accessories et cetera – while still retaining the economies of scale derived from highly specialised assembly lines. Moreover, the ability to use standardised components also enables savings as the manufacturer is able to reuse these components across multiple product lines, reducing the costs associated with constructing and warehousing different parts for each product (or model).

[6] Gawer (2009) distinguished between industry platforms and *multi-sided markets*, describing the latter as encompassing distinctly non-technical phenomena such as social venues. The distinction is, however, down-played in subsequent literature (Gawer, 2014; Gawer & Cusumano, 2014), instead focusing the discourse on how certain aspects of multi-sided markets, such as same-side and cross-side network effects, are germane for industry platforms.

Supply-chain platforms expand the scope of internal resources by including multiple actors that occupy the same value chain. In purely mechanical terms, supply-chain platforms do not differ substantially from internal platforms. The ultimate aim is the same: to find an agreeable trade-off between production efficiency and output variety. Instead, the main difference may be expressed in terms of the increased number of stakeholders. That is, the platform is no longer established and used by a single firm, but by multiple firms in a value chain or a similar form of persistent relationship. Again, the automotive industry provides plenty of examples as it is common for different manufacturers to share an owner – or for multiple owners to form alliances – and use similar components across multiple brands. The inclusion of more stakeholders does entail the potential for a political dimension to platform governance as different parties may have different interests and priorities. However, the risk of open conflict is limited due to the strong bargaining position by the last link in the value chain. While both internal and supply-chain platforms are mostly theorised in relation to the manufacturing industry (e.g. Brusoni, 2005; Meyer & Utterback, 1993; Sako, 2009; Ulrich, 1995), they may also be exemplified using IBM's System 360 computer platform from the 1960's and 1970's. Initially conceived as a strictly internal platform to facilitate efficient production within IBM, the use of standardised interfaces enabled external suppliers to provide their own components for IBM computers (Gawer, 2009).

Industry platforms broaden the scope even further by inviting actors that are willing to abide by rules and regulations specified by either a single provider or a consortium of sponsors. While those who use the platform may have strong ties similar to those found in value chains, it is more likely that stakeholders are only loosely affiliated and interact through short-term contracts or not at all. This arrangement marks (at least) two significant shifts in the purpose of the platform. First, it emphasises the role of the platform as a foundation on which to conduct business-related activity (rather than "merely" enabling modular manufacturing). As such, the overall purpose of industry platforms is more closely related to harnessing external resources than enabling efficient production (Adner & Kapoor, 2010). Second, as the platform ties together multiple, loosely-connected actors that build upon the platform, the ultimate aim is not to attain a particular (fixed) outcome. Hence, industry platforms are not only open for participation, but also take the leap from planned development to emergent innovation (Tiwana, 2014) as each firm has its own goals and interests that are reflected in the manner in which they leverage the platform to suit their needs (van de Ven, 2005). The ability to provide sufficient leeway to enable innovation and growth yet not enough to lose control, highlights the challenge of platform

governance and the precarious position of the *providers* of industry platforms. While both internal and value-chain platforms may be illustrated using the manufacturing industry (e.g. automobiles), industry platforms are more prevalent in the digital industries where the rate of change forces specialisation of the constituent components in hardware platforms (Wareham et al., 2014), and low costs provide few barriers to entry for complementors in software platforms (Tiwana et al., 2010).

Based on an extensive literature review, Thomas et al. (2015) summarised the value derived from platforms in terms of three leverage logics that can be applied to internal as well as external structures. *Production logic* describes the ability of platforms to incorporate both economies of scale and economies of scope into the development and construction of differentiated products and services. This leverage logic corresponds to the aforementioned examples from the automotive industry where manufacturers benefit from the platform by retaining the advantages of large-scale production and adding the ability to provide product variety. *Innovation logic* is somewhat similar to production logic, but focuses on intangible resources and the role of a platform as a hub for gathering the skills and intellectual capital needed to develop new products. By utilising the platform, innovators are able to lower their barriers to market entry and commercialise their ideas at a faster pace. *Transaction logic* is based on the notion that actors i.e. buyer and seller, are willing to interact, but are unable to do so. As a shared structure that is situated between two stakeholder groups, the platform provides value for both parties by providing a suitable hub for interaction and coordination which reduces search and transaction costs. This logic is widely adopted in business literature (e.g. Caillaud & Jullien, 2003; Eisenmann et al., 2006; Rochet & Tirole, 2002) that describes studies of platforms in relation to network effects and multi-sided markets. While platforms can only apply one leverage logic at any given time, they can alter their focus e.g. by facilitating transaction rather than innovation.

According to Thomas et al. (2015), industry platforms provide an exception to the single-logic rule as they are able to incorporate multiple leverage logics at the same time due to their ability to spawn ecosystems of diverse, loosely-coupled actors. These *platform ecosystems* may be considered a subset of the wider notion of business ecosystems (Moore, 1993; 1996) with the distinguishing characteristic of being centred on a focal industry platform (Gawer & Cusumano, 2008), alternatively referred to as a *keystone* (Iansiti & Levien, 2004). Due to their inherent potential to focus diverse resources, industry platforms have garnered much interest from scholars as well as practitioners even though their establishment is generally associated with high costs and complexity (Hagiu, 2014). Gawer and Cusumano's (2002)

study of Intel and Cisco demonstrated how a prominent position in a platform ecosystem (or simply *platform leadership*) can enable a firm to foster not just innovation and productivity, but also have a significant impact on the trajectory of an entire industry. While platform leadership implies a rather direct causality between platform owner influence and collective ecosystem action, recent research has employed the term network (or ecosystem) *orchestration* to stress the difficulties in applying a direct command-and-control approach to ecosystem governance (Nambisan & Sawhney, 2011; Tiwana, 2014). The platform owner should encourage innovation, either through incentives (e.g. tools or decision rights) or by leading through example and hopefully create "wakes of innovation" (Boland et al., 2007) where one (major) innovation leads to subsequent (lesser) innovations in the same area.

2.2. Platform Components

If one were to present a generic perspective of platform architecture, it would simply entail two aspects: a stable *core*, replaceable *complements* or *modules*, and the rules that determine permissible forms of interrelation (Baldwin & Woodard, 2009; Gawer, 2009). In simple terms, a core describes a "low-variety element" that is persistent across multiple (or all) applications. These low-variety elements are then combined with "high-variety elements" in order to create variety or innovation as the end result. The ultimate aim of this arrangement is to provide a flexible structure that can be leveraged for efficiency within a single organisation, or used to add complements from external parties (see chapter 2.1). Extant research identifies three major streams of platform literature depending on the research context: product development, technical systems, and market transactions (Baldwin & Woodard, 2009). The combination of a stable core and replaceable modules brings distinct advantages in each situation: economies of scale and scope in product development and manufacturing (Simpson, 2004; Ulrich, 1995), the rise of specialist manufacturers in high-tech industries (Gawer & Cusumano, 2002; Gawer & Henderson, 2007), or marketplaces that helps capital and labour (Evans, 2009) or retailer and customer (Eisenmann et al., 2006) connect. As platforms hardly describe a uniform set of phenomena, it follows that the nature of the core follows suit – it may be quite an elaborate physical structure as is the case in the automotive industry (Nobeoka & Cusumano, 1997), or merely a set of standards which is the case in the IT industry where the pace of change is exceedingly high and all components become obsolete within months (Wareham et al., 2014). Hence, the extent to which the concept of a core can be applied is heavily bounded by the context in which the platform is applied.

If one traces the idea back to its industrial roots, platforms are largely based on the concept of modularity (Schilling, 2000) and the ability to derive flexible product architectures that permit the substitution of one part while retaining the remaining parts of the overall product or system. Modular architectures are enacted by 1) preserving tight couplings between components and their respective function(s), and 2) preserving loose couplings between the components that form the overall architecture. In other words, there is a tight coupling between component A and function 1 as well as component B and function 2, but there is a loose coupling between components A and B, permitting component B to be replaced with component C which in turn is tightly coupled with function 3 and so on. Hence, modular architectures may be decomposed into components (or subsystems) where each component corresponds to a functional role (Simon, 1996). In that sense, a modular architecture provides an antithesis for *integral* architectures where there is no similarly decomposable structure, and there is no clear correlation between component and function (Sanchez & Mahoney, 1996). In other words, component A may enable functions 1 and 2 whereas function 3 is shared between components B and C. Henderson and Clark (1990) outlined how a modular perspective can be applied to innovation in product development by focusing on either improvements of a single component in isolation, or recombination of the linkages between existing components. They refer to the former as modular innovation and the latter as architectural innovation – both of which may be illustrated using modern computers. As components are connected using standardised interfaces, we may replace individual parts with improved or differentiated variants (modular innovation) without scrapping the rest of the hardware or software. Alternatively, we may recombine existing parts in order to give the PC a new appearance or different area of application (architectural innovation).[7]

Since early efforts to theorise platforms explicitly referred to "product platforms" (Wheelwright & Clark, 1992) as a means to leverage modular platforms for product design and manufacturing, the distinction between product and platform may be somewhat muddled. Indeed, the difference may be even less discernible today when interconnected physical products can act as digital platforms for services (Porter & Heppelmann, 2014). In the interest of distinguishing between the two concepts, a *product* is a market offering that is the outcome of design and production whereas a *platform* is a structure that facilitates or enables the development of new products or other offerings. Whereas a product is expected to go through a life-cycle and

[7] For instance, the individual components of a computer will need to be combined differently if used in a desktop PC, or as part of a larger system such as an automobile or an Automated Teller Machine.

then be replaced with a newer model (Hsueh, 2011; Kim, 2003), a platform cannot simply be replaced as that could effectively undermine the ability to develop future products (or other offerings). Drawing on data from Intel (a manufacturer of microprocessors and similar semiconductor-based components), Gawer and Henderson (2007) suggested that a piece of technology may be categorised as a platform (rather than a product) when it is part of an *evolving* technical system, when there is strong functional interdependence between the majority of other components in the (overall) system, and when customer demand is skewed towards the system as a whole (i.e. components arranged into a product) rather than the individual components. In other words, a platform – internal or external – must offer a high degree of continuity whereas the derivative products may be replaced quite frequently.

2.3. Platform Stakeholders

As structures that permit (or even solicit) external complements have been theorised as platform, they have also become increasingly intertwined with the dynamics found in double-sided (or multi-sided) markets. That is, the success and viability of an (industry) platform is not solely determined by virtue of rational design or engineering prowess, but also economic factors such as market dynamics or network effects (Gawer, 2014). Network effects may arise among actors that access a technology on the same terms or that derive the same benefits. These are typically referred to as same-side network effects (Katz & Shapiro, 1985) where the value (real or perceived) of the technology increases as more actors join the network. Common examples of same-side network effects include any technology used to connect multiple actors e.g. social media (Cusumano, 2011; Tiwana, 2014), as there is little or no value in being the sole adopter. As value increases with the number of users, same-side network effects may also be a potent driver of adopting a technology (or one technology over another).

Another variant of the same phenomenon is cross-sided (or double-sided) network effects (Eisenmann et al., 2006; Rochet & Tirole, 2003) where actors access a technology on different terms or with different interests.[8] A basic (and often used) example of cross-sided network effects is the use of credit cards (Rochet & Tirole, 2002). In order for credit cards to provide value or benefit, you need actors on both sides of a transaction to agree that a piece of plastic is a viable – or even preferable – means of payment. Furthermore, cross-sided networks do not arise if you simply add more users

[8] Alternatively, same-side network effects may be referred to as *direct* network effects, and cross-sided network effects may be called *indirect* network effects (Gawer & Cusumano, 2014, p. 422).

to one side of the network i.e. credit cards will not become more useful if every customer has one, but no retailer accepts them. Rather, cross-sided network effects only materialise if there is a balanced number of actors on either side.[9] It is primarily the latter type of network effect that has been embraced in platform research as a means to conceptualise the benefits that may be attained from platforms that "serve two distinct and mutually attracting groups of users" (Eisenmann et al., 2011, p. 1273).

Whereas the development of double-sided markets has chiefly been described in economic literature (e.g. Armstrong, 2006; Evans, 2003) where the medium for transaction is "black-boxed" or taken for granted, platforms (whether internal or external) express "'manageable objects' that organizations [sic] purposefully manage to bring multiple parties within the industry together – primarily users and complementors" (Gawer & Cusumano, 2014, p. 420). This carries with it two corollaries. First, the change from *customers and retailers* to *users and complementors* is not merely a matter of applying different synonyms, but rather reflects the dependency on the platform. Complementors provide additions (complements, modules) to the platform rather than market offerings that can function in isolation. The user's access to said additions is dependent upon his or her access to the platform. Second, explicit consideration of the platform also necessitates attention to the actions and motivations of a third actor – that of the platform owner. Hence, we may identify *three* broad types of stakeholders related to platforms: owner, complementor, and user.[10]

The role of platform *owner* may be filled by a single firm that has managed to position its platform – and by extension, itself – as a major hub in an industry and the focal point of an ecosystem of complementors and users. The concept of platform ownership is often equated with the notion of platform *leadership* (e.g. Gawer & Cusumano, 2002). Platform leadership expresses the co-location of platform ownership with considerable firm resources or a strong market presence. The attainment of this privileged position is by no means simple or straightforward, but the rewards are substantial. IT-oriented firms such as Apple, Facebook, Google, and Microsoft all represent platform leaders that have managed to position their offerings as platforms and been able to extract vast profits from their ability to both enable innovation in the surrounding ecosystem of actors, and

9 The term "balance" does not necessarily denote equal numbers, but rather a suitable proportion of different actors e.g. consumer and vendor. See Evans (2009) for an extended discourse on this topic.

10 Specific types of platforms may well have additional stakeholders. For instance, mobile ecosystems are affected by the activities of the operators that provide the network infrastructure needed to use both platform and complements (e.g. Eisenmann et al., 2009). However, the three stakeholder types outlined here are generic and applicable across a wider range of contexts.

leverage this wealth of external resources for their own benefit (Hagiu, 2014). However, platform ownership may also be manifested under less spectacular circumstances. Iansiti and Levien (2004) distinguished between market dominators and keystone firms, where the former captures market influence and the latter ownership of a platform (or technology with strong platform potential).[11] Keystone firms have become quite common in IT-oriented industries where relatively small firms can develop turnkey solutions that can attract the interest of larger firms (i.e. dominators) in solving specific problems or filling peripheral functions e.g. web hosting. In addition to distinguishing between strategic roles and market influence, the ownership of a platform may reside with a single firm, a joint venture, or a consortium. Shared platforms may be illustrated using the Symbian mobile platform (West & Wood, 2013) which was (initially) co-created and co-managed by several handset manufacturers such as Ericsson and Nokia, or the Digital Versatile Disc (DVD) format for home entertainment (Eisenmann et al., 2009). Both instances demonstrate how shared platforms can capture shared interests among multiple parties – including firms that are in direct competition with one another. It is however difficult to affect change and develop the platform core (see chapter 2.4) in a shared platform, which is reflected in the demise of Symbian and status quo of the DVD format.

By basing its offerings on the technical architecture and market access provided by the platform, a *complementor* gains two distinct advantages. First, the complementor does not have to develop a "complete" offering *de novo*, but is able to leverage the (often considerable) technical architecture provided by the platform to develop new innovations or different areas of application (Gawer & Cusumano, 2014). Second, providing complements to an established platform may serve to significantly lower the barriers to entry for start-ups, innovators, niche players or, indeed, smaller firms in general (Iansiti & Levien, 2004; Tiwana, 2014). While the platform provides a foundation on which the complementor is able to build their business, participation in an (industry) platform ecosystem is usually contingent upon compliance with certain rules and restrictions (Ghazawneh & Henfridsson, 2013). Hence, the platform also acts as a regulatory device that determines which actions are permissible – and which are not. Placing limitations may be considered a form of control exerted by the platform owner – often with the explicit purpose of ensuring the quality of the complements. Noticeable examples from the digital industries include both Nintendo in the 1980s and Apple in the 2000s, who placed severe restrictions on third-party complementors that were intended to root out inferior (or inappropriate)

[11] The distinction between keystone firms and platform leaders may also be as simple as a matter of time. Indeed, Iansiti and Levien (2004) illustrated keystone firms using the early years of Microsoft's role as a software supplier to IBM.

complements that would reflect poorly on the platform as a whole (Boudreau & Hagiu, 2009). The consequences of rules and regulations imposed by platform owners can however be overly limiting, with complementors feeling limited by pervasive power asymmetries. Regulations may, at times, serve to shift much of the risk and development cost to complementors while platform owners reap a consistently healthy profit margin (Bergvall-Kåreborn & Howcroft, 2014; Tiwana; 2014).

While platforms offer significantly lower barriers to entry, in a sense they can erect barriers for *users* (alternatively *end users*). As platforms are chiefly conceived as architectures for product development, foundation for innovation, or hubs for business transactions (Thomas et al., 2015), it follows that the platform itself offers limited appeal to end users. Instead, the platform serves as an enabler of flexibility and future strategic investments. This perspective on platforms may be expressed using options theory (Tiwana, 2014; also paper 1), which describes how investments are not merely related to tangible returns (i.e. financial returns), but also a portfolio of options for subsequent investments and future activities (Adner & Levinthal, 2004; Sambamurthy et al., 2003). While platforms enable access to a plethora of complements, the perceived value is ultimately dependent upon the complements rather than the platform itself. Taudes et al. (2000) described the value of platforms as *vicarious*, meaning that it is not the adoption of the *platform* that provides value, but the subsequent opportunity to access an assortment of appealing complements from a variety of developers. Hence, both current and prospective platform owners are highly motivated to attract appealing complements by any means they can.

2.4. Platform Strategies

As platforms have developed from a means to facilitate efficient production and component reuse to structures that enable inter-organisational exchange and innovation, they have also come to be highly desirable pieces of market real estate. The role of platform owner can be quite lucrative as the provider typically extracts some manner of rent for its use e.g. a percentage of the purchase price as is the case in Apple's AppStore. Hence, there is no shortage of actors seeking to set themselves up as platform providers and become a major hub for business and innovation. Extant research (Gawer, 2009; Gawer & Cusumano, 2008) has identified two main strategies for advancing your own interest over that of the competition: coring and tipping.

A *coring* strategy is applied in situations where there is no dominant or influential platform in an industry or market. The ability to establish a piece

of technology as a *de novo* platform is contingent on two crucial factors. First, the technology is able to solve an essential systemic problem, i.e. a problem that is not specific to one or a handful of instances, but prevalent throughout a wider context. Second, the resolution of the systemic problem in question is considered a business priority by a significant number of actors. If a technology meets both these criteria, the provider can use this as a core element of a would-be platform. A similar line of reasoning is used by the notion of a keystone that provides a simple "turnkey" solution to a common problem as outlined by Iansiti and Levien (2004). While simplicity of use would be sufficient for a conventional, product-based perspective, a distinguishing feature of a platform strategy is to enable connectivity to different forms of complements that either provide additional functionality, or permit application in different situations.[12] By inviting external actors to devise complements to your core technology, the would-be platform provider hopes to tap into a significantly wider pool of resources (financial and intellectual) than one can accommodate when working in isolation. The latter holds particular attraction as expansion into additional markets or industries can vastly expand the footprint of a platform in terms of profit as well as innovation. While the ability to accommodate complements is an essential property for platforms, openness also carries certain risks. Both Gawer and Henderson (2007) and Wareham et al. (2014) illustrated this issue using, as an example, IBM's System 360 platform for computers devised in the 1960s. Originally intended as a scheme to provide standardised interfaces between components (comparable to an internal platform, see chapter 2.1), this new modular approach to computer systems permitted third-party developers to develop their own System 360-compatible hardware. Over the next couple of decades, IBM gradually lost control of their own platform (now referred to as "PC") to complementors specialised in a given niche, such as Intel who manufactures microprocessors. Based on the lessons learned from the power struggle between IBM and third-party complementors, Gawer (2009) advocated strict control of one's intellectual property in order to exclude unwanted complements. Ghazawneh and Henfridsson (2013) have provided an empirical example of how a digital platform provider may, over time, alternate between different strategic patterns when actively soliciting external interest whilst simultaneously taking steps to ensure control of the platform core. Their study of the iPhone demonstrated how the platform provider (Apple) alternated between actions intended to secure the platform from complements that could jeopardise stability, and actions intended to provide resources that would stimulate innovation and support third-party

[12] Francis and Bessant (2005) have provided additional detail under the guise of "position innovation" where a technology is applied in a different industry or situation with little or no alteration.

developers. In other words, while a platform provider must support complementors with the use of toolkits and Application Programming Interfaces (APIs) (von Hippel & Katz, 2002), they must also be prepared to act in their own self-interest in order to preserve control.

A *tipping* strategy is applicable in situations where there are already established platforms in a market – or where multiple platforms are competing for dominance. In contrast to the aforementioned coring strategy, which is largely related to positioning a technology as a preferable alternative to the current status quo, tipping is aimed at outperforming the competition e.g. through aggressive pricing, coalition building, or providing exclusive complements that are not available from competing platforms. Strategic moves, in keeping with a tipping strategy, are pervasive in the video game industry (Thomes, 2015) where a few major players, Nintendo, Sony, and Microsoft, have been competing with one another for almost 15 years. All three rely heavily on offering exclusive access to certain games through their respective platforms, either by in-house development, wholly-owned subsidiaries, or contracts formed with independent third-party developers. The use of exclusive content as a strategic lever is intended to encourage consumers to pick one platform over another or submit to "multi-homing" (i.e. adopting multiple platforms). As this illustrative example suggests, tipping strategies can escalate into outright platform wars that are costly for providers who need to buy or develop exclusive complements, and detrimental for consumers who may need to adopt multiple platforms, partially undermining the potential for platforms to promote cohesion, decrease complexity, and mitigate risk in a market (Gawer, 2014; Tiwana et al., 2010).

In addition to facing down the competition in a given market, a variant of the tipping strategy can also assume the form of complement absorption (Gawer, 2009) or platform envelopment (Eisenmann et al., 2011). Both expressions essentially capture the same phenomenon – leveraging extant resources in order to enter into a new market. Platform envelopment/complement absorption is commonplace in the software industry where a wide variety of features that are now included in operating systems like Microsoft Windows, e.g. web browsers, were once third-party complements that supplied additional functionality to the platform (Windrum, 2004). As a phenomenon, platform envelopment provides something of an inversion of the aforementioned example of IBM's System 360. In that case, IBM (platform provider) lost control of their platform to specialised complementors (e.g. Intel) who offered better components than IBM themselves could provide. Conversely, platform envelopment describes instances where powerful platform owners displace third-party complements

by providing (free) substitutes that are often technically inferior, but "good enough" for the average user.

2.5. The Character of Digital Platforms

While product development, technical systems and industrial economics have supplied the theoretical foundations for platform research and theory (Baldwin & Woodard, 2009), recent years have seen this body of knowledge increasingly applied to different IT-based platforms (Thomas et al., 2015). Examples include computer operating systems (Eisenmann et al., 2011), e-commerce (Evans, 2009), smartphone operating systems (West & Wood, 2013), computer components (Wareham et al., 2014), video games (Eisenmann et al., 2006) and last, but not least, "app" stores (Bergvall-Kåreborn & Howcroft, 2014; Ghazawneh & Henfridsson, 2013). Lusch and Nambisan (2015) argued that IT possesses two properties that makes it particularly apt for a platform perspective. First, digital technologies enable resource liquefaction – the ability to extract information resources from their point of origin. Although digitised data is not without limitations (Blanchette, 2011), the separation of content (what is said) and medium (carrier of message) permits information and instructions to be promptly conveyed across vast distances. Second, separation of content and medium also permits us to enhance the density of information as well as knowledge resources that are brought together for various value-adding activities. The very same scrap of information can be used to provide immediate feedback e.g. from a handheld device whilst also being recorded in a database for long-term analysis. Hence, IT permits digitally enabled services that not only link the point of origin (i.e. a service consumer) with new resources, but also allows the service providers to combine their resources to co-create a solution.

2.5.1. The Materiality of Digital Platforms

In broad terms, digital technology encompasses two material layers: physical hardware and digital (or digitised) data which provide the opportunity to separate the form, function, and matter of an object (Kallinikos, 2012). The manner in which the physical and digital materialities interact has been captured in one coherent structure by Yoo et al. (2010) in their layered *modular architecture* (see figure 1). The architectural model is made up of four layers: device, network, service and contents. The device layer encompasses the basic technical architecture that enables the performance of services and essentially acts as a physical interface where digitised data is managed. It is delineated into physical machinery (i.e. computers or similar hardware) and logical capability (i.e. the software instructions or operating

system provided with the hardware). As the hardware is decoupled from its set of instructions, it may be reprogrammed to serve as a tool for a plethora of different tasks. The device may also serve as an interface for other, more specialised, peripherals which will extend its functionality. The visibility of devices and peripherals will vary, from mobile telephones that are consciously employed by users, to sensors, GPS transponders, and other embedded components that do not rely on conscious or direct human interaction. As use contexts and user requirements vary, hardware design needs to reflect the demands placed upon the device in terms of both functionality and cost. While a multi-purpose device such as a smartphone or a desktop computer may require hardware that offers both high performance and high flexibility, there are numerous applications for which cheaper, less capable hardware is sufficient (Woodard et al., 2013). The network layer, which addresses connectivity, may also be delineated into two discrete aspects. Physical transport describes the manner in which the device is able to communicate with the outside world e.g. cable or wireless connectivity, and logical transmission describes the standards used to transmit or exchange data between points in a network. Much like the logical capability aspect of the device layer, the standards encoded into the network layer are digital in nature. The network layer essentially describes the increasingly complex information infrastructure that links different devices and permits exchange of information. Infrastructure – digital or otherwise – tends to be overlooked or taken for granted when functioning properly (Star & Ruhleder, 1996), but is absolutely vital in order to ensure that modes of application such as mobile computing (Cousins & Robey, 2015) and remote diagnostics (Jonsson et al., 2009) can be reliably executed.

While the device and network layers are amalgams of hardware and software, the service and contents layers are entirely comprised of digitised data that are either used as inert material, or act to create or modify other data. The distinction is tantamount to the difference between *operand* resources that are passive and essentially express raw material, and *operant* resources that somehow trigger change or activities (Nambisan, 2013). The service layer concerns the functionality e.g. in the form of a software program, that allow users to manipulate or view information. It is essentially an expression of the functions and logic that are brought to bear on data exchanged with users. Although both services and user data are digitised, it is important to maintain the conceptual separation between the two layers. Services describe the algorithms and processes that are applied to user data, but not the data in itself. We may illustrate the distinction using a website for social media or e-commerce. While the site itself may be considered a service, it is distinct from the content uploaded by each user or retailer. As services, much like websites, are not limited to any specific content, the same

service can be used in multiple instances and locations – a phenomenon sometimes referred to as position innovation (Francis & Bessant, 2005). Finally, the contents layer represents the manner in which the service is presented to a user via an interface (i.e. what the user sees on a screen) as well as the specific nature of the data being exchanged. While digital data is often described as free from restrictions, the freedom is partly illusory as successful transmission of data is subject to a process of negotiation between two or more parties (Hanseth & Lyytinen, 2010). Hence, in addition to the information viewed by the user, this layer may also encompass account identification, copyright information and similar metadata where relevant.

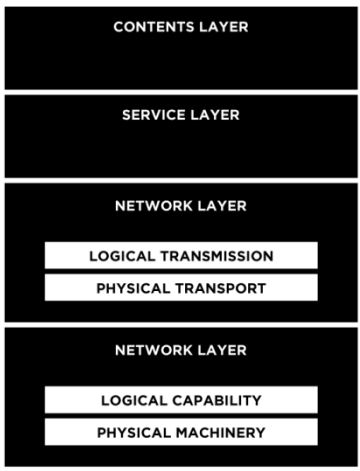

Figure 1. Layered modular architecture (Yoo et al., 2010)

The layered modular architecture captures the ontological foundation for the high level of flexibility found in IT artefacts and provides a useful framework for analysing the transformative and innovative potential unleashed when combining homogenised, infinitely mutable data and the generic, reprogrammable hardware (Yoo et al., 2012; Kallinikos et al., 2013). As purely digital artefacts such as software or digitised video or music are not tangible, they rely on physical hardware for their very existence. Furthermore, while we, as users, can leverage digitised data in a million different ways in our private and professional lives, we need physical devices in order to create, store and access digitised content or services (Blanchette, 2011). Conversely, digitised data gives purpose to the physical hardware, and is more closely related to our goal or intention (Bailey et al., 2012). People do not spend hours and hours gazing at their mobile telephone because they enjoy its design or processing capabilities, but because it permits them to access (digitised) information or interact with people irrespective of physical

location. Indeed, the recent uptake of service-dominant logic in information systems research (Barrett et al., 2015; Lusch & Nambisan, 2015; Nambisan, 2013) further emphasises the role of hardware as an enabler or delivery mechanism for service, a perspective which is based on one of the foundational premises of service dominant logic: "goods are distribution mechanisms for service provision" (Lusch & Vargo, 2014, p. 62).

While the term "materiality"[13] is frequently associated with physical artefacts i.e. tangible objects such as buildings, office furniture, computer hardware, and bodies (Leonardi, 2010), it is not only physical things that have materiality. Intangible objects such as software and databases are material, both in the sense that they materialise or instantiate an activity (e.g. calculation) or thing (e.g. simulation), and also in the sense that they have matter i.e. significance (Blanchette, 2011). Hence, unlike the neat ontological distinction found in the layered modular architecture, physical and digital materiality are closely related in practice – or *mangled*, as some might say (Pickering, 1995). Harnessing the potential of combined digital and physical materiality is an ongoing process of establishing rules, protocols or standards that are sufficiently restrictive to avert chaos, yet permissive enough to permit user customisation. The combination of fixed physical materiality (i.e. hardware) and mutable digital materiality (i.e. software) permits procrastinated binding of form and function (Yoo et al., 2012; Zittrain, 2006), meaning that a digital device can be modified or complemented long after it has left the factory. Hence, physical objects may be mass-produced as physically identical, yet be applied in highly varied markets and situations. Indeed, one may consider the omnipresent smartphone as an example of this phenomenon. They are physically indistinguishable when they leave the factory (except perhaps for colour), yet no two are quite the same after even a short period of use. Their customisation primarily draws upon the addition of digital complements rather than physical additions or modifications. Ideally, one seeks to balance flexibility and standardisation in order to ensure interoperability without quelling the ability for localised customisation (Monteiro & Rolland, 2012). Striking this balance can be slow and arduous, but can have profound implications. Indeed, the Internet itself is the outcome of such a process of finding an agreeable compromise between common rules and individual autonomy (Hanseth & Lyytinen, 2010).

[13] Note that the term "materiality" is here used to denote the distinguishing properties between *physical* information technology hardware and *non-physical* digitised data.

2.5.2. Platform Research and Digital Platforms

Investigation of industry platforms represents a confluence of two streams of research. The first (the engineering perspective) stems from literature on product architectures derived from industrial manufacturing (Simon, 1996; Ulrich, 1995) from which we understand platforms as persistent structures that enable economies of scope. The second (the market perspective) draws on the theory of network effects and multi-sided markets derived from industrial economics (Katz & Shapiro, 1985; Rochet & Tirole, 2003) from which we derive many of our insights into stakeholder involvement and market dynamics. While both streams provide valuable insights, they also tend to assume somewhat static perspectives, in terms of both platform development as well as stakeholder involvement (Gawer, 2014), that need to be revisited in relation to digital platforms.

From an engineering perspective, platforms are assumed to be stable structures with innovation limited to clearly defined and delineated modules (Gawer, 2014). This view is useful for understanding how internal and value-chain platforms enable economies of scope, and also how industry platforms can harness external resources to facilitate innovation. However, it does not help to explain how platforms can be *evolving* technical systems (Gawer & Henderson, 2007) or how platform providers can *continuously innovate* on the platform core (Gawer, 2009) in order to bolster its appeal further. The nature of a platform core is always an outcome of a design decision at some level. With regards to industrial applications, the core is designated by identifying a portion of the architecture that can be kept stable across multiple product varieties, thus reducing the complexity and costs of large-scale production (Wheelwright & Clark, 1992). Theories on modularity may be employed to calculate optimal avenues for decomposing complex structures into persistent and variable components (Schilling, 2000). Digital platforms – built upon a layered-modular architecture (Yoo et al., 2010) – do not lend themselves to similar decomposition by virtue of their material makeup. It may appear *prima facie* that physical devices represent natural candidates for a platform core, given their persistence relative to digitised data. However, research on technology ecosystems (Wareham et al., 2014) as well as mobile platform ecosystems (Ghazawneh & Henfridsson, 2013) has indicated that both IT components and the aggregate products either become obsolete or are replaced at an increasing rate. Furthermore, there is significant conceptual research that highlights the necessity to acknowledge at least two layers of analysis – the modularity of physical components and the modularity of digital components (Yoo et al., 2010; Tilson et al., 2010). In theory, the prospect of leveraging not one but *two* interweaving architectures for platform development carries with it tremendous potential.

However, there is an emerging body of work that highlights difficulties in reconciling different kinds of architecture into one coherent structure as they tend to evolve at different speeds (Henfridsson et al., 2014; Svahn, 2012). Hence, the issue of continuously *developing* a technical system whilst preserving a sense of *stability* remains a central concern for digital platforms.

From a market perspective, stakeholder involvement is usually conceptualised as a consumer-based relationship where transactions are conducted at arm's length through well-established boundaries or interfaces. This view is useful for understanding how the dynamics of two-sided markets can make or break a platform (Evans, 2009). It also provides insight into the mechanisms needed to govern large ecosystems (Baldwin & Woodard, 2009; Ghazawneh & Henfridsson, 2013). However, the relationship between platform and (external) stakeholders is assumed to be unproblematic in that both complementors and users take the platform's existence (and capabilities) for granted (Gawer, 2014). The issue of user perception of platforms has been addressed in relation to generativity (e.g. Tilson et al., 2013) as well as service-dominant logic (Lusch & Nambisan, 2015) in information systems research. Tilson et al. (2013) argued that generative potential is largely rooted in the user's perspective, and the degree to which he or she associates the technology (or platform) with qualities such as utility, adaptability, ease of use, accessibility and transferability of complements. In their argument for the potential of IT to enable platforms for service, Lusch & Nambisan (2015) argued that a holistic view of the user and his/her context is required, claiming that "…value occurs when the offering is useful to the customer or beneficiary (value-in-use), and this is always in a particular context" (p. 159). Their reasoning is based in service-dominant logic, in which the locus of value creation is always the customer and his/hers/its application of goods or products (rather than imbued in the goods or products themselves). Following this line of reasoning to its conclusion, one may argue that the definition of a "platform" is inherently capricious and entirely based on analytical framing. Indeed, if one considers the layered modular architecture outlined by Yoo et al. (2010), we find that existing research identifies the existence of a structure that is used as a platform to facilitate some manner of activity between actors in each individual layer – software content (Tiwana et al, 2010), service (Evans, 2009), device (Suarez & Cusumano, 2009), and network (Greenstein, 2009).

Moreover, as the advent of digitisation brings more and more digital capabilities to an ever wider range of goods (Lee & Lee, 2015; Porter & Heppelmann, 2014), the distinction between physical product and digital platform is in the eye of the beholder rather than an objective property of an

item. A pertinent illustration has been provided by Svahn et al. (2017) in their study of the (ongoing) digitisation of automobiles. Their research highlighted the variance in perspectives where the car manufacturers see themselves as producers of a premium *product*, whereas the external firms that supply services for the car's "infotainment" system see them as just another *digital platform* through which to distribute content. Hence, any inquiry into digital platforms should proceed from the idea that they are not self-evident "things" *per se*, but rather an outcome of how things are applied or regarded by actual or prospective users. Thus, "platform" is a property *ascribed to an object by one or more stakeholders* rather than an inherent property if the object itself.

3. Affordance Theory

Dissatisfied with the deterministic "technological imperative" developed in the 1950's and 1960's, efforts to theorise the complex relationship between people and technology are by no means a novelty to information systems research (Markus & Robey, 1988). Two of the more influential streams of research to this end are based on actor-network theory (Latour, 2005) and structuration theory (Giddens, 1984). Latour took umbrage with two assumptions: 1) that technologies are often treated as "black boxes", and 2) that their effects are stable over time and similar for different users. He sought to overcome the former by explaining how objects or technologies are formed by alliances of different forces. He refers to the alliances as *actor networks* and the forces as *actors* (which entails both humans and artefacts such as standards or regulations). In Latour's view, technologies are not necessarily formed in a top-down, deliberate process, but rather formed from the relative influence (or active mobilisation) of different forces found in actor networks. With regards to combatting the deterministic view of technology, two of the core concepts in actor-network theory are inscription and translation (Walsham, 1997). *Inscription* describes how different features are built into a technology or object in a manner that may suggest values, priorities, or modes of use. *Translation* describes the social process of enrolling a group of actors into a particular view on how an object or technology is to be viewed and applied. Via the distinction between inscription and translation, actor-network theory emphasises the distinction between the properties of an object, and the appropriation of an object. Latour's (2005) line of reasoning focuses on how technologies *come into being* (Orlikowski & Iacono, 2001), and has been applied to the study of information systems in politicised contexts such as medical information systems (e.g. Braa et al., 2004; Braa et al., 2007), project escalation (Mähring et al., 2004), and development of standards for infrastructure (Hanseth & Monterio, 1997; Monteiro & Hanseth, 1996).

Structuration theory is based in the work of sociologist Anthony Giddens (1984) and has been applied in information system research to address the perceived dichotomy between social organisation and material technology (Orlikowski & Robey, 1991). The seminal *structuration model of technology* developed by Orlikowski (1992) describes how technology has a tendency to become reified in institutions (i.e. institutionalised) and used without proper understanding of its justification or purpose. Orlikowski outlines two premises that permits this phenomenon to occur: the *duality* of technology and the *interpretive* flexibility of technology. The duality of technology

expresses how creation and use of technology are not distinct and separate, but rather two sides of the same coin. Human actors and technology influence one another in that humans *use* technology in order to perform different actions, but technology is also *created by* humans in various creative efforts. Interpretive flexibility captures the disconnect between *creation* and *appropriation* of technology. That is, it is not uncommon for technology to be designed and used by two distinct groups of actors, e.g. vendor and customer. Furthermore, the motives and assumptions that gave rise to the technology are easily lost over time – or not (adequately) communicated to users in the first place. Following Orlikowski, a significant body of work has applied or adapted structuration theory in different ways. DeSanctis and Poole (1994) operationalised the ideas of structure and (user) perspective as "structural features" and "spirit" in their adaptive structuration theory (AST) – a framework for analysing the role of technology in organisational change. Orlikowski and Gash (1994) outlined how user assumptions, expectations, and knowledge can be expressed as "technological frames" that affect their perception and understanding of technology. Boland and Tenkasi (1995) describe how user perspectives can propagate using (electronic) communication systems as a medium. A review by Karsten & Jones (2008) shows that Giddens' writings has been widely applied in information system research (in over 330 instances), but also that structuration theory provides little or no theoretical guidance regarding the nature of IT artefacts. However, it is implied that he "recognizes [sic] that there is some interaction between technology and human action that may be significant for social practice" (Ibid, p. 150).

Recent years have witnessed a renewed interest in the material properties of technical artefacts, and to what extent they enable or constrain our actions (see e.g. D'Adderio, 2008; Jonsson et al., 2009; Lee et al., 2015; Leonardi & Barley, 2008). As outlined by Faraj and Azad (2012), there are at least three good reasons for doing so. First, technology is often specified using *vendor-defined categories* that may direct our attention away from issues relating to their structural makeup or purpose. Certain product categories e.g. Enterprise Resource Planning (ERP) systems, have become so entrenched that they are practically accepted as distinct "things" rather than complex, heterogeneous entities that need to be better understood and theorised (Strong & Volkoff, 2010).

Second, the term "technology" may be simple from a conceptual standpoint, but is difficult to delineate in practice, given that it is essentially a *bundle of separate features*. In some cases, the practice of "black-boxing" these bundles of technology can lead to lack of specificity. For instance, an inability to access or send e-mail may not be related to the technology itself, but

rather the infrastructure needed to transmit data or established regulations (e.g. filters) regarding permissible and non-permissible messages. Furthermore, it is not only the bundles of technology that are diverse, but also the human element. As different stakeholders have varying interests and roles, they are likely to utilise features unevenly, ignoring certain features while relying heavily on others (Malhotra & Majchrzak, 2012).

Third, descriptions of a technology tend to overlook the ways in which it *changes over time*. This particular issue may be considered as a cumulative outcome of the previous two points. If we rely on convenient categories that inadequately describe bundles of technologies, we may well overlook significant qualitative differences that occur as new technologies are leveraged for familiar applications. For instance, word processing has been around for several decades. In an abstract sense, it describes the practice of utilising computers and software to read, produce and modify text. However, the software that I am using to type this document is very different from the tools that were available in the 1980s. It is more flexible, provides more advanced features, permits exporting and importing data from other sources, and has many other attributes that make a modern word processor an entirely different artefact compared to older variants.

In response to the aforementioned issues, the last decade has seen information systems research along with organisation science take an increasing interest in *affordance theory* as a means to address the technology artefact and its effects in different contexts without the restrictions of predefined, static categories. In organisation science, Zammuto et al. (2007) outlined how organisational processes and structures are increasingly enabled and interweaved with information technology. They argued that the interplay between IT and organisation may be expressed using affordance theory to capture how "…new combinations of technology and organizational[sic] features continually create possibilities that affect organizational[sic] form and function" (p. 750). They continued by describing five affordances for organising that are enabled by information technology: visualising work processes, flexible product and service innovation, virtual collaboration, mass collaboration, and simulation. The adoption of an affordance perspective on technology is motivated by previous research (e.g. Boudreau & Robey, 2005) which argued that technology can support actions as well as encourage learning, but also constrict human agency. Hence, affordances for organising are not spontaneously realised by the grace of technology alone, but must be complemented by expertise, organisational processes, management, boundary spanning, and other *social* capacities. Given the difficulty in separating organisational applications from technical architecture, Zammuto

et al. (2007) argued that theoretical development of the affordance concept should ideally utilise language from both information systems research as well as organisation science. Much of the literature on affordances that has been published in IS journals (e.g. MIS Quarterly and Journal of AIS) has retained a predisposition towards addressing issues pertaining to organisational structure or change.

Table 1. Affordances in IS and organisation literature

Author(s)	Type	Focus
Zammuto et al., 2007	Literary review	Organisational structures
Markus & Silver, 2008	Conceptual paper	Model reconceptualisation
Anderson, 2011	Empirical study	Artefact use, work practices
Leonardi, 2011	Empirical study	Organisational change
Kaplan, 2011	Empirical study	Organisational strategising
Faraj & Azad, 2012	Literary review	Theory integration
Robey et al., 2012	Literary review	Theory extension
Malhotra & Majchrzak, 2012	Survey	Organisational coordination
Seidel et al., 2013	Empirical study	Organisational sustainability
Leonardi, 2013	Empirical study	Organisational change
Lindberg & Lyytinen, 2013	Conceptual paper	Theory extension
Robey et al., 2013	Literary review	Organisational change
Volkoff & Strong, 2013	Theory development	Organisational change
Fayard & Weeks, 2014	Literary review	Theory integration
Jung & Lyytinen, 2014	Empirical study	Media choice
Strong et al., 2014	Empirical study	Organisational change
Cousins & Robey, 2015	Empirical study	Work-life boundaries
Jarzabkowski & Kaplan, 2015	Conceptual paper	Organisational strategising

In addition to (or perhaps as a result of) the influence of theorising and developing affordances in relation to organisational change, a significant portion of the discourse has revolved around reconciling (or discussing) the distinction between human agency and artefact agency e.g. in the form of performativity (Lindberg & Lyytinen, 2013). Indeed, a significant portion of the discourse has revolved around whether affordances are a useful vehicle for a socio-technical perspective (e.g. Markus & Silver, 2008; Robey et al., 2012; Robey et al., 2013), a sociomaterial perspective (Faraj & Azad, 2012; Fayard & Weeks, 2014; Strong et al., 2014), or a critical realist perspective (Volkoff & Strong, 2013).

While it is entirely justified to situate affordances within a discourse on sociomaterial or socio-technical paradigms if one seeks to conceptualise the nature (and interrelationships) of human and material agencies, it is unclear what relevance it offers for affordance as a means for other types of contributions. Some studies (e.g. Cousins & Robey, 2015; Jung & Lyytinen, 2014) that apply affordance theory as a theoretical lens for empirical studies have not taken any explicit stance regarding their perspective (although we are, of course, free to make assumptions and draw implicit conclusions). Others (e.g. Leonardi, 2011; 2013) do address social and structural factors, but do so in a very pragmatic manner. As it is the stated intent of this thesis to further our understanding of strategies for digital platforms, we will not delve deeper into the relative merits of socio-technical or sociomaterial perspectives (cf. Leonardi, 2012).

3.1. The Relationship between Objects and Users

While the emerging body of literature surrounding affordances in IS research is far from homogeneous, it reflects how information technologies are not monolithic, but rather comprised of a myriad of features that may be used or ignored in different ways by different users (Orlikowski & Iacono, 2001). Strong et al. (2014) attributed inadequacies of extant literature to the fact that technology is treated as an undifferentiated whole. They argued that an affordance perspective can be beneficial as it offers opportunities to acknowledge heterogeneity in artefact as well as actor capabilities and motivations. In other words, there is a functional, yet *indeterminate*, relationship between artefacts and their context of application. Some features may be perceived as useful and extensively used, while others are largely ignored. Consequences are afforded, but not determined, by material properties (Robey et al., 2012). Given the link between affordances, effects and action, causal relationships are complicated as users will only appropriate features of a technology if they perceive those features as offering affordances for action.

One of the early efforts to theorise affordances related to information technology (and more generally, information systems) was provided by Markus and Silver (2008). Their approach is partially built on the work of Giddens (1984) as well as derivative works such as Adaptive Structuration Theory (DeSanctis and Poole, 1994) that emphasise the manner in which human agency imprints itself onto technology. Markus and Silver (2008) proposed that existing (insufficient) theories can be extended or adapted to more explicitly address the properties of IT artefacts. They exemplified their reasoning with a model consisting of three central constructs, as show in figure 2: *technical objects*, *functional affordances* and *symbolic expressions*. These three constructs will be used as a framework for the subsequent discourse on affordance theory.

Figure 2. The relationship between objects and users mediated via affordances and expressions (Markus & Silver, 2008)

There are two points regarding the ontology of affordance theory that require clarification. First, the locus of affordances has been the subject of some debate in both ecological psychology (Michaels, 2003; Stoffregen, 2004) and IS literature (Fayard & Weeks, 2014; Robey et al., 2013). There are essentially three perspectives: 1) affordances are a property of the object or artefact, 2) affordances are a product of the (wider) context and 3) affordances are a product of the relationship between an object and actor (Robey et al., 2012). This paper will proceed from the third view presented by Chemero (2003) i.e. that affordances are created in the relationship between the properties of an object and the capabilities of an actor. The social and physical contexts will, of course, influence the interests and motivations of the actor (cf. Stoffregen, 2003), but will not be considered as a constituent aspect of the affordance itself. This is a reflection of the distinction made by Markus and Silver (2008) between functional affordances and symbolic expressions, where the latter is more aligned with understanding and intentionality of both user and designer (see chapter 3.4).

Second, while affordances are relational and formed in the relationship between objects and actors (see chapter 3.3), they are not figments of our imagination. One might be tempted to describe affordance as subjective – which is either true or false depending on what meaning you attribute to the term (Michaels, 2000). It is subjective in the sense that one specific

environment or object may offer different affordances to different actors. However, they are not subjective in the sense that they are purely experiential or mental constructs. This view goes right back to Gibson (1979) who offered a number of practical examples of affordances in order to stress the relative nature of affordances and highlight the distinction between the existence and perception of affordance:

"The affordance of something does not change as the need of the observer changes. The observer may or may not perceive or attend to the affordance, according to his needs, but the affordance, being invariant, is always there to be perceived. An affordance is not bestowed upon an object by a need of an observer and his act of perceiving it. The object offers what it does because it is what it is." (Gibson, 1979, p. 138-139)

While not all applications of affordance theory make their position clear (e.g. Leonardi, 2011; Strong et al., 2014), a similar perspective to that of Gibson has been adopted by some seeking to theorise affordances in IS research (e.g. Fayard & Weeks, 2014; Volkoff & Strong, 2013).

3.1.1 Technical Objects

Technical objects describe artefacts and their constituent (internal) components as well as their (external) interface. For the purpose of clarity, technical objects conform to the notion of *technology artefacts*[14] described by Lee et al. (2015) as "a human-created tool whose raison d'être is to be used to solve a problem, achieve a goal or serve a purpose that is human-defined, human perceived or human felt" (p. 8). Natural objects have dispositional ("real") properties that will always manifest under the right circumstances e.g. a crystal will always reflect light if exposed to sunshine (Turvey, 1992). Applied to technical objects, they too have dispositional properties that are the result of a socially determined process of design (Kling, 1992; Simon, 1996). For example, a lightbulb will always emit light if provided electricity, but it is up to the designer to determine just how the lightbulb will look, which kind of socket it requires, and how much light it is capable of emitting. In relation to digital technology, technical objects comprise physical components which are tangible (i.e. computer hardware) and digital components which are not tangible (i.e. digitised data). While both physical and digital components are necessary for the operation of a technical object, they are loosely coupled and thus replaceable (see chapter 2.5), meaning that physical components may accommodate different digital

[14] Unless otherwise stated, the terms "technical objects" and "technology artefacts" will be used interchangeably.

components just as digital components are not dependent upon a particular physical component. Ontologically speaking, either type of component is considered to possess objective properties regardless of whether they are physical or mental/digital (e.g. images on a screen). Hence, there is a distinction between the (objective) properties of the technical object and our (subjective) understanding or interpretation of them.

The use of the term "technical object" highlights the distinction between general technologies and designed artefacts. The transition from technology to (technical) artefact is a social process whereby different approaches are negotiated between actors, deliberated by individuals, and finally implemented in a design. Simon (1996) utilised the distinction between the study of natural objects and creation of artificial (i.e. designed) objects to describe the purview of engineering. While it is the task of the engineer to predominantly apply skills derived from the natural sciences in order to derive rational solutions to real-world problems, the creation of artificial objects is always coloured by the subjectivity and creativity inherent to a design process. In other words, "[t]he engineer, and more generally the designer, is concerned with how things ought to be – how they *ought* to be in order to *attain* goals, and to *function*" (Ibid, p. 4-5, emphases in original).

The choices made in the design process place restrictions on the subsequent transition from artefact to implementation in a real-world context that is fraught with caveats and change. An artefact – as a synthesis of designer judgment, design criteria and material properties – represents a specific instantiation of a technology (or technologies). Hence, the artefact is imbued with a number of fixed properties that may be appropriate to a specific time or place, yet prove less desirable under different circumstances. The inherent limitations of the design process are captured by Simon: "Artificial things are synthesized (though not always or usually with full forethought) by human beings" (Ibid, p. 5). Woodard et al. (2013) have provided a long-term perspective on the consequences of design choices and situated their reasoning in the organisational context of technology-based firms and how design decisions can either enable or limit future activities. They applied the concept of *design capital* which they defined as "the cumulative stock of designs owned or controlled by a firm" (Ibid. p. 539) to describe how design decisions that we face today are not isolated events, but rather a result of past design decisions, and how they will affect future design decisions. During the design process, a firm can either invest in new or improved technology in their product (i.e. technology artefact), or adopt a more frugal approach and go for a simpler, cheaper option. Each design decision serves to either enable or limit the potential for (and cost of) future product development or business strategies. More substantial investments will likely

bring flexibility in terms of an extensible architecture that facilitates future development, or a product with features that invites a wider range of applications which permits flexibility in business strategy and marketing. Small investments will require less in terms of time and resources, but the firm will likely incur *technical debt* which will result in limitations on future product development or poor quality products. However, the more frugal approach may be necessitated due to business constraints resulting from either financial hardships or products with low profit margins.

Our ability to integrate multiple functionalities into a single technology artefact (e.g. a smartphone) serves to highlight the fact that object and affordance do not describe a one-to-one relationship. An artefact can fulfil multiple affordances depending on the user and his/her goal. Likewise, a specific affordance may manifest in the relationship between a user and a wide variety of artefacts (or bundles of artefacts). You may, for instance, call a friend using a wide variety of mobile or stationary telephones. Yes, there will be slight variations in the sound quality and there are, of course, differences in terms of mobility – but the "remote conversation" affordance will still exist. However, if we consider other forms of communication – transmission of video as well as audio – we sharply reduce the types of artefacts with the right features to afford this activity. A tool typically affords applications that are simpler or more mundane than their designers intended. You may, for instance, use your brand new laptop computer as a tray for carrying your meal. The same is, however, not true for simpler tools and more complicated tasks e.g. a tray may not be used as a computer. In other words, the underlying technology must be equal to, or more advanced than, the affordance that one seeks to actualise (Jarzabkowski & Kaplan, 2015).

3.1.2. Functional Affordances

The notion of functional affordances is closely aligned with the affordance concept as presented in ecological psychology (e.g. Chemero, 2003; Gibson, 1979; Stoffregen, 2003) as well as sociology (Hutchby, 2001a; 2001b) in that it captures *possibilities for action* permitted by a technical object. While "affordance" is often conflated with terms such as "feature" (Fayard & Weeks, 2014), the concepts differ in two respects. First, as affordances are relational – created in the relationship between an object and an actor – they are distinct from related concepts such as feature which captures the objective properties of an object. Second, while feature describes "possibility of use", affordance captures "purpose-driven actions taken by people" (Malhotra & Majchrzak, 2012, p. 6:2). In other words, affordance describes "… the potential for behaviors[sic] associated with achieving an immediate

concrete outcome and arising from the relation between an object (e.g. an IT artifact[sic]) and a goal-oriented actor or actors" (Volkoff & Strong, 2013, p. 823). Hence, the ontology of (functional) affordances may be considered somewhat complex. They are dispositional insofar as they are a subset of (technical) features and thus exist irrespective of actors, but they are also relational in that they lack meaning or relevance in the absence of goal-oriented actors (Fayard & Weeks, 2014).

As affordance theory has its roots in ecological psychology, it was originally applied to conceptualise the mental processes of individual actors (or, rather, animals). However, as the concept has been applied in an organisational context, research in the field of information systems and organisation science has seen the need to address the issue of individuality versus commonality. As any single technology (that is, bundle of features) can support multiple affordances, Leonardi (2013) suggested that we need to distinguish between the idiosyncratic affordances that exist for each individual and the ability to enable action for a collective group. He offered a three-tier typology consisting of *individualised* affordances that are unique to a single person working towards a personal goal, *collective* affordances that are also unique yet with a motive and output that benefits a group, and *shared* affordances where both affordance and output is largely or entirely similar for a wider group. The distinction between individual and collective action is highly relevant in an organisational context. While affordances do not exist independently of actors, they must be enacted through wider patterns of use at the group level in order to permit network changes. Robey et al. (2013) argued that theories of affordances were not likely to be of any significant use for IS research if they merely addressed individual behaviour. In other words, a "critical mass" of a particular technology feature being used in a similar manner is required for IT/IS use to be considered applicable across research contexts (Malhotra & Majchrzak, 2012). Volkoff and Strong (2013) tackled the issue using a slightly different approach. Inspired by critical realism, they proposed the notion of *generic affordance* as a means to promote cross-case analysis and thus advance affordance theory in IS research. In this instance, "generic" implies that the outcomes are not perfectly similar, but comparable within a given set of parameters – much as how no two flowers are identical, but still identifiable as flowers by an observer.

Much of the work on affordances has focused on theorising IT artefacts as key aspects in a generative system of organisational routines. As artefacts are implemented in an organisation, they can become embedded to the point where the tasks and routines cannot be enacted in their absence. Once this occurs, they may be considered material agents that can guide or constrain

human actors (Lindberg & Lyytinen, 2013; Robey et al., 2012). Empirical work to support this reasoning has been provided by Leonardi (2011, 2013) in his study of the co-development of system affordances and organisational routines at a crash safety laboratory. Rather than perpetuate an all-too common image of flexible organisational routines and inflexible technical artefacts, Leonardi outlined how organisation and technology coevolve in a process of "imbrication" where changes in an artefact are a result of pre-existing routines, and how modifications to an artefact will, in turn, provoke changes in subsequent routines (and so on). In his research, Leonardi (2011) distinguished between affordance which he applied in a positive sense to denote possibility or opportunity, and *constraint* which is used to highlight limitations placed on human actors by (*in situ*) artefacts. A similar distinction was highlighted by Anderson (2011), in his study of how healthcare systems can provide enabling affordances and constraining affordances for medical staff in US hospitals.

In addition to utilising affordances to theorise the relationship between routines and artefacts, efforts have also been made to address causality and how affordances can be linked. Gaver (1991) provided a basic illustration of affordances that are sequentially linked in the form of a door and door handle. The door may be opened only *after* the door handle has been turned. Hence, there is a sequential relationship between two separate affordances – manipulation of the door handle and opening the door. In other words, affordance "A" has to be *actualised* (i.e. realised or otherwise acted upon) in order for affordance "B" to materialise. The idea of linkages between affordances has also been applied to conceptualise how the different affordances – rather than features or technologies – provided by information systems can be categorised. Volkoff and Strong (2013) argued for stratification into lower and higher level affordances in order to assess relationships between affordances (e.g. lower lever affordances enable higher level affordances). They illustrated their point by reinterpreting two previously published studies that described wildly disparate instances of organisational use of information systems. In the cross-case analysis, they identified "basic" affordances (related to input/output) and standardisation (process and information uniformity) as generic, lower lever affordances found in both instances. In their study of Electronic Health Records, Strong et al. (2014) stressed that existing literature had not explored the interrelation between affordances in sufficient detail e.g. how new (higher level) affordances can manifest when different (lower level) affordances are bundled together and become interrelated (in practice, if not logic). They argued that the omission is partially related to the lack of understanding of how affordances are actualised. They described affordance actualisation as an iterative, imperfect process, formed of "… the actions taken by actors as

they take advantage of one or more affordances through their use of technology to achieve immediate outcomes in support of organizational [sic] goals" (Strong et al., 2014, p. 70).

3.1.3. Symbolic Expressions

Symbolic expressions capture value-oriented aspects such as interpretation, communicative abilities, and intent. In relation to technical objects, the most obvious example is the manner in which information is presented to prospective users e.g. through an interface. While the interface itself is part of the object itself (and thereby objectively "real"), the level of comprehension or interest expressed by the user is relational to a user or group of users. The significance of symbolic expressions and how users perceive objects and technology has been explored in great detail in relation to design theory (Gaver, 1991; Norman, 1999; 2013) as well as sociology (Heft, 2003). From a purely practical standpoint, there are situations in which symbolic expressions and Norman's (1999) idea of perceived affordances could overlap i.e. instances where designer and user agree on *how* an object should be used and for *what purpose*. However, whereas Norman argued that perceived affordances are a part of design (and therefore an intrinsic property of the object), symbolic expressions are determined in the relationship between the object and user; that is the user may interpret the object differently to the way the designer had intended.

As both functional affordances and symbolic expressions are derived from technical objects, the distinction is not always perfectly clear. Indeed, empirical studies conducted in IS research (e.g. Cousins & Robey, 2015; Jung & Lyytinen, 2014; Leonardi, 2011) tend to include both aspects in a (wider) affordance construct. However, we may discern two reasons for preserving the distinction between affordance and expression in relation to technical objects. First, while functional affordances express "the possibilities for goal-oriented action afforded to specific user groups" (Markus & Silver, 2008, p. 622), the existence of functional affordances does not necessarily mean that we recognise them. Given the complexities of digital technology, the act of recognising an affordance is by no means assured. It is related to our perception, experience, and skill set (Heft, 2003) as well as the design of the object itself (Norman, 2013), and warrants explicit attention. Second, the notion of functional affordances does not incorporate issues related to values or intentions, or how the intentions of those who design the technical object matches (or clashes) with the intentions of prospective users. User agency and volition is ultimately what distinguishes possibilities from actions (Stoffregen, 2003). In other words, "it is critical to distinguish 'what I can do'

from what 'I want to do' [...] Affordances that are irrelevant to an [actor's] goals are likely to be of little interest" (Stoffregen, 2004, p. 82).

The non-technical aspects of artefacts were captured by Lee et al. (2015) when they proposed the wider concept of "IS artefact" for the purpose of highlighting the ontological differences between different artefacts by situating technology in a greater social and informational system. They described three constituent subsystems of an IS artefact: technology artefact (which is described in chapter 3.2), information artefact, and social artefact. The *information artefact* describes the manner in which information is captured and conveyed e.g. letters, numbers, or bits. For the information artefact to function as intended, all parties involved in the exchange must be able to understand the scheme in which information is encoded. The *social artefact* "consists of, or incorporates, relationships or interactions between or among individuals through which an individual attempts to solve one of his or her problems, achieve one of his or her goals or serve one of his or her purposes" (Lee et al., 2015, p. 9). It essentially describes an amalgamation of persistent societal concepts such as institutions, cultures, laws, and also intermittent exchanges such as meetings that combine to affect relationships between actors in a distinctly social process. Lee et al. utilised the distinction between different artefacts to make two explicit points. First, technology does not determine the shape of information systems. Quite to the contrary, technology artefacts require commensurate social and informational artefacts in order to operate as expected or desired. Second, informational and social significance can be imbued in a technology artefact long after its design and realisation.

The social aspects of technology artefacts have been explored in great detail by Hutchby (2001a; 2001b). As a sociologist, he outlined how human actors shape technology through their respective requirements and preferences regardless of whether their perspective aligns with the original intent of the designers or not. For instance, the telephone was originally marketed (or "written" in social constructivist terminology) as a tool for business negotiations and management of domestic services. However, people soon began to use (or "read") telephones for the purpose of socialising, causing telephone companies to change their marketing and reposition ("re-write") their offering to conform to this use. Hence, the social meaning of a technology artefact is an outcome of negotiation as much as designer intention.

3.2. Affordances and Digital Platforms

The framework used to analyse and integrate the findings from the appended papers 1-4 is based on the model presented by Markus and Silver (2008) which has been elaborated in the preceding chapters. Thus, we will proceed from the underlying idea that technical objects express functional affordances and symbolic expressions to prospective users. However, while the generic framework presented in figure 2 provides a basis for analysing IT artefacts in general, it will be modified in order to better reflect the topic at hand.

First, based on the typology of platforms presented in chapter 2.1 as well as the empirical context (see chapter 4.4), the object of this study may be characterised as an *industry platform*. While this categorisation of the phenomenon under study is, in itself, an analysis of sorts (cf. Gregor, 2006), it does not offer any significant insights beyond a label of sorts that situates it within extant research. Applying a specific label to the phenomenon under study serves to delimit and focus the analytical process in a particular direction and guides the researcher to consider relevant factors. In this case, identification of platform type is a crucial first step in understanding the phenomenon in its environment (see chapter 4.3) so that we may then proceed to theorisation and (eventually) generalisation beyond that specific context.

Second, as the phenomenon under study is an industry platform, we may characterise the platform as *external* to the platform provider: the platform is a market offering presented by the provider to *other* actors rather than a structure used to improve the provider's internal processes.

Third, based on platform type and the discussion outlined in chapter 2.3, we identify *three distinct stakeholder categories*: platform owner, complementor (i.e. third-party provider), and user (i.e. customer). In practical (and legal) terms, the platform is, of course, more closely aligned with the platform provider who designs and owns its core components. However, the platform's success or failure as the hub of an ecosystem is still dependent on the interest and participation of all three stakeholder types.

Fourth, as industry platforms are more commonly associated with innovation and harnessing external resources rather than fulfilling any singular, specific purpose (Tiwana, 2014), we assume that stakeholders have *different perspectives and interests* in the platform.

Fifth, as the object of study is a digital platform (rather than a physical or digital product), we characterise it as an *evolving technical system* rather than rigid architecture (see chapter 2.2). Hence, it is subject to changes depending on opportunities to apply new technologies or changes in market dynamics.

Sixth (and last), based on the layered modular architecture presented by Yoo et al. (2010) as well as the discussion outlined in chapter 2.5, the evolving technical system is explicitly delineated into physical and digital aspects. The physical aspects incorporate localised hardware (e.g. tools, physical peripherals), centralised hardware (e.g. back-office systems), and network connectivity. The digital aspects incorporate digitised operant resources (i.e. software, digitally-enabled services) as well as operand resources (i.e. all manner of "passive" data).

The modified version of the framework is summarised in figure 3. While the framework captures the gist of the points enumerated above, it is, of course, difficult to explicate all aspects as geometrical shapes, lines or arrows. As such, some of the points enumerated will remain implicit in their application as a theoretical lens through which to re-interpret and integrate findings from the respective papers appended to this thesis (see chapter 4.5.2).

Figure 3. Framework for affordances of digital platforms

4. Research Design/Methodology

This chapter outlines the theoretical assumptions and methodological choices that have served to shape my research. Succinctly put, I have pursued an interpretive case study, primarily using qualitative data in the form of interviews, in investigating the actions taken by a specific firm who has, over the course of 15 years, evolved from (digital) product developer to platform provider. I find an interpretive philosophy a necessity for the subject matter as the reprogrammability of information technology (hardware) and mutability of digitised data bestows virtually limitless flexibility to digital technology (Yoo et al., 2012). Hence, whether a (digital) artefact is a product, platform or infrastructure is essentially a matter of subjective interpretation rather than objective reality. My study of the same platform/artefact across two distinct research contexts serves to illustrate the interpretive freedom of digital technology. My choice of methodology is motivated by the need to place the platform in a wider (business) context i.e. as viewed by multiple stakeholders with distinct perspectives and requirements, rather than focus merely on a single (technical) dimension. Furthermore, a case study approach permits me to draw upon the rich knowledge and experience of informants to understand not just development over time, but also the underlying motivations for different decisions and actions. The remainder of this chapter will provide additional details regarding ontology, epistemology and empirical settings. However, we will begin with a brief account of information systems as a field of practice and research.

4.1. Information Systems Research

Recent years have seen an increasing interest in exploring the rich and diverse history of the IS field. Davis (2000; 2006) as well as Hirschheim and Klein (2012) have produced extensive reviews of historical events related to Management Information Systems (MIS) as well as the conceptual foundations of the discipline. Others e.g. Culnan (1986), Orlikowski and Iacono (2001), and Grover and Lyytinen (2015) have provided considerably more focused reviews in order to make a very specific point. Indeed, recent work conducted at my own department has included reviews of IS history (Nylén, 2015; Sandberg, 2014; Wimelius, 2009; Öbrand, 2015). While reviewing the IS field is useful in positioning one's own contribution, it can also serve as a basis for conducting research in its own right. Bryant et al. (2013) and Porra et al. (2013) promoted the "historical method" as a means to conduct retrospective research on developments over longer periods than permitted by case studies or field studies.

Any depiction of "history" is not as neutral as one might think. While the factual content of past events may be treated as objective, there is a significant degree of subjectivity with regards to how events are weighted, signified, related to one another, divided into different categories or periods et cetera. Information systems research is no exception as different forays into the annals of our field vary considerably in scope, orientation and focus depending on the motivation of the author(s). However, no matter the scope, all reviews of a field as diverse as MIS (or simply "IS") are unavoidably inundated with some degree of subjectivity and/or selectivity. As Hirschheim and Klein (2012, p. 190) described it in the introductory remarks to their review of 45 years (!) of developments in the IS field:

"*It should go without saying that all histories are biased. While we have done our best to articulate key events, artifacts [sic], people, research themes and ideas, we are well aware that others will believe we have not done justice to their favorite [sic] historical facts; that we have underplayed/undervalued certain events, people, or research topics or missed major mile stones. This paper represents 'our' view of history.*"

As it is neither the stated nor implied purpose of this chapter to exhaustively review the field of information systems research – or indeed review the extant reviews of said field – I beg the reader's indulgence as I provide a selective review of our field and highlight those facets that are particularly relevant to the subject at hand. In this dissertation, I discuss the relatively new phenomenon of digital platforms. A central issue to my argument is the relationship between technical artefacts that lend themselves to standardisation, and their application which is bounded by social conditions and restrictions. We may (somewhat simplistically, I admit) describe information systems research as an ongoing inquiry into the disparate qualities of the underlying technology and the manner in which it is appropriated in different situations (Davis, 2006). For all their diversity, digital computers and computer-based technology are essentially the product of engineering as an application of physics and mathematics (Blanchette, 2011). As such, they are considerably more susceptible to a linear progression which we may predict with a fair degree of accuracy. Hence, we have long been able to make educated guesses regarding the development of the hardware that power computerised information systems and anticipate increased computational power, reduced chip size and enhanced energy efficiency. Furthermore, these developments have been equally applicable across all manner of situations and environments. However, the application of computer technology is anything but linear.

While early computers were essentially integrated machines, the introduction of IBM's System 360 series of computer systems in the mid 1960s offered a high degree of modularity between physical components and instructions (i.e. software) (Hirschheim & Klein, 2012). With an architecture of compatible yet differentiated computer hardware, organisations were able to exercise greater discretion in tailoring computerised systems to different tasks. This development paved the way for subsequent developments in minicomputers and personal computers, further separating the loose coupling between hardware and software. However, early applications of data processing favoured quantity over quality, giving rise to scornful monikers such as "Management Misinformation Systems" (Ackoff, 1967).

We may discern several distinct perspectives related to the application of computerised systems and their potential challenges and benefits. The first goes back to work conducted at the University of Minnesota and the formation of the Management Information Systems Research Center (MISRC) in the late 1960s along with concomitant efforts to develop educational programmes in business schools intended to leverage the novelty of computerised systems and data processing to support decision-making and derive strategic advantages (Davis, 2000; Hirschheim & Klein, 2012). With close ties to commerce, these early scholarly development of (management) information systems in North America were largely focused on deriving *business value*. A strong managerial perspective on data processing gave rise to streams of research focusing on Decision Support Systems (Sprague, 1980), information system design and evaluation (DeLone & McLean, 1992; Gorry & Scott-Morton, 1971), and key performance indicators (Rockart, 1979).

A second perspective is based not on business value per se, but rather on the manner in which *social aspects* of technology interpretation influence system efficacy. The idea of Socio-technical Systems (STS) came to the forefront through the work of Emery & Trist (1965), Mumford (1974), and Kling (1980; 1996) who argued that studying either technology or social systems as separate entities could not account for the resulting phenomena. As interaction between social systems and technological systems is unavoidable, any new system should be conceived with input from the end users – an approach that came to be called participative design (Mumford, 2006). A variation on the same theme was provided by Peter Checkland (1981; 2000) with his idea of Soft System Methodology which – among other things – stressed the need to socially establish and agree upon the "root definitions" of a problem and its constituent parts. Without this initial (and often political) step, subsequent work to solve complex problems may incur significant problems as individuals apply their own interpretations to

pertinent events or issues. Hence, any project should proceed from the assumption that the problem at hand needs to be defined in the current context before meaningful progress can be made.

A third perspective, that focuses on the distinction between *data and information*, is here exemplified by the Scandinavian tradition of information systems research. One of the more influential figures in the development of information systems research – or *informatics* as it came to be called in Scandinavia (Dahlbom, 1995) – is Börje Langefors. He argued for the need to clearly distinguish between datalogical problems (pertaining to the ability to process and manage data) and infological problems (which relate to understanding data). An engineer by training, Langefors (1968; 1995) expressed the variance in data interpretation in an exceedingly concise yet profound manner: I = i (D, S, t). In his view, the information (I) that we derive is dependent upon how our cognitive faculties (i) process a given situation based on the available data (D), our semantic structure (S) and the time available (t). The notion of semantic structure represents the knowledge and values of our accumulated life experiences. As such, the contexts with which information systems interact amount not only to the aggregate notions of institutions or cultures, but also to individuals who care imbued with their own experience and training. Moving from theory to practice, Ehn (1988) contributed ground-breaking work on cooperative action design research when working alongside users to design tools in the DEMOS and UTOPIA projects.

As a relatively young discipline that, in many ways, has developed in different directions in North America and Europe, the Information Systems (IS) community has struggled to find a balance between the need for cumulative, yet socially-bounded development. At the very first international conference on information systems (ICIS), Keen (1980) stated in no uncertain terms that research into management information systems (MIS) needed – among other things – a cumulative tradition and a clear definition of relevant concepts such as information. While it would be unfair to suggest that IS research has not progressed in the last 30+ years, the matter of identity seems as relevant today as it did then – if not more so. As was made abundantly clear by Hirschheim and Klein (2012), the progression of the IS field has hardly been a disciplined, single-file march. If anything, it has been apt to morphing into different shapes, addressing the challenges faced by practitioners as technology evolved in leaps and bounds. As such, the research has often been situated in a given context, determined by the tools, problems and values of the time. Hence, there was a lack of commonality as different accounts described MIS as an intersection of several separate fields such as accounting, organisation theory, management and economics (Davis,

2000; Wimelius, 2009). While it may seem odd that an area of research can display such a lack of cohesion, it is hardly surprising when one considers the fragmented origin – and indeed existence – of IS departments at universities. Housed in different faculties i.e. business, social studies, engineering et cetera, it is only natural for information systems research to be heavily influenced by the dominant theories, world views and areas of concern of each respective branch of science (Avgerou, 2000; Hirschheim & Klein, 2012).

Furthermore, MIS first emerged not as an academic discipline in its own right, but rather as a collection of activities that were largely separate from the core capabilities of a firm, yet too specific and important to outsource or in some other way externalise (Davis, 2000). This peculiar standing of information systems gradually diminished as IT-related and IS-related practice became subject to different forms of externalisation e.g. in the form of outsourcing (Loh & Venkatraman, 1992) or offshoring (Hirschheim, 2009). Even when firms retained internal capabilities, it was common for large gaps (figurative, literal, or both) to manifest between IT departments and the rest of the organisation (Peppard, 2001). The IS community has, at times, found itself challenged outright by external forces. Two of the more salient instances occurred in the 1980s when the term "IT productivity paradox" denounced the efficacy of IT investments (Brynjolfsson, 1993), and then again in the early 2000s when Carr (2003) bluntly stated that "IT doesn't matter" and lacked strategic significance for modern organisations. The latter occasion in particular sent the IS community into something of a panic, scrambling to justify investments in information technology and giving rise to existential quandaries regarding the very nature or relevance of the field. In addition to external criticism, or perhaps as a result of them, internal voices have also raised concern regarding the status and direction of the field. Although IS research has preserved its ties with the underlying technology, the link has been tenuous at times. A review of articles published in Information Systems Research showed that alarmingly few papers addressed the IT artefact in any significant manner (Orlikowski & Iacono, 2001). Markus (1999, quoted in Hirschheim & Klein, 2012) pondered the disappearance of IS as a discipline as we know it today. As information technology grows ever more prevalent, it also becomes intertwined with business processes and different social phenomena to the point where the technology is effectively eclipsed and relegated to the background.

Although 30 years apart, Keen (1980) as well as Hirshheim & Klein (2012) both called for a shared tradition in the IS field in order to promote greater homogeneity and understanding. The early 2000s saw an especially intensive debate regarding the issue of commonality versus diversity (e.g.

Agarwal & Lucas, 2005; Alter, 2006; Galliers, 2003; Lyytinen & King, 2004; Robey, 2003). Benbasat and Zmud (2003) referred to an "identity crisis" in the IS discipline and lamented the tendency to borrow heavily from reference disciplines rather than create novel theory. They argued the need for a common "core" in the field which would help focus research by excluding topics or concepts that were only superficially related to information technology or information systems. The notion of a core is interpreted by Weber (2003) as an area where phenomena are not (sufficiently) addressed by other disciplines. Identifying – and limiting oneself to – such an area would facilitate the development of theories that are sufficiently general to lend themselves to wide applications rather than contingent upon numerous contextual factors. Subsequent articles have landed on both sides of the fence, some concurring with the need for a unified stream of research whilst others claim that diversity is preferable (Agarwal & Lucas, 2005). Regardless of means, the purpose is to create a clearer sense of what information systems research is and is not. Arguably, this would strengthen the research contribution of the field in that it would be easier to build upon extant literature rather than risk revisiting the same issues due to differences in terminology or area of application. Furthermore, it would enable outsiders to form a clearer conception of information systems research is rather than potentially face widely divergent explanations when consulting different researchers or literary sources. In a sense, the institutionally weak (Avgerou, 2000) discipline of IS research would derive greater legitimacy as an academic field if it were easier to "pin down" and convey in a parsimonious manner. Legitimacy is, however, a double-edged sword. Defending itself against this type of criticism would no doubt be easier if the IS community were more closely knit, but that would also serve to limit the range of issues and real-world phenomena that could be addressed (Lyytinen & King, 2004; Robey, 2003). An overly strong focus on technology could limit theory development to technological determinism, omitting social and/or organisational aspects or the unpredictable phenomena that emerge when the two interact (Markus & Robey, 1988).

The information systems field is, to some extent, concerned with the creation of artefacts – artificial constructs of some kind. This is not a recent trend, but rather an on-going development, with different themes and approaches moving in and out of vogue (Hirschheim & Klein, 2012). Recent years have seen design science research appear and provide some manner of middle ground between design practice and scientific rigour as it seeks to theorize the design of IS and/or IT artefacts (Gregor & Jones, 2007; Hevner et al, 2004). However, IT artefacts (such as computers and mobile telephones) are not specialised tools limited to a single area of application, but rather multi-purpose tools capable of facilitating exceedingly diverse tasks (Orlikowski &

Iacono, 2001). The nature and execution of these tasks is an intricate weave of knowledge, preferences and goals of any number of actors, including manufacturers of hardware, designers of software, corporate management, and end users. The manner in which these actors interact may fluctuate greatly over time as they are influenced by one another, or the artefacts themselves as they mature and develop. Hence, once we adopt a macro perspective, causality becomes muddled and it is more difficult to ascertain whether the context determines the artefact or if the artefact is, in fact, shaping the context (Orlikowski & Barley, 2001). This thesis will proceed from the view that the IS-field should not restrict itself to a "core" concern, but rather consider our objective as a target that is both moving and frequently morphing into new shapes as technical artefacts become more advanced (i.e. powerful) and versatile (i.e. gaining a wider range of applicability). Hence, to whatever extent our field has a core; it should at the very least be considered *elastic* and sensitive to external forces beyond our control.

4.2. Philosophical Foundations

In this section, I will clarify my assumptions and views on fundamental ontological and epistemological issues. One of the central themes in my thesis is the need to address digital platforms (or specifically the core of digital platforms) as relational objects. Thus, the benefits and values brought by a platform should not be considered in absolute terms, but related to the interests of each type of stakeholder. A digital platform offers different *affordances* to the platform provider than it does to a third-party developer or the end user.

Philosophical assumptions are commonly discussed in terms of ontology and epistemology. Ontology addresses the nature of *things* and how they relate whereas epistemology describes the nature of *knowledge* and how it is created (Mason, 2002; Van de ven, 2007). Although research may be conducted using a wide variety of approaches, three epistemological positions stand out as more prevalent in information systems research: positivist, interpretivist, and critical approach (Orlikowski & Baroudi, 1991). This dissertation is essentially based on an interpretivist approach which stipulates that the object under study is shaped through our interpretation (Walsham, 1995; 2006). By some accounts, the interpretive approach is a branch of the relativist research tradition (Van de ven, 2007) and includes methodologies such as ethnography and case studies (Lee, 1991; Klein & Myers, 1999). While the different interpretive methodologies are by no means homogeneous, they share certain basic precepts regarding epistemology and ontology.

In terms of epistemology, interpretive approaches state that knowledge is created in a subjective (or intersubjective) process where – in sharp contrast to the neutrality of positivist approaches – interpretation is a core aspect of knowledge creation (Orlikowski & Baroudi, 1991). Moreover, as knowledge creation in any given context is based on interactions with *people* (e.g. through interviews) rather than inanimate objects or materials, interpretation is a two-tier process. First, the interviewee (i.e. source of data) retells an interpretation of events or outline of a process. Second, the interviewer (i.e. researcher) interprets, aggregates and analyses data in order to derive constructs that are generalisable beyond the original context (Walsham, 1995). This process may also be referred to as "double hermeneutics", further emphasising that actual events are interpreted twice before reaching the reader of the finished research (Giddens, 1984). Knowledge of different phenomena is gained through a web of social constructions e.g. shared meanings, language and artefacts (Klein & Myers, 1999). Organisations are social systems and, as such, cannot be evaluated without due consideration to the people that form said organisation. On the other hand, the issue of subjectivity and – equally relevant – *selectivity* is put front and centre as the researcher is essentially tasked with "…accessing other people's interpretations, filtering them through their own conceptual apparatus, and feeding a version of events back to others" (Walsham, 1995, p. 77)[15].

In terms of how the world is perceived, interpretive approaches are considered to follow an constructivist ontology (Leonardi & Barley, 2010) whereby reality does not exist apart from our perception. Rather, it is given shape and significance through human construction (and re-construction) in a social process (Van de ven, 2007; Orlikowski & Baroudi, 1991). Strict adherents to constructivism maintain that technology is, in itself, a social construct devoid of inherent properties. Certain sociologists in particular (e.g. Grint & Woolgar, 1992; Woolgar & Grint, 1991) have reiterated that all technology creation and utilisation is the result of social processes that may be likened to an onion where "the number of layers is indefinite and that the notion of a technical core [at the heart of the onion] is illusory" (Grint & Woolgar, 1991, p. 374). Rather, product manufacturers "configure" the user by inscribing boundaries on the product which guide the user to encounter it only as the producer sees fit. Arguments have been made for a "technology-as-text" metaphor where both the design ("writing") and application ("reading") of technologies and artefacts are negotiated processes (Woolgar, 1991). As such, technology does not have any actual properties except the ones we, as human actors, attribute to them. This "hard line" constructionist

[15] For more details, see Yin's (2011, p. 11-13) outline of the relevance of emic and etic researcher perspectives.

view of technology has received criticism from Kling (1992, 1996) who argued that while objects and technologies do not determine action, they do have "real" properties that go beyond our conception of them. While we may, of course, consider abstract technologies open to infinite possibilities for interpretation in a social process of design, the result (i.e. artefact) is imbued with certain finite qualities that go beyond interpretation. Kling provided a rather vivid illustration of his point by comparing firearms and flowers:

"... contemporary pistols and assault rifles also have unique capabilities of tearing flesh and splintering bone with high-speed bullets, when compared with other kinds of weapons, such as knives and hands. Without a gun, it is hard to tear so much flesh and splinter so much bone so rapidly and readily and with such focus while standing 10 feet away from an intended victim. [...] I view the ontological status of physical objects as different from the ontological status of linguistic constructs. [...] However, physical objects like guns and roses have some capabilities that are not only arbitrarily derived from the talk about them. It is much harder to kill a platoon of soldiers with a dozen roses than with well-placed high-speed bullets" (Kling, 1992, p. 362).

As I argued in the preceding chapter (4.1), I consider the tension between standardised (and often centralised) technology and localised appropriation one of the enduring issues in the history of information systems research. The contextual boundedness that separates strict attention to technology (e.g. as one might in the field of computer science) from information systems research (or informatics) has been captured in many ways. Rob Kling has argued for the need to address social context in relation to technology (1980; 1996; 2007) whilst not forgetting that technology does have certain objective, enduring properties. Hence, one could consider critical realism as a viable alternative to the interpretivist approach as it combines a realist ontology with a relativist epistemology (Van de ven, 2007). Indeed, one of the more influential writers on interpretive research, Geoff Walsham (2006), considered "critical realism as one possible philosophical position underpinning interpretive research" (p. 320). Also, researchers active in information systems as well as sociology have presented arguments for adopting a critical realist perspective in relation to affordance theory. Volkoff and Strong (2014) recently argued the relevance of combining a critical realist perspective with affordance theory in the study of organisational change and adoption of computer-based systems. In his studies of technology use, Hutchby (2001a; 2001b) argued that technical artefacts (e.g. telephones) are real and have objective, invariable properties, but their appropriation and application is dependent upon context and user interest.

"*...an acceptance that our interpretations and uses of technological artefacts, while important, contingent and variable, are constrained in analysable ways by the ranges of affordances that particular artefacts, by virtue of their materiality, possess*" (Hutchby, 2001b, p. 193)

The use of one philosophy over another should be a matter of active choice rather than passive compliance or consent (Van de ven, 2007). I agree to some extent with the ontological world view presented in critical realism. In keeping with Kling (1992), I recognise that there need to place common-sensical limitations on the idea of a constructivism. While we are, of course, free to interpret the significance and meaning of different objects and technologies, interpretation should not be confused with imagination. Hence, there is (at least for analytical purposes) an objective "real" world of technical artefacts with fixed properties out there, but our interpretation and use thereof is entirely subjective. However, I consider an interpretivist approach better suited for this thesis as the constituent papers address a gradual process of development from digital product to *platform* using several different theoretical perspectives. The shift in identity is not determined by the structural makeup of the artefact itself, but rather an outcome of socially constructed interpretations by those that observe the artefact. Moreover, these interpretations are not stable or given a priori. For instance, while papers 1, 2, and 4 approach the IT artefact as a platform, paper 3 demonstrates an instance when it is treated as infrastructure for communication. Both interpretations are in keeping with the *function* of the artefact, but not its *role* as a platform. Indeed, with platform literature encompassing (mechanical) product platforms (Robertson & Ulrich, 1998), manufacturing plants (Sako, 2009), software suites (Eisenmann et al., 2011), and e-commerce (Evans, 2009), designating any phenomena a platform is subjective at best (and capricious at worst). It is my view that adopting a critical realist perspective would tilt the balance of this thesis towards exploring the IT artefact at the expense of its reconceptualisation as a platform.

4.3. Qualitative Case Studies

In this section, I will outline the nature of qualitative case studies and describe how they have been applied in my research. As an approach, qualitative case studies are (as the term suggests) situated at the nexus between the *qualitative* approach to scientific research, and *case study* as a methodology.

In his writings on qualitative research, Yin (2011) argued for the use of a qualitative approach in a very straightforward manner: "You just might want

to study a real-world setting, discover how people cope and thrive in that setting – and capture the contextual richness of people's everyday lives"(p. 3-4). He cited examples from studies of the homeless, the impact of mass vaccinations on public health, and more mundane instances of capturing how a private conversation is conducted using a mesh of words and body language. Mason (2002) echoed Yin's sentiment in extolling the "unrivalled capacity to constitute compelling arguments about *how things work in particular contexts*" (p. 1, italics in original). Hence, the impetus for adopting a qualitative approach is not primarily rooted in epistemology or ontology per se, but rather that it "…enables you to conduct in-depth studies about a broad array of topics […] in plain and everyday terms" (Yin, 2011, p. 6). Hence, qualitative research fills a gap by furnishing us with a set of tools for conducting research where other approaches would be impractical, impossible, or would simply omit relevant factors. For instance, a laboratory experiment would be highly suited to isolate a single variable or aspect of a phenomenon, but that would also serve to extract it from its natural, real-world environment, limiting insights and possibly affecting the results. Rather than isolating variables, qualitative research embraces the relative "messiness" of the real-world context by soliciting multiple sources of data as this serves to mitigate the risk of undue influence or bias from any one source (Klein & Myers, 1999; Yin, 2011).

Research conducted in information systems may be (very) broadly divided into quantitative and qualitative approaches. Whereas quantitative approaches primarily base their empirical investigations on numerical data that can be used for statistical analyses and hypotheses testing, qualitative approaches draw upon less "cut-and-dried" sources of data, such as observations or different forms of written or verbal accounts, observations, or design efforts (Conboy et al., 2012; Yin, 2011). Mason (2002, p. 8) stressed the diversity of qualitative research and that it "…should not be seen as a unified body of philosophy and practice, whose methods can simply be combined unproblematically". Although often associated with interpretive underpinnings and case studies, qualitative research includes a diverse set of methods, such as action research, ethnography and design science (Conboy et al., 2012; Mason, 2002). Indeed, Yin (2011, p. 17) listed ten separate varieties on qualitative research that are used in different fields of research. In addition to its diversity, qualitative research has long struggled to attain respectability in high-ranking outlets, with quantitative methods often being considered more rigorous and easy to transfer from senior to junior researchers (Conboy et al., 2012; Sarker et al., 2013). Hence, while the number of qualitative research papers indicates a generally positive trend since the early 2000s, the sheer diversity of qualitative research still necessitates careful consideration and explanation of ontological

underpinnings, methodological assumptions, and transparency in data presentation and analysis (Sarker et al., 2013; Yin, 2011).

Case studies (Mason, 2002; Yin, 2003) have described a specific methodology associated with a qualitative approach. One of the early influential texts on case study methodology in relation to information system research mentions "… a general dissatisfaction with the type of research information provided by quantitative techniques" (Benbasat et al., 1987, p. 369) and that a qualitative research strategy may provide a complementary set of tools. The primary distinction between quantitative and qualitative approaches is described in terms of *nomothetic* and *idiographic* research strategies. Nomothetic research seeks to create general laws that are universally applicable and provide exact answers. The researcher accomplishes this by establishing controlled environments and testing the outcomes derived from adjusting relevant variables. The case study approach marks a significant departure in that it is idiographic in nature, meaning that it seeks to understand a phenomenon in its natural environment or social context. This makes qualitative studies useful when seeking to understand causality and answer "how" or "why" questions, but less so when trying to establish "how many" or "how often" (Eisenhardt & Graebner, 2007).

Although case studies describe a qualitative *approach* to research, they are not limited to utilising qualitative *data*. In seeking to explore and understand a specific case, a researcher may employ any combination of qualitative data (e.g. interviews or observations) and quantitative data (e.g. archival records or other forms of documentation) that is relevant for the particular context.[16] Physical artefacts may provide additional data that can be both quantitative (technical specifications) and qualitative (design philosophy) depending on how they are used by the researcher (Eisenhardt, 1989; Yin, 2003). For all their potential to contribute rich data, case studies have been criticised for their use of small samples. Indeed, a single-case study draws upon a single instance of a phenomenon, effectively making a sample size of *one*. The critique is primarily based on the idea that one cannot generalise from such small samples (Lee & Baskerville, 2003). In responding to this issue, Yin (2003) distinguished between two distinct types of generalisation: generalisation to population and generalisation to theory. Yin characterised the former as *statistical generalisation*, whereby the researcher, as a necessary preamble to theorising, establishes population characteristics based on a sample. For instance, a survey among 100 chief executive officers is used to establish a set of characteristics for all chief

[16] As it is recommended practice for researchers to take field notes as well as record and transcribe interviews (e.g. Walsham, 2006; Yin, 2011), the researcher does, in a sense, create their own records that may be likened to quantitative data.

executive officers. Based on the inherent logical limitations of induction, Lee and Baskerville (2003) called the merit of statistical sampling into question by arguing that it cannot serve to predict the characteristics of a population regardless of sample size. While it is true that increasing the sample size or sampling frequency is beneficial, the improvement is only relevant for the characteristics of the sample itself and the ability to replicate the sampling process. It does not provide any greater insight into the characteristics of the population as a whole. Generalisation to theory, or *analytic generalisation*, describes an entirely separate activity whereby the researcher seeks to develop theory based on the insight derived from the population (Yin, 2003). With quantitative methods, the population is determined by the aforementioned statistical generalisation. With qualitative case studies, the population is the case (or cases) under scrutiny.

Analytical generalisation may be undertaken using several different stances, including positivist, interpretive, or critical approaches (Klein & Myers, 1999). Some of the more widely cited contributors to formalising case study research (Benbasat et al., 1987; Eisenhardt, 1989; Yin, 2003) employ a positivist approach which assumes a strict separation between the objective existence of the world that is being studied and the research whose efforts are "directed toward the development of testable hypotheses and theory which are generalizable [sic] across settings" (Eisenhardt, 1989, p. 546). In contrast, a critical approach views the world in terms of socially constructed meanings and systems, and sees that both people and artefacts possess potentials that remain unfulfilled due to their situation in a specific social or historical context. A critical approach seeks to understand the present situation, its antecedents and how the researcher may "create awareness and understanding of the various forms of social domination, so that people can act to eliminate them" (Orlikowski & Baroudi, 1991, p. 19).[17]

In my research, I have pursued an *interpretive* stance to the qualitative case study methodology. An interpretive approach falls somewhere between the positivist and critical approaches, embracing the critical view that the world is socially constructed and understood, yet sharing the positivist tradition of the researcher as an objective, "outside" observer. Interpretive research follows several of the research traditions established in anthropology, such as the provision of thick descriptions which permit deep understanding of a given phenomenon (Walsham, 1995). Indeed, it has been argued (Siggelkow, 2007) that one of the main advantages of case study research is its ability to be persuasive by providing practical illustrations of theoretical concepts,

[17] For a recent application of a critical perspective in IS research, see Arvidsson's (2015) work on digital transformation.

ground research questions in reality, and inspire new ideas by showcasing extreme or emergent practices. One of the distinctive properties of interpretive research is that findings are generated rather than existing a priori. In other words, interpretive research does not presume to report facts or definite findings per se, but rather "interpretations of other people's interpretations" (Walsham, 1995, p. 78). While this approach can permit the researcher to understand nebulous social phenomena and derive rich insight, the relative lack of universally applicable rules can give rise to doubt. Whereas users of quantitative methods can rely on canonical statements and formal methods, researchers who apply interpretivist qualitative case studies may find it hard to explain their methods and justify their results (Siggelkow, 2007).[18]

Realising the need to establish guidelines for interpretive research, yet acknowledging that such guidelines cannot be prescriptive in a strictly formulaic sense, Klein and Meyers (1999) established seven principles for interpretive field studies (of which case study is a subclass) based on the philosophic traditions found in hermeneutics. While it is not a foregone conclusion that interpretive research should be based on hermeneutics[19], the principles offered by Klein and Myers (1999) represent one of the more comprehensive and accepted contributions in this area to date. Furthermore, the authors are clear in stating that, even though the diversity and context-dependent nature of interpretive work may limit the application of a uniform set of criteria, "it does not follow that there are no standards at all by which interpretive research can be judged" (p. 68). With that in mind, I will now outline the different principles and how they are reflected in my own work.

1. The Fundamental Principle of the Hermeneutic Circle. The very first principle presented by Klein and Myers is not really a first among equals as it represents the overarching perspective for the remainder. In many ways, it would therefore have been more appropriate to present this first principle as a large circle with the remaining six principles depicted as different varieties of nested circles. This initial/overarching principle highlights the duality of the case as a whole and its constituent parts, and that we as researchers must alternate between the two perspectives in order to fully understand the phenomenon in question. Klein and Myers illustrated their reasoning using linguistics. In order to understand a sentence (e.g. for the purpose of translation), you must understand the meaning of the individual words, the manner in which they should be linked together, and

[18] This challenge is, of course, compounded by the aforementioned perceived limitations of theorising based on findings from a single case.

[19] Walsham (2006) considered both critical realism and phenomenology as viable alternatives.

the overall meaning of the sentence. Carlile (2002; 2004) provided a more comprehensive discourse on the same issue in his analysis of how syntactic boundaries (meaning of words), semantic boundaries (how words are interpreted), and pragmatic boundaries (how words stimulate action) all contribute on different levels in the creation and transfer of knowledge. As this dissertation revolves around a single IT artefact (and its use as a platform), we may consider each paper a figurative lap around the hermeneutic circle, each time highlighting different aspects of the case, and permitting this cover paper to present as comprehensive a picture as possible.

2. The Principle of Contextualisation. Case-based research faces the ternary challenge of understanding the case and its context, capturing the relevant aspects, and communicating the results to a wider audience. In order to accomplish this, the researcher must understand the case as situated within a social, historical, and technological context. This is particularly significant for interpretive research in order to capture not just *what* changes occur over time, but also *how* and *why* people actively reason and act to bring these changes about. Although all four papers provide some background to guide the reader, the principle of contextualisation is perhaps more emphasised in the first two papers which focus on the artefact (paper 1) and the business model and ecosystem (paper 2). Each case presents unique aspects of the case filtered through different theoretical frameworks.

3. The Principle of Interaction Between the Researchers and the Subjects. Whereas the preceding principle accentuates the need to position the case within a context, this principle addresses the ability of the researcher to access said context. As previously mentioned (see chapter 4.2), the interpretive researcher gathers data regarding the case through interviews with (or documents prepared by) practitioners. Hence, research may be likened to a two-tier process where the researcher does not access "reality" directly, but vicariously through documents or people that possess the insights sought (Walsham, 1995). It is difficult to point to any single paper or other clearly defined aspect of this thesis where this principle has been applied. As the bulk of the research presented in this thesis is based on interviews rather than written documentation or observation, the issue of establishing a rapport with informants has been an ongoing issue from the very beginning. The work of Kvale and Brinkmann (2009) has provided important guidance regarding the conduct and challenges of conducting interviews in qualitative research, ranging from preparation (e.g. preparing manuscripts for semi-structured interviews) to interview techniques (e.g. *deliberate naiveté* – openness to unanticipated or unknown avenues for

query) and managing interview data (e.g. approaches to transcribing recorded interviews and field notes).

4. The Principle of Abstraction and Generalisation. While the generalisability of case studies has, at times, been called into question (Lee & Baskerville, 2003; Yin, 2003), the simple fact is that all forms of research strive to some manner of generalisation beyond the original context. In their own application of the seven principles to three different interpretive studies, Klein and Myers (1999) found that abstraction and generalisation "played a dominant role" (p. 87) in all three. However, while generalisation is a shared ambition and yardstick among all research, there are several approaches to create general knowledge from specific cases. Walsham (1995) described four types of (analytical) generalisation that we can attain from interpretive research: development of concepts, generation of theory, drawing implications, and contributing rich insight. As papers 1 and 3 both apply ex ante frameworks as a theoretical lens, their respective contributions may be characterised as rich insight that can be useful for practitioners as well as researchers that pursue the same area of concern (i.e. digital platforms and co-created connected devices). Papers 2 and 4 both synthesise several streams of research into a succinct framework that is then applied to the data. As these frameworks represent novelties with a stronger basis in theory than the actual case study, they serve to generate theory which may be applied in other (non-platform based) studies related to technology-fuelled entrepreneurship or digital services.

5. The Principle of Dialogical Reasoning. Try as we might, it is exceedingly hard to enter into any form of research with a completely open mindset as we all intuitively draw upon our knowledge and experience as we deal with new situations. (Perhaps it would be more apt to say that we consider new situations simply as variations of familiar situations.) Whereas positivist researchers consider this "prejudice", which inhibits objectivity and value-free generation of knowledge, interpretivists (in the hermeneutic tradition) see our initial mindset as a starting point for further exploration. Walsham (1995) described our initial research design and theoretical base as a scaffolding which may be of use during the delicate initial stages in case studies. However, once the scaffolding has served its purpose i.e. when the case presents us with findings that go beyond the initial theories, it becomes necessary to remove the scaffolding and either apply a different theoretical base or create a novel theory. The four papers that form the basis for this thesis all focus on platforms (or platform ecosystems) and essentially draw upon the same body of related research (see chapter 2). However, each paper applies a different theoretical framework rooted in previous work on organisational boundaries (paper 3), options theory (paper 1),

entrepreneurship (paper 2), and service-dominant logic (paper 4). Hence, different papers have provided no shortage of opportunities to both formulate and revisit different conceptions of platforms and their constituent parts.

6. The Principle of Multiple Interpretations. As interpretive case studies are directly (through interviews or observations) or indirectly (through documentation or physical artefacts) based upon the actions or opinions of other people, it is only prudent to consider the existence of multiple interpretations of the same phenomena. Slight variations on a theme may not pose a problem, but directly conflicting or incompatible accounts may force the researcher to revise his or her understanding and consider alternate research strategies. In this thesis, this principle is most clearly reflected in the disparity between papers 1, 2, and 4 where the IT artefact is treated as a platform, and paper 3 where it is "merely" considered as communications infrastructure. Neither interpretation was imposed or constructed by the researcher, but was derived from informant statements. While it is possible that the aim and scope of the respective projects (see chapter 4.4) helped shape perspectives, the influence is considered negligible as the majority of informants interviewed for papers 1, 2, and 4 had no knowledge of the project, but were selected due to their existing relationship with the "platform" provider. Furthermore, the dominant party in paper 3 ("WashCo") expressed a very clear interest in connecting their products in order to enhance service operations, and an equally clear *disinterest* in building any form of platform around their products. The disparity in perspectives forced the researcher to rethink certain previously-held assumptions and is – at least partially – responsible for the perspective presented in this cover paper.

7. The Principle of Suspicion. The seventh and final principle offered by Klein and Myers bears some resemblance to principle #6 in that it suggests caution in taking every perspective at face value. A direct consequence of deriving data from living actors rather than inanimate objects is that actors are imbued with their own interests, agencies and ambitions. While we should perhaps not expect brazen lies, the researcher should be wary of self-aggrandisement or omission of key details. The research presented in this thesis rests (primarily) on interviews with informants in a wide range of positions, in firms of different sizes and influence, and different relationships with the focal platform/IT artefact. Every effort was made to stress both the neutrality of the researcher(s), and that interviews were carried out in the interest of conducting academic research. While no obvious contradictions (save for the ones noted under #6) were noted, there were some minor differences in perspective when comparing large and small

firms. The most noticeable of these related to power, where customer D (table 3) and the manufacturer (table 4) both represented relatively large enterprises and were therefore able to exert considerably more influence than other stakeholders. In addition to carefully weighting informant statements, interview data were compared to quantitative data (e.g. financial statements, policy documents) when possible.

4.4. Research Context and Data Collection

This dissertation is based on empirical material gathered as part of two separate projects that varied both in scope and orientation. The first project (chronologically speaking), titled "Platform strategy for Swedish process industry", was intended to bring about a shared platform that would act as a marketplace and shared infrastructure for industrial firms and their suppliers of technical solutions. The second project, "Connected professional products – technical and business-oriented requirements", was aimed at mapping out the various possibilities and challenges related to enacting the Internet of Things (IoT) in professional appliances. While the projects differed significantly in both aim and scope, both featured the same platform – and platform provider – that serves as a basis for the bulk of the theorising in this dissertation. I used *different pseudonyms* in each respective paper – PlatformCo, CommCo, LinkCo, and DigitalCo – but they are all the *same firm*. Pursuing the same platform across two different projects offered different opportunities for data collection. The scope and nature of project #1 presented the opportunity to carry out a retrospective study, where interviews were intended to paint a rich picture of events that led to the platform's current status. Project #2 offered the opportunity to follow events as they unfolded, and thus study the application of the platform in a new context. Both projects were partially funded by *Vinnova* – the Swedish Innovation Agency. The following sections will provide greater details of the context and aim of each project, but first I believe a brief note on data collection *across* the two projects is in order.

All interviews were semi-structured and, as such, provided me with considerable flexibility to adapt the precise wording of questions to conform to the informant's position as well as follow up on unanticipated statements or insights (Kvale & Brinkmann, 2009; Mason, 2002). However, all interviews (with the exception of the group interview conducted in project #2) followed a similar set of general *themes* to address (see table 2). These themes were not the result of data coding and analysis i.e. as one would expect from thematic analysis (Braun & Clarke, 2006), but applied *ex ante* as a high-level logic for organising questions and ensuring some manner of commonality despite the diverse set of informants. As a matter of

practicality, the number of questions covered under each theme varied in order to reflect the informant's position and skill set. A chief operating officer or systems developer would, for instance, be able to answer more in-depth questions regarding "technology" whereas a sales representative or service contractor would be able to provide greater insight into "sales and customer interaction". Hence, although the application of analytical frameworks and theoretical perspectives varies considerably across the four papers, a relatively homogeneous set of topics were used for data collection.

Table 2. Themes used in interview manuscripts

Theme	Content
The person	Background information
	Areas of responsibility
The company	Informant's position in the organisation
	Company's business offerings
	Company development in recent years
	Overall challenges and opportunities
Technology	Technologies in use to support business
	Sources of friction (if any) between technology and work processes
	Interaction with suppliers or partners
	Commitments vis-à-vis partners or suppliers
Sales & customer interaction	Types of customers
	Forms of customer interaction
	Commitments vis-à-vis customers
	Customer requirements and influence
Development	Approach for soliciting new customers or partners (where applicable)
	Influences for technology development (where applicable)
	Drivers for platform adoption or development
	Opportunities for organisational- or personal development
	Trends and future plans

4.4.1. Project #1: Platform Strategy for Swedish Process Industry

The process industries, such as mining, paper and pulp, and dairy, are part of the mainstay of Swedish industry. They represent an annual turnover of 800 billion SEK, 30% of national exports, and well over 10% of GDP. The constituent companies provide more than 200 000 job opportunities. In addition to the dividends provided by the process industry as a whole, these companies also provide an appealing market for providers of various solutions for IT and process automation – yielding another 100 000 job opportunities and a turnover of 150 billion SEK. With the overall significance of the process industry, any improvements may have a significant impact on not just the individual firm, but also the Swedish economy in general. However, improvements are not just a matter of welcome additions, but are increasingly becoming necessary conditions for doing business. In order to remain competitive on a global stage, continuous efforts to improve efficiency, provide customer value and foster innovation are essential. Attaining meaningful change is, however, not easy as it is common practice for suppliers to deliver their systems as "stove-pipe solutions". These are systems that are vertically integrated and the different components are only compatible with components from a single supplier.

The intent of project #1 was to ameliorate the situation by creating an IT-based platform that could facilitate richer interactions between firms and their suppliers. The basic idea can be compared to an "app store" for business-to-business consumers in general, and the process industry in particular. As the level of standardisation in the process industry is comparatively low, the platform sought to establish a shared technical architecture as well as a marketplace that was neutral and not specific to any one actor. The project ran from 2012-08-01 to 2014-07-31, and saw participation from 20 different actors, representing the process industry, suppliers of systems and applications, industrial networks and researchers from academia as well as private institutions. With such a diverse composition of actors, the overall project was divided into several work packages, covering activities ranging from concept development and formulation of business scenarios, to developing technical architectures and evaluation support structures. In terms of realising the platform architecture, the project worked with two different concepts – one intended for integrating (large-scale) stationary equipment and one for more mobile resources such as vehicles. Both concepts were based an existing platforms that were already in commercial use by different industries.

As the project had been divided between several relatively isolated work packages, it soon became apparent that gathering data from the entire

project was not feasible. Furthermore, I soon realised that the best-case scenario regarding the outcome of the project would be a mock-up or proof of concept rather than a platform per se. Hence, with the support of my advisor, I opted to focus on the platform that served as a basis for the latter of the two concepts. In many ways, the platform in question may be considered a microcosm for the platform project as a whole. The provider has gradually managed to develop a solution that can, with relative ease, be installed in a wider range of user contexts where it acts as an interface between localised equipment and back-office system(s). As they have integrated (digital) services from a range of partners active in different industry verticals, they have successfully built a small ecosystem around their platform. Despite being a relatively small firm, they have managed to capture a sizeable piece of the market in several industries – perhaps most notably public transportation, where they have installations in roughly 50% of all (city) buses in Sweden.

Altogether, 19 interviews (see table 3) were conducted related to the platform provider and their ecosystem. Seventeen interviews were conducted by me, one together with senior colleagues, and one (with the CEO of the platform provider) was provided for me in the form of a transcript. Furthermore, I also attended two project meetings related to the greater platform project (*platform strategy for Swedish process industry*) that gathered representatives from all 20 project members, and several smaller workshops in which the platform provider participated, but did not play a major role. The interviews did not primarily relate to the greater platform project as such, but rather the development of their own platform over the past 15 years. Details pertaining to the interviews, analysis and coding may be found in the respective papers. A subset of these 19 interviews served as a basis for paper 1, while papers 2 and 4 incorporated the full dataset. While these all draw upon the same empirical material, it is worth emphasising that the theoretical framework, coding and analysis differed considerably from one paper to another. This is partially a purposeful, systematic process whereby I applied different theoretical perspectives to the data in order to consider different aspects of platform development and establishment. However, it has also been a journey of personal discovery as I came across new ideas in reading articles or attending conferences. For instance, a special issue of MIS Quarterly published in 2015 featured several articles (e.g. Barrett et al., 2015; Lusch & Nambisan, 2015) that focused on service-dominant logic and service innovation in IT – topics that I had previously never considered. As I saw its relevance for my own work, I managed to incorporate it with some measure of success in paper 4.

Table 3. Interviews conducted in project #1

Firm	Business area	Informant position
Platform Provider	Machine-to-Machine Communication	Chief Executive Officer (2 interviews)
		Chief Operating Officer
		Business Area Manager
		Area Sales Manager
		Research and Development Manager
Integrator	Systems Integration	Sales Manager
		Sales Manager + Consultant
Provider A	Geographic Information Systems	Developer
		Sales Manager
Provider B	Information Display	Chief Executive Officer
Provider C	Electronic Systems Design	Systems Developer
Provider D	Fuel-Efficienct Driving (”Ecodriving”)	Research and Development Manager
Customer A	Logistics (small firm)	Administrative Manager
Customer B	Logistics (medium-sized firm)	Human Resources Administrator
Customer C	Logistics (large firm)	Transport Manager
Customer D	Public Transportation	Head of Systems Administration
		Head of Strategic Systems
		Product Manager

4.4.2. Project #2: Connected Professional Products

The Internet of Things (IoT) is poised to bring about a new world of information availability as devices are connected to the Internet and thus continuously accessible. Connected products create possibilities to collect

detailed data on product status, use, position, identity, history and so on. Furthermore, a connected product may also be remotely updated with new software or other forms of updates. These added capabilities enable new forms of business models where the provider is compensated based on continuous delivery of service or function rather than intermittent product retail. Adding new capabilities may also serve to strengthen one's position vis-à-vis competitors. This latter point is especially salient for Swedish manufacturing firms that face competition from cheaper alternatives that operate out of low wage countries.

Project #2, "*Connected Professional Products – Technical and Business-oriented Requirements*", addressed professional products i.e. products used by public or private organisations in their business processes, as a context for the application of IoT. More specifically, the project focused on appliances intended for professional use, such as refrigerators, washing machines and dishwashers that one may find in hotels, restaurants, laundromats or apartment buildings. Professional products differ from their private consumer counterparts in the significant focus on life-cycle management and demand for high reliability. In addition to product retail, there is usually a strong market for after-market services such as repair and maintenance. Internationally, professional appliances represent a 100 billion SEK per year industry – excluding after-market services. The project ran from 2014-11-01 to 2015-04-30, and was intended to create a prototype for how a professional appliance could be furnished with Internet connectivity and deliver information to a web-based interface via a back-office system. Given the limited scope of the project, the prototype was applied to a single appliance – a washing machine. The project included four parties from the private sector that represented the different skill sets needed to create a connected product: product manufacturing, machine-to-machine communications, telecommunications infrastructure, and information presentation.

As with the previous project, work was divided into several work packages. The four aforementioned parties were responsible for the practical tasks directly associated with connecting the appliance to a back-office system, extracting relevant data from the appliance, and presenting the raw data in a comprehensible manner via a user-friendly interface. As participants from academia, I – along with two senior colleagues – were responsible for investigating the needs and requirements placed upon a connected product by potential customers. We approached the latter task by conducting 20 interviews (see table 4). Thirteen of the interviews were conducted face-to-face, with the informant and interviewer alone in a room. One interview was conducted as a group interview, where representatives from all project

members participated. The remaining six interviews were conducted on the telephone. I personally conducted or participated in eighteen of the interviews, and the remaining two were conducted by senior colleagues. In addition to interviews, the project also featured one major two-day workshop at the start of the project in which representatives from all project members participated, and ten project meetings in which at least two project members met and discussed planning and work progress.

The data collected from *connected professional products – technical and business-oriented requirements* served as a basis for paper 3. There are, however, two issues that require clarification. First, the scope and focus of paper 3 is such that it does not consider the full range of project participants or stakeholders. We only consider the relationship between three actors that had the most distinct functional roles in the realisation of the finished proof-of-concept: the manufacturer, the systems developer and the platform provider. Hence, much of the collected data is not used in paper 3. Second, while referred to as a platform provider in table 4 (as well as papers 1, 2 and 4), the firm in question is not described as such in paper 3. Rather, it is described as a provider of IT infrastructure and "enabler" of machine-to-machine communication. This is not an oversight on my part, but an accurate reflection of the role which the firm played within project #2.

Table 4. Interviews conducted in project #2.

Firm type	Business area	Informant position
(Group interview)	Various	Various
Platform Provider	Machine-to-Machine Communication	Chief Executive Officer
		Business Area Manager
Manufacturer	Professional Appliances	Category Manager
		Customer Care Manager
		Salesman
Infrastructure Provider	Telecommunications Infrastructure	Business Developer
Systems Developer	Information Presentation	Chief Executive Officer
Landlord	Apartment Rental	Systems Developer
		Building Manager (#1)
		Building Manager (#2)
		Repairman (#1)
		Repairman (#2)
Municipal Office	Civic Service	Head of Technical Planning and Administration
Service Contractor	Appliance Service and Repair	Manager
Service Contractor (#2)	Appliance Service and Repair	Manager
Housing Cooperative	Housing	Procurer
		Maintenance
Housing Cooperative (#2)	Housing	Maintenance
Call Centre	Customer Support, Professional Appliances	Manager

4.5. Data Analysis

This section will summarise the different theoretical influences underlying the appended papers as well as the analytical approach pursued in the cover paper. However, for specific details regarding data coding and analysis, I refer you to the appended articles.

4.5.1. The Appended Articles

While the four years spent as a doctoral student have of course been a period of constant discovery of new ideas and perspectives, we may for the purpose of explaining my choices of analytical frameworks broadly outline two distinct phases. Initially, my thinking was largely influenced by options theory (e.g. Sandberg et al., 2014; Woodard et al., 2013) as a means of viewing and theorising the application of digital technology to form digital artefacts, and also entrepreneurial alertness (e.g. Kirzner, 1973; Sambamurthy et al., 2003) as a reflection of the need to consider the limitations of resources and context in real-world applications. The operationalisation of these theoretical perspectives is presented in papers 1 and 2, respectively.

The latter half of my doctoral studies saw a shift in terms of both theoretical influences and research context. First, I was influenced by literature on digital innovation (e.g. Yoo et al., 2010; Yoo et al., 2012) that explored both challenges and opportunities of digital technology, for instance with regards to balancing change and stability. Furthermore, a recent uptake of service-dominant logic in the IS field (e.g. Lusch & Nambisan, 2015; Nambisan, 2013) – culminating in a 2015 special issue of MIS Quarterly entitled "Service Innovation in the Digital Age" – highlighted the subjective nature of value in relation to information technology. Second, I became involved in a different research project (see chapter 4.4.2) that involved the firm upon which I had based my previous research, yet featured an entirely different set of goals. As both projects featured the same firm in different roles (platform provider in project #1 and technical infrastructure in project #2), the new dataset allowed me to further consider how the same technology can carry different labels depending on the circumstances. Consequently, the latter half of my doctoral studies became more focused on matters of stakeholder perspective and influence which is operationalised using organisational boundaries in paper 3 and value propositions (and, more generally, a service-oriented perspective) in paper 4.

In light of my shifting understanding and theoretical perspective, I have analysed data from project #1 using three distinct theoretical frameworks

(papers 1, 2, and 4), and data from project #2 using one framework (paper 3). It is worth mentioning that the relative emphasis on data from project #1 is not a reflection on the value or quality of the respective projects, but merely that research is a time-consuming process, and I have had more time to process data from project #1. As a case in point, two of the included papers have both gone through intermediate forms before attaining their current state. Papers 2 and 4 represent more developed versions of papers originally presented at the European Conference on Information Systems (ECIS) in 2014 and 2015, respectively (see chapter 4.6). In both cases, the conference papers utilised a smaller dataset compared to the versions appended to this thesis (similar in scope to paper 1). This "two-stage" process has provided a fledgling researcher with valuable publications as well as opportunities to receive invaluable feedback and suggestions from experienced colleagues in the IS community.[20]

The datasets gathered from the respective projects have been treated separately, that is, interviews from project #2 have not been added to the pre-existing dataset from project #1, but treated as entirely different entities. Even so, each project yielded over 200 pages of transcribed interviews (font size 11, normal spacing). While details of coding and analysis are provided in each individual paper, a brief comment on the use of tools to aid the coding process is in order. While Atlas.Ti (version 6) was used for coding and analysis for papers 2, 3, and 4, it was not used for paper 1. As paper 1 drew upon a relatively small set of data, coding and analysis were carried out using a standard word processor with coding achieved by applying different colours or adding comments to interview transcripts. While a purpose-built tool like Atlas.Ti offers very different experiences and opportunities for coding qualitative data compared to a word processor, it should be made clear that they did not constrain or drive the coding process used for each paper. It would, however, have been very difficult to use the larger dataset and the more complicated coding process described in the remaining papers (especially paper 2) using a word processor.

Furthermore, while paper 1 provides a contribution to the thesis in terms of its findings, it also served to help me make sense of the research context and help flesh out the research design (Yin, 2011, p. 66-67). Previous experiences prior to embarking upon my doctoral studies had largely focused on matters of organisational change in general and Enterprise Architecture in particular (see e.g. Magoulas et al., 2012). Although useful for studying change management in large, heterogeneous organisations, it was difficult to apply these experiences in this new context as projects #1 and #2 were both

[20] Indeed, the title of paper 4 is based on a suggestion I received at ECIS 2015 in Münster, Germany.

technology oriented, and both focused on inter-organisational co-creation. As such, paper 1 may be considered as an early exploratory step which forced me to "drop my tools" (Holmström & Truex, 2011; Weick, 1996) and seek alternatives better suited to research on (inter-organisational) platforms.

4.5.2. The Cover Paper

The idea of seeking new tools in order to highlight different aspects of the case(s) under investigation has permeated much of the work underlying this thesis. Moreover, the opportunity to study the same "platform" across two different projects has complemented theoretical eclecticism with empirical diversity. While the IT artefact served the same functional role across the two projects (i.e. machine-to-machine communication), it is readily apparent that it was ascribed a different role and purpose. The discord between project #2 (captured in paper 3) and paper #1 may seem trivial, but forced me to reconsider some previously held assumptions – such as the designation of a platform. For all its diversity, extant platform research (e.g. Gawer, 2014; Gawer & Cusumano, 2014; Thomas et al., 2015) does not question the identification of a platform. We know that platforms may fail to "ignite" (Evans, 2009) and that tensions may arise between platform providers and complementors (Ghazawneh & Henfridsson, 2013), but is still difficult to say with any degree of certainty *what makes a platform*. This realisation – that a platform is as much about a mutual designation by all stakeholders (i.e. platform provider, complementors and users) – has guided the application of (yet another) framework in this cover paper. As such, it is very much a result of a gradual dawning of awareness rather than a part of the initial research design (or part of the scope of either research project). It is likely that the constituent papers of this dissertation would have looked very different – as would the research design of the overall thesis – had these insights come to me sooner.

This cover paper introduces affordance theory which is a "new" theoretical perspective that is not present in any of the appended papers. In doing so, this dissertation follows an approach similar to Sandberg (2014) and Westergren (2011), which is to introduce a new theoretical perspective through which to view, consider and integrate findings from the respective papers into a coherent thesis. The first instinct was to seek an established methodological approach to guide (and validate) the application of a novel theoretical lens to the findings of extant studies. Terms like "secondary analysis" or "meta-analysis" made sense from a purely lexical perspective, but I soon came to realise that both terms are associated with distinct methodologies. *Secondary analysis* refers to the re-use of data gathered for another purpose, in another situation or gathered by another author. The

motivation for doing so is typically to pursue new research questions, test the generalisability of findings across multiple contexts, or apply alternative methods for analysis (Heaton, 2008). *Meta-analysis* refers to the practice of integrating disparate findings from a large population of studies in an effort to integrate seemingly incongruous findings, and form an overall picture of a collective body of knowledge (Glass, 1976; Glass et al., 1981). As such, it is commonly used for literary reviews and has been widely applied in the medical field and the pursuit of evidence-based medicine (Davis et al., 2014).

While the ultimate aim of meta-analysis i.e. to integrate different findings, may perhaps be considered compatible with the application of a novel theoretical perspective in this cover paper, any further comparisons carry the risk of grossly mischaracterising my own approach. First, this cover paper seeks to integrate the findings from four papers which I authored or co-authored, not an entire field and hundreds of disparate studies. Second, a meta-analytical approach advocates the exclusive use of statistical, quantitative methods, whereas I apply an interpretive perspective (see chapter 4.2) where my own first-hand understanding of the papers is an integral component. Instead, my analysis is more in keeping with some of the extant research in theorising affordances in relation to information systems research. For instance, Markus and Silver (2008) "unpack" the Adaptive Structuration Theory by DeSanctis and Poole (1994) in an effort to more explicitly address the role of information technology. Volkoff and Strong (2013) "reanalyse" two previously case studies as they argue for the commensurability of affordances and a critical realist perspective.

Examples from previous literature notwithstanding, I find myself drawing upon the distinction between "theory" and "theorising" explicated by Weick (1995) rather than any prescriptive methodology. The four appended papers may be considered expressions of *theorising* that "represent interim struggles in which people intentionally inch toward stronger theories" (Ibid, p. 385). That is, each paper represents an attempt to capture some significant aspect of the object of study, and the perspective presented in this cover paper is an attempt to gather the disparate insights into a more complete understanding. I deliberately use the verb "attempt" to describe both activities, as theorising is an ongoing process and there are no doubt additional insights that I have yet to attain. The distinction was perhaps best expressed by Weick when he highlighted the difference between "process and product, between theorizing [sic] and theory, between doing it and freezing it" (Ibid, p. 390). Hence, the contribution towards understanding digital platforms provided by this cover paper is the result of the "frozen moments" captured in the appended papers.

4.6. Additional Publications

Listed below is the work carried out during my period as a doctoral student that, for various reasons, did not fit in the overall thesis. Just as the cover paper is the result (or *product* if you prefer) of theorising executed in the appended papers, several of the appended papers (especially papers 2 and 4) were preceded by less refined attempts to theorise the same aspect.

Ahlin, K. & Saarikko, T. (2013). The necessity of knowledge: from structured information to boundary objects. *22nd Nordic Academy of Management Conference*, Reykjavik, Iceland, 21-23 August 2013.

Saarikko, T. (2014). Digital Service Platforms: Considering Reciprocity in Value Propositions. *30th EGOS Colloquium*, Rotterdam, the Netherlands, 3–5 July 2014.

Saarikko, T., Jonsson, K. & Burström, T. (2014). Towards an understanding of entrepreneurial alertness in the formation of platform ecosystems. *22nd European Conference on Information Systems*, Tel-Aviv, Israel, 9-11 June 2014.

Saarikko, T., Jonsson, K. & Burström, T. (2015). Architectural digital service provision: Modularisation in a cross-industry context. *6th International Seminar on Service Modularity: Architectures, Platforms and Interfaces*, Helsinki, Finland, 15-16 January 2015.

Saarikko, T. (2015). Digital platform development: A service-oriented perspective. *23rd European Conference on Information Systems*, Münster, Germany, 26-29 May 2015.

Saarikko, T., Westergren, U. H. & Blomquist, T. (*Forthcoming*). The Internet of Things: Are You Ready for What's Coming? *Accepted for publication in Business Horizons*.

5. Summaries and Contributions of Research Papers

This chapter will offer brief summaries of the four papers that are appended to this thesis. Each subsection will consist of two functionally distinct parts. The first part will provide a general summary of the paper, including background, theoretical framework and findings. As papers 1, 2, and 4 draw upon data gathered in the same project, there is a degree of overlap in the empirical descriptions of each paper. The second part will therefore be more specific and focus on the primary contributions provided by each respective paper in relation to the framework outlined in chapter 3.5.

5.1. Paper 1

Saarikko, T. (2014). Here Today, Here Tomorrow: Considering Options Theory in Digital Platform Development. *Creating Value for All Through IT: IFIP WG 8.6 International Conference on Transfer and Diffusion of IT*, TDIT 2014, Aalborg, Denmark, June 2-4 2014.

The first paper draws upon a subset of the interviews (n=5) gathered from project #1 (see chapter 4.4.1) which were all conducted with employees at the platform provider (PlatformCo). As such, the paper may be considered to be centred on the platform provider – and more specifically the technical development of the platform. The stated purpose of the study was to address how platforms relate to the development of options for application as well as future development. In doing so, the study applied two distinct variations of *options theory*: real options (McGrath, 1997) and digital options (Woodard el al., 2013). Real options theory draws upon the logic of financial theory where a small initial investment grants preferential access to a more substantial investment at a later time. Applied to business strategy, it expresses a form of incremental decision-making where an initial investment expands the range of subsequent avenues for strategic action. Applied to digital technology, digital options are conceptualised as IT-enabled capabilities that may be captured in two orthogonal properties: option value and technical debt, where the former captures opportunities for action and future development, and the latter captures constraints and limitations in the current architecture. Applied to the case of PlatformCo, the study shows how the platform has been developed in three distinct generations through separate (and costly) design moves; first to increase the number of options, and then to reduce the technical debt. A tangible expression of this

development is how the relative emphasis has transitioned from a heavy focus on design of robust hardware to a more balanced perspective where hardware should be robust *and* flexible in order to accommodate a wider range of customisation using software updates. Each generation has shifted the focus away from technical specification and more towards *function* – a more abstract notion that may relate to several distinct components that are technically unrelated. While more involved undertakings in platform development are more complex and costly, they are also necessary for long-term flexibility and ability to adapt a digital platform for new contexts.

In relation to the overall thesis, the paper contributes to our understanding of how development of the *technical object* provides the necessary (but not sufficient) conditions for functional affordances to materialise. The study describes how design choices have an enduring effect on the development of the digital platform. The application of digital technology to platforms means that platforms are not enabled by physical modularity – even a fixed, integral architecture can accommodate different digital components over time. That does not, however, necessarily reduce complexity, but rather emphasises the need for current hardware design to accommodate future software requirements. Hence, undesirable or insufficient architectural properties arguably have a more significant impact for digital platforms as they have the potential to either enable – or severely impede – the properties sought from the technical object in the pursuit of new (presently unknown) functional affordances. The study also contributes to our understanding of how digital and physical properties intertwine to form the preconditions for basic functional affordances needed for a platform provider to leverage the technical object as a platform. First, a greater focus on software over hardware affords *continuity* which may be considered a major distinction between digital product and digital platform. In other words, the essence of the platform is not lost if one were to trade one generation of hardware for a newer (or different) model. Second, the ability to remotely alter software instructions affords *customisation* in that the platform provider may profoundly alter the nature of the technical object (e.g. through software modification) long after it has been delivered to the user (and introduced into a localised context). Hence, while offering the technical object as a platform (rather than product or component) diminishes the salience of hardware as an offering, it remains an important enabler for the delivery and quality of the instructions provided in the form of digitised data.

5.2. Paper 2

Saarikko, T., Jonsson, K. & Burström, T. Platform establishment: A case study of entrepreneurial alertness. *Under review in an international journal (first round).*

This paper uses the full range of interviews from project #1 and focuses on strategies in digital platform establishment. Existing research on platform strategy favours studies of platforms that are mature and firmly entrenched in their respective niche or market. More often than not, these platforms are frequently offered by large, influential firms that can leverage considerable resources in establishing their respective platforms and dictate the rules of its use. Less is known regarding strategies for platform establishment and building initial third-party support. Business (or platform) ecosystems exhibit a life-cycle that encompasses four distinct stages: creation, growth, maturity and renewal (or decline). The study[21] traces the activities of a platform provider (CommCo) as they have brought their platform through the initial "creation" phase, and are now moving into a period of rapid growth. We argue that the creation of any novelty (such as a platform) requires an entrepreneurial mindset and the ability to sense and respond to market requirements. Based on this line of reasoning, we develop a framework based on the concept of entrepreneurial alertness (Kirzner, 1973) which is based on the notion that markets are in a constant state of disequilibrium due to the fact that market knowledge is unevenly distributed and firms act based on imperfect or insufficient information. In Kirzner's view, the role of entrepreneurship is to facilitate the interaction between different resources or actors in an effort to bring the market closer to equilibrium (i.e. a market with perfect and equally distributed knowledge). It is through these activities that the entrepreneur creates value for the concerned parties and profit for himself/herself. We build upon the notion of entrepreneurial alertness as coined by Kirzner and applied to IS research by Sambamurthy et al. (2003), and present a framework based on four types of awareness: market awareness, technology awareness, resource awareness and context awareness. The former two refer to explorative activities where the entrepreneur (i.e. platform provider) "scans" its surroundings for entrepreneurial opportunities and/or new technical trends. The latter two refer to exploitative activities where the entrepreneur gathers and adapts resources needed to address specific problems or requirements. Findings show that the platform was introduced into a market (or rather, markets) where it was common practice for each supplier to offer integrated systems,

[21] The stated purpose of the study in paper 2 is to investigate how a firm may strategise in establishing a *software* platform. Please note that the difference in nomenclature is a reflection on the intended outlet rather than a shift in research design or analytic stance on behalf of the researcher(s).

meaning that each supplier provided their own hardware even if it was just to provide a single function or (digital) service. The consequence of this practice was that users often had to maintain several parallel systems even though there was considerable functional overlap. For instance, a bus that uses systems from three different suppliers had three separate antennas on the roof even though one could service all three systems. Furthermore, this practice also served to raise the barrier to entry for smaller, specialised developers as customers (who are keen to minimise the number of systems and antennas on the roof) favoured large suppliers that could offer the widest range of functionality. While CommCo was able to carve out a niche as a platform provider that could accommodate multiple services from different developers, engaging with actors in several industries or market segments entailed learning the problems and priorities of their diverse range of customers and developers. Although laborious and time-consuming, it was also necessary in bridging the gap between offering a *function* and offering a *solution* to a concrete problem.

In relation to the thesis, the primary contribution in this paper is to highlight how *functional affordances* and *symbolic expressions* are conceptually distinct, yet have to be closely related in practice. The study describes how CommCo positioned their technology object as a platform that could solve issues faced by two distinct stakeholders: (small) developers (i.e. potential complementors) with different niche competencies that can be marketed as digitally delivered services, and customers (i.e. potential platform users) that stand to benefit from the aforementioned services. On a superficial level, the platform offers the same *generic* functional affordance to both stakeholder groups: the ability to reduce complexity and let CommCo supply a shared platform for all services. However, the provision of this functional affordance was, in itself, not sufficient to sway would-be stakeholders (who were weary of this departure from the established "one provider, one system" norm). Rather, the (same) functional affordance had to be complemented with (different) symbolic expressions. In other words, the platform offering needed to be framed in a manner consistent with the respective interests, priorities and requirements of different stakeholders. While complementors were generally agreeable to the convenience of leaving cumbersome infrastructural concerns to another party, they did have two major concerns with enacting the idea in practice: 1) the risk that CommCo might copy or otherwise mimic their services, and 2) that their existing relationship with customers could be disrupted or encroached upon. Both concerns are legitimate in a digital economy where customer relations are precious and intellectual property rights are difficult to assert (Zittrain, 2006). Hence, the situation required CommCo to complement their technical/functional offering with a distinctly social pledge not to analyse data traffic (which

could be used to reverse-engineer services) or offer competing services to customers. The other group of stakeholders i.e. users, also welcomed the idea of *one* physical system for multiple digital services. However, they too had decidedly non-technical concerns as the idea of multiple complementors delivering services using the same platform raised new questions regarding customer support and the respective responsibilities of each actor. In the "old" way of doing things, each developer supplied their own system to deliver their own service which made troubleshooting and customer support easy. If *service* A isn't working, the problem is probably located in the corresponding *system* A, and so you call the technical support of *developer* A and report an error. Although technically redundant, this approach is conceptually simple. So, how do you manage the same process when all developers utilise the same platform and there is no corresponding one-to-one relationship between developer and system? Who are you going to call?[22] Again, positioning their platform vis-à-vis a set of stakeholders required CommCo to complement the technical/functional offering with a social component. In this case, the key enabler was the willingness of CommCo to assume first-line support for all incoming calls – regardless of where the problem was actually located, thus mirroring the technical integration with a corresponding organisational structure. Only then did the promise (or affordance if you will) of simplicity fully materialise in the eyes of users.

5.3. Paper 3

Saarikko, T., Westergren, U. H. & Blomquist, T. (2016). The Inter-Organizational Dynamics of a Platform Ecosystem: Exploring Stakeholder Boundaries. In *2016 49th Hawaii International Conference on System Sciences (HICSS)* (pp. 5167-5176). IEEE.

Unlike the other papers appended to this thesis, paper 3 draws upon data from project #2 (see chapter 4.4.2). Another point of departure is the theoretical framing. While the paper partially draws on literature about platform ecosystems, the overall emphasis is on the Internet of Things (IoT) as an emerging phenomenon. The IoT represents a new frontier in digitisation as estimates predict anything up to 50 billion connected devices by 2020. The majority will be "smart" products that are able to communicate with their surroundings in order to relay information regarding status, position, usage et cetera. The realisation of connected products requires a conflation of different types of firms with distinct skill sets. You need an *engager*, who is essentially a manufacturer of products that customers want

[22] Ghostbusters!

to purchase and use, an *enabler* who is able to provide the connectivity and technical infrastructure needed to ensure a reliable connection between product and back-office system, and an *enhancer* that can filter, aggregate and analyse the massive amounts of data generated by connected devices (Burkitt, 2014). The purpose of the study is to investigate the inter-organisational dynamics that present themselves as a prototype of a connected product is co-created by three firms – WashCo, LinkCo, and InterfaceCo – that possess complementary skill sets. The actors also differ in size as both the enabler (LinkCo) and enhancer (InterfaceCo) are relatively small firms, whereas the engager (WashCo) is a global enterprise that manufactures washing machines and other appliances.
The paper applies a multi-facetted model of organisational boundaries presented by Santos and Eisenhardt (2005) as a framework for analysing different aspects of the relationships between the three focal firms of the study. The four types of boundaries capture efficiency (focus on transaction costs and governance), power (control and autonomy), competence (knowledge-based resources), and identity (organisational coherence and culture). Boundaries of efficiency are often formalised in contracts or similar measures and thus relatively easy to identify. The remaining boundaries are less clear-cut, but may nonetheless be detected when encountered in practice. The study shows that the three firms entered into this collaborative effort with different expectations. WashCo wanted a turn-key solution for connecting their products with a short-term goal of streamlining parts of the service-process through automated error messages, and a long-term vision of fully transitioning to a service-based business model and a more intimate customer relationship. They are accustomed to either developing new products or services in-house, or utilise subcontractors for development of systems that are not part of their own core competency. In the latter case, WashCo typically formulates contracts that ensure that they retain full ownership and user rights of the developed system or product. On the other hand, LinkCo and InterfaceCo frequently work with other firms to develop new applications or solutions based on customer requirements. Furthermore, both firms are accustomed to retaining the rights to what they develop, and then incorporating that service or function into their own offering as a standard or an option. While the study only extends as far as the design and implementation of a prototype, there are clear hints of emerging tensions in the collaboration between the three firms. The most salient hints may be discerned when we consider the boundaries of power and competence, where WashCo as the larger firm (by far) clearly has more influence, but LinkCo and InterfaceCo both possess the skills needed to transition from product to *connected* product. The influence of WashCo appears to be the dominating force in the short-term, but it is unclear how the dynamics between the three firms will develop as they move forward.

The paper contributes to our understanding of the fundamental significance of *symbolic expressions* for the identity of digital platforms. While the market offering of LinkCo is regarded as a "platform" in other business contexts (e.g. project #1), it was merely seen as communications infrastructure by WashCo – even though the relevant functional affordance is essentially identical. In both instances, the technology object offered by LinkCo creates the preconditions for connecting point A to point B. In the instances described in papers 1, 2, and 4, LinkCo has managed to leverage this affordance as a basis for a digital platform for services. This was, however, not the case here. Quite to the contrary, the study showed that WashCo had no interest in either regarding LinkCo as a platform provider, or linking their washing machines to any kind of platform. Rather, their interest was greater insight into how their products are used and exploring new forms of contractual relationships with customers (i.e. selling *function* rather than *product*). Due to their strategic interest, the functional affordance derived from the technical object was merely linkage between their products and corresponding back-office system. Hence, paper 3 highlights how goals and intentions (as constituent parts of symbolic expressions) influence the perception functional affordances and technical objects.

5.4. Paper 4

Saarikko, T. (2016). Platform Provider by Accident: A Case Study of Digital Platform Coring. *Business & Information Systems Engineering*, 58(3), 177-191.

This paper uses the full range of interviews from project #1 and focuses on the strategy of "coring" (see chapter 2.4) in relation to digital platforms. Platform coring describes the strategic activities involved in establishing a new platform in the absence of direct competition, usually based on the ability to solve a widespread or systemic problem. The notion of a platform core is typically regarded as a stable construct upon which the platform provider can build and invite external actors to provide complementary innovations (Gawer, 2009). However, although the notion of a platform core may be clearly identified as a tangible structure in physical platforms (e.g. for industrial manufacturing), its description is rather vague in extant literature on platform strategy. Furthermore, it is unclear what a core is – or how it might manifest – in relation to digital platforms, given their disaggregated architecture, the short life-span of technical components, and mutability of digital components. The aim of the study is therefore to investigate what a core is in relation to a digital platform, and how a platform provider (DigitalCo) may pursue platform coring in relation to digital

platforms. Inspired by the recent influx of service-dominant logic in information systems literature (Lusch & Nambisan, 2015), the study draws upon a combination of several streams of literature, including digital innovation, innovation and service to formulate a theoretical model of a service-oriented digital platform. The model encompasses four layers: client interface, service concept, delivery system, and technology options. The first two describe the front-end which is customised in order to accommodate the needs and wants of different market segments or customers. The latter two capture the back-end which serves as a service infrastructure that is largely standardised across all markets, industries, or customers.
While the digital platform analysed in the study is ostensibly stable, it is not entirely clear where the source of stability resides. In other words, it is difficult to designate any particular *structural* aspect as the platform's core. Platform literature typically distinguishes between core and complements, where the former is persistent over time and the latter replaceable and/or transient. Although appealing in its simplicity, the core-complement perspective is difficult to apply in relation to digital platforms given that physical and digital components are entangled and mutually interdependent. A physical component may remain in use over an extended period of time, but receive frequent software updates throughout its lifespan. Conversely, a digital component may be housed and enacted in different computers or a computer where the specifications are frequently altered as components are replaced. Hence, it is suggested that the notion of a core should not be considered as a noun, but rather a *verb*. That is, coring may be expressed as the capability to deliver a similar outcome across multiple instantiations despite changing preconditions. Furthermore, while platform strategies are typically conceived as one-sided and focused on the actions of the (prospective) platform provider, the influence of service-dominant logic suggests that digital platform coring could be conceived as a form of co-creation between different stakeholders. The paper operationalises this perspective as an exchange of *value propositions* that flow to and from the platform. For instance, different complementors may present various functional *requirements* to the digital platform that they would like to see realised in order to enhance the potential for new or better complements, but it is ultimately up to the platform provider to decide whether this constitutes a sufficiently compelling value proposition to actually modify the platform. Conversely, the platform offers a set of functional *possibilities* to complementors, but it is up to each respective complementor to decide which possibilities are relevant to them. In addition to stakeholders, the platform provider derives influences from the surrounding technical and business contexts. For instance, the rapid *development* of digital technology as well as the general *applicability* of digital technology across industries constantly offers new opportunities for the platform provider to develop

their platform. However, it is neither practical nor financially feasible to incorporate everything or pursue every market niche. Hence, each possibility for technical development or application may be considered as a value proposition which the platform provider must carefully consider before acting.

The paper contributes to our understanding of how *symbolic expressions* are inherently subjective and influenced by technical as well as contextual considerations. A digital platform must provide functional affordances for several distinct stakeholders (user types as well as individual users) at any one time. Their respective goals, values and interests act as a perceptive filter for viewing the technical object. The operative question may well be quite easy: *does this "thing" satisfy our needs*? If it does, then there is a good chance that it will be adopted by the prospective user or complementor. If not, then it is rejected pending efforts to redesign or amend the thing that is perceived (i.e. the digital platform) by the platform provider or a change in the goals or interests of the observer. The former is arguably what drives platform development, with disparate, disharmonious requirements from (external) stakeholders over time coalescing to form patterns of broader expectations. The process may be likened to a transition from *individual* affordances to *shared* affordances (see chapter 3.1.2). A functional affordance (or rather the prerequisites for a functional affordance) sought from one single actor may not motivate platform redesign, but multiple actors clamouring for the same unmet affordance (albeit for different services) implies wider necessity and business potential. The incentive to improve the technical object (i.e. platform) can be especially compelling if the need for improvement is felt by the platform provider as well as external stakeholders. An illustrative example from the study is the redesign from generation 2 to generation 3 which was advantageous for DigitalCo (cf. paper 1) as well as one of their larger customers who had a strategic need to ensure that the platform was built on a solid architectural foundation that would permit future expansion. Hence, they did not consider this platform (or any other platform for that matter) a viable alternative until the technical specification was to their liking. However, the appeal of a platform may be related to factors that are wholly out of the platform provider's control. The manner in which each actor perceives a technical object is inherently subjective and situated in a given time and place. This is especially germane to digital platforms given the rapid development of their underlying technologies. For instance, prospective users were originally hesitant to seriously consider DigitalCo's market offering as they were unaccustomed to service-based models where the majority of resources are centralised rather than localised. The notion of digital services was therefore initially met with suspicion, as it entailed a break with established practice. However, that all

changed when major technology firms started advertising similar concepts and “cloud computing” emerged as a legitimate way of doing business. This essentially *social* development arguably had a wider impact on the viability of digital platforms than any action pursued by DigitalCo to improve their *technical* object.

6. Discussion

Although platforms were originally theorised in the realm of product development and market economics, the application of IT has served to drive much of the subsequent theoretical development of platforms and their application (Thomas et al., 2015). Starting with (or at least popularised by) Gawer and Cusumano's (2002) study of how technology firms like Intel and Cisco strategised to attain platform leadership, subsequent work has explored how technologies can be leveraged to harness *external* resources and innovation rather than depend solely on internal capabilities. Subsequent research has followed in the same vain and have utilised IT-based platforms to build theory regarding ecosystem governance (Ghazawneh & Henfridsson, 2013), typologies (Gawer, 2009), life-cycles (West & Wood, 2013) and strategies for building (Gawer & Hendersson, 2007) or expanding (Eisenmann et al., 2011) a platform. Furthermore, IT-based contexts are also frequently used to illustrate platform-based markets in order to explore the dynamics (Eisenmann et al., 2006; Tiwana, 2014), challenges (Evans, 2009) and benefits (Gawer & Cusumano, 2008; Hagiu, 2014) of two-sided markets where a platform provider can extract significant rents for access to a market (or ecosystem) of potential customers.

Despite the preoccupation with technology-based platforms in general, and information technology-based platforms in particular, little interest has been given to the notion of *stability*. Extant platform research typically attributes stability to the notion of "low-variety elements" (i.e. a *core*) that is persistent over time (Baldwin & Woodard, 2009). On the other hand, platform research also argues for the core as an evolving technical system, and how the platform owner should continuously innovate on said core in order to maintain its relevance and usefulness (Gawer, 2009; Gawer & Henderson, 2007). This seeming dichotomy becomes all the more stark in relation to IT-based platforms given the high rate of obsolescence in digital technology (Wareham et al., 2014) and the ensuing volatility in digital ecosystems (Tiwana et al., 2010).

Furthermore, the bulk of platform theory assumes a provider-centric view, whereby a technology is leveraged (as a platform core) to derive benefits for the owner of said technology. To the extent that *stakeholder* influence is theorised, it takes the form of access rights to the platform (Ghazawneh & Henfridsson, 2013) or terms for platform ecosystem participation (Bergvall-Kåreborn & Howcroft, 2014). The nature of the core is seen as unproblematic in that it is assumed that external stakeholders perceive the technology in the same way as the provider. Again, this is especially concerning in relation

to digital platforms given its separation of form and function into a disaggregated architecture (Kallinikos, 2012; Yoo et al., 2010) permits different stakeholders to contribute without sharing a common view or goal. The research presented in this thesis suggests that platform perception is by no means objective, and similar interpretations among multiple stakeholders is not a necessity (or even a likelihood) when applied to digital platforms.

In this thesis, I have sought to theorise digital platforms in terms of their stability for stakeholders in the face of constant technical change. I have pursued the research question via an affordance perspective in an effort to capture the notion of a platform core not as objectively perceived or in a state of arrested development, but rather as a relational concept that is perceived differently for each stakeholder. By pursuing this line of reasoning, we may consider how the properties of digital technology and the knowledge and interests of different stakeholders combine to form a platform (or not). I have operationalised the relational perspective using three central constructs: technical objects, functional affordances, and symbolic expressions. While the first expresses an object with an "objective" existence, the latter two captures how it is related to three types of platform stakeholders: platform owner, complementor (i.e. third-party provider), and user (i.e. customer).

6.1. A Relational Perspective on Digital Platforms

Affordance theory "travels light" when adapted to other fields, leaving much behind as it becomes adapted to the constructs and interests of other fields of research (Bloomfield et al., 2010). We may – at least speculatively – anticipate how digital platforms could be approached and studied in the *other* major fields that have embraced affordance theory. While the topic of digital technology is perhaps a stretch for ecological psychology, we may consider the tension between perception as an individual, intuitive process where we consider what we could possibly do with a technical object (Gibson, 1979) and perception as filtered through social conditioning where we are influenced by others (Heft, 2003). Design researchers would likely assume a more artefact-centric perspective and focus on the actions of the designer (i.e. platform owner) in creating suitable affordances for function and comprehension – either adapted to a specific group of users or generalised for the mass market (Hartson, 2003; Norman, 2013). Sociologists that embrace (technology) affordances would consider the boundaries that the platform places on interpretation and application in a social context (Hutchby, 2001a) and how the social context strongly influences the manner in which a piece of technology is used (Bloomfield et al., 2010).

As affordance theory in information systems research is often applied to analyse organisational change (see table 1), it is not unreasonable to suggest that a "conventional" approach in *our* field would be based in the perspective of a platform adopter (i.e. customer) and consider the platform as an externally derived "technology" that requires modification (Leonardi, 2011) and gradual sensemaking (Strong et al., 2014) in order to satisfy personal or organisational goals (Jung & Lyytinen, 2014). As the norm in our field is to apply affordance theory in an intra-organisational setting, there is a propensity to theorise affordances in terms of functional type or functional relationship. For instance, Leonardi (2013) characterises affordances as individualised, collective or shared based on the degree to which they contribute to personal or organisational goals. Seidel et al. (2013) describe four types of affordances – reflective disclosure, information democratisation, output management and delocalisation – that facilitate sustainable business practices. Strong et al. (2014) differentiate between lower-level affordances that are needed in order for higher-order affordances to materialise. However, as we apply affordance theory in an *inter-organisational* setting and address multiple stakeholders, we need to acknowledge that realising an affordance is not necessarily the outcome of an individual cognitive process (or the exchanges within a small group). As the platform is part of a commercial offering, the provider is also tasked with demonstrating its usefulness in different ways via a social process similar to teaching or instruction (e.g. Heft, 2003). Hence, following Markus and silver (2008) we have complemented the idea of functional affordances with symbolic expressions which capture the social and perceptual aspect of the relationship between a technical object and an actor.

Platform ownership may take the form of loose consortia of firms with a shared, non-business essential problem e.g. in the development of technical standards for products (Eisenmann et al., 2009). However, it is more enticing (and relevant to the discourse at hand) to consider platform ownership under the purview of one firm. Extant literature depicts platforms as turn-key solutions that 1) address a widespread systemic problem and 2) are easily applicable (Iansiti & Levien, 2004). While the process of getting there is often glossed-over, it is not as easy as snapping your fingers. As "artificial objects" or "human-created tools", the construction of any technical artefact is an inherently social process where a designer (or team of designers) are guided by a combination of engineering principles as well as a variety of other criteria, e.g. purpose or resource restrictions (Lee et al., 2015; Simon, 1996). Applied to digital platforms, the task of the platform owner is to design a structure that is amenable to current needs, but also adaptable to accommodate future requirements. Furthermore, as platforms are intended to solve problems and facilitate applicability, the yardstick is

not technical specifications per se, but rather the notion of *functionality*. As the designer and proprietor of a digital platform, the platform owner arguably has considerable insight into the underlying technical architecture on which the platform is based. Even so, the conversion of technical specifications into more abstract functions involves a process of interpretation as much as calculation.

The material properties of digital platforms i.e. reprogrammable hardware and mutable software, serve to "soften" the consequences of certain design decisions as digital technology permits procrastinated bindings of digital and physical materials (Yoo et al., 2012). That is, an improper or insufficient design of hardware can to some extent be compensated or amended even after construction and delivery. However, there are limits to this plasticity as evident by the research conducted in this thesis. On two occasions, the platform required major redesign in order to reflect the need for extended or differentiated functionality. While the newer "generations" of the platform involved working with more flexible (and powerful) components, the process of getting there was essentially similar i.e. an interpretive translation between technical specifications and the desired functionality performed by the designer. Hence, the ongoing creation (and re-creation) of functionality in a platform is an outcome of the *relationship* between the properties of the technical object and the goals and priorities of the platform owner.

The guidance provided in extant literature for establishing a platform is largely based on the ability of an actor to identify a "technology" that can 1) solve an important function to a system, and 2) that the system in question is relevant to a variety of firms (Gawer; 2009; Gawer & Cusumano, 2008). Both of these assumptions can provide valuable input to a prospective platform provider in designing a technical object with requisite functionality. However, while functionality may be considered a prerequisite for utility and application, it is still an inherent property of an object that does not reflect the interests, knowledge or agency of a (human) actor. As one of the foundational properties of digital technology is the separation of form and function (Kallinikos, 2012), it is by no means certain that remaining stakeholders i.e. complementors and users, will share the same view as the would-be platform provider. The ongoing digitisation of (physical) products provides an additional dimension to the discourse. In essence, digitisation permits physical products to act as digital platforms e.g. for services (Ostrom et al., 2015). As the lines between product and platform blur, we need to acknowledge that a digital platform is not a preordained identity or role, but rather a potential result of how things are *perceived* and how things are *utilised*.

Viewed through a relational lens, the idea of a platform is to create affordances that are *shared* (Leonardi, 2013) or *generic* (Volkoff & Strong, 2013). That is, that the functions that are built into the technology, object, or system will be interpreted and enacted as realised functional affordances in a similar manner by all users. The research papers appended to this thesis suggest that the progression from technical function to realised affordance is highly dependent upon the skills and interests of the stakeholders. Despite their initial scepticism, *complementors* have supplied much of the impetus to develop the digital platform. As each complementor approaches the technical object (upon which the platform is built) with different perspectives, they each see affordances that can be accommodated, and affordances that cannot be accommodated. The latter may also be considered as constraints (Leonardi, 2011). *Users* essentially follow the same pattern, albeit with a greater focus on the bottom line. That is, they do not necessarily see the platform as a structure on which to build, but rather the potential for practical application in aid of organisational functions, strategies or goals. In other words, each complementor and user provides a view of *individual* affordances that are – or are not – enabled in the current platform architecture. Although there may be no such thing as truly *shared* affordances in an ecosystem of uncoordinated actors (as that would entail common goals), we may consider *generic* affordances as a "critical mass" of similar individual affordances sought from the platform. It is well-established in theory and practice that (industry) platforms focus external resources and thus facilitate value-creation and innovation (Gawer, 2014; Tiwana, 2014) and that platform owners need tools such as boundary resources to manage the ecosystem of actors (Eaton et al., 2015; Ghazawneh & Henfridsson, 2013). A relational perspective on digital platforms provides complementary insights by showing how the unique perspectives and skills of stakeholders provide input for development of the platform itself.

6.2. Digital Platform Stability

The idea of stability in platform research harkens back to ideas developed in industrial manufacturing. Manufacturers that sought to combine economies of scale with economies of scope adopted a product architecture that permitted the combination of low-variety elements and high-variety elements (Meyer & Utterback, 1993; Wheelwright & Clark, 1992). The underlying logic is that the low-variety elements that remain invariable over time can be mass-produced and used in multiple products or variants of the same product, whereas high-variety elements are used to create variance in market offerings. This approach is widely used in the automotive industry, where parts of the frame (as well as other components) are reused whenever possible in order to expedite new product development and reduce

manufacturing costs (Gawer, 2009; Nobeoka & Cusumano, 1997). The idea of stability as the result of fixed components in an architecture has remained a mainstay in subsequent research, even as the platform-concept has been applied to other empirical phenomena (Baldwin & Woodard, 2009). However, as platform research increasingly draws upon IT-based platforms (Thomas et al., 2015), the idea of individual components as a source of stability is difficult to apply. Simply put, the limited life-span of digital technology and dynamicity of digital ecosystems do not readily lend themselves to the notion of low-variety elements (Tiwana et al., 2010). With the exception of the fundamental standards that permit interoperability between computer components (Wareham et al., 2014) and communications networks (Hanseth & Lyytinen, 2010), digital technology is essentially comprised of only high-variety elements.

Given the high rate of obsolescence in digital technology, basing the stability of a digital platform solely upon any structural (i.e. technical) element is problematic at best and infeasible at worst. Stability would soon give way to arrested development as the platform would be unable to reflect new technical requirements and innovation permitted by competing actors and/or platforms. The rapid demise of the Symbian platform for smartphones provides a germane (and chilling) illustration of just how fast a technically stable yet structurally rigid platform can become dislodged in the face of more enticing alternatives (West & Wood, 2013). Faced with the inadequacy of considering components or technology as low-variety elements, we require alternative conceptualisations of stability for digital platforms. In keeping with the relational perspective applied in this thesis, we need to address the multifaceted nature of the focal phenomenon. A similar point is argued by Lee et al. (2015), albeit from a design science perspective. In order to further our understanding of design, we must expand our scope from a generic information technology perspective to a more contextually bounded *information systems* perspective. With that in mind, they propose the concept of information systems artefact (or simply *IS artefact*) which is comprised of thee subsystems: technology artefact, information artefact, and social artefact (see chapters 3.1.1 and 3.1.3). Although their discourse is primarily design-oriented, I consider their conception of how an IS artefact represents a confluence of technical, informational, and social aspects pertinent to discuss the relevance of these same factors in relation to stability in digital platforms.

The results from the research presented in the appended papers (as summarised in chapter 5) suggest that it is difficult to attribute stability to any one aspect of the digital platform. As a *technology* artefact, it progressed through three distinct generations. While each generation furnished the

platform with improved functionality and flexibility, they also featured highly disparate architectures that are technically incompatible. Even so, hardware from all three generations is still in use with access to the same selection of complements.[23] As an *information* artefact, the platform accommodates different externally developed complements and is integrated in a wide variety of user contexts. Facilitating the connection is not merely a matter of physical connectivity, but also a matter of providing the necessary instructions for how to handle the different streams of data and translate between the syntaxes of the different systems. As this process is difficult to standardise, software modifications are a frequent necessity. As a *social* artefact, stakeholders have different relationships with the platform. The platform owner is keen to present it as a platform through which to access different complements (in the form of digital services). However, this viewpoint is not a self-evident fact given that its ability to facilitate secure communications can be applied for any number of reasons in a variety of circumstances. The most obvious disparity between perspectives may be gleamed from paper 3 where the user did not consider it a platform at all, but merely infrastructure. Hence, viewed as an IS-artefact, we may surmise that all aspects of the digital platform are fluid and subject to technical, informational and perceptual change.

Based on the findings presented in this thesis, I suggest that stability in digital platforms should not be considered as absolute, but rather a "moving target" that reflects technical development, functional requirements and societal expectations that change at different speeds. In a previous effort to theorise digital platforms, I argued that the "notion of a digital platform core may be better explained as a capability to deliver an invariant outcome (i.e., a service) despite variable technical baselines" (Saarikko, 2016, p. 188). While I do not wish to refute my own claims, I will admit that the phrasing is unfortunate as "invariant outcome" could imply that the end result is always the same. With the benefit of hindsight – and a new analytical context – I would therefore like to offer a more open-ended definition of stability in relation to digital platforms. Stability may tentatively be expressed as the ability to leverage digital technology to attain *goal-oriented outcomes* despite variant circumstances. Furthermore, results suggest that while technical development and varied functional requirements may be manageable given the right set of skills, the issue of societal expectations – and more broadly *platform identity* – may pose a more serious challenge.

[23] However, the hardware in the older generations cannot accomodate all complements. For instance, the lack of GPS transponders in generation 1 hardware prevents the use of services based on positioning.

6.3. Digital Platform Coring

The guidance provided in extant literature for establishing a platform is largely based on the ability of an actor to identify platform potential in a technology which is typically abstracted into the concept of a platform *core* (Baldwin & Woodard, 2009). The strategy of *coring* describes "the set of activities or strategic moves a firm can use to create a platform when none existed before by identifying or designing an element (a technology, a product or a service) and making it fundamental, or 'core', to a technological system as well as to a market" (Gawer, 2009, p. 65). In relation to industry platforms, a core expresses a technical structure that provides a foundation of some kind upon which complementors can build, innovate and ultimately create value for themselves as well as the platform owner. The relationship between platform owner and complementors are typically described as based on technical interfaces that embody rules and standards (Greenstein, 2009) as well as what types of complements are permissible (Boudreau & Hagiu, 2009). This approach is often a matter of convenience or even necessity as industry platforms have the potential to attract large ecosystems of actors with disparate perspectives, skills, agendas and goals (Tiwana, 2014). Iansiti and Levien (2004) argue for the systemic importance of platform providers in their notion of *keystone firms* which "occupy richly connected hubs that provide the foundation for creating many niches, regulate connections regulate connections between ecosystem members, and work to increase diversity and productivity. They provide a stable and predictable platform on which other ecosystem members can depend, and their removal would lead to the catastrophic collapse of the entire system" (p. 82).

The means by which a (prospective) platform owner identifies a technology/product/service with platform potential is via its ability to 1) perform an essential technical function, and 2) solve a business problem for a large number of firms (Gawer, 2009; Gawer & Cusumano, 2008). An underlying – yet unstated – assumption in this conception of a coring strategy is that the intended benefits and values of the core technology are readily perceptible and comprehensible. That is, would-be platform stakeholders (i.e. users and complementors) find the core not just appealing, but also understand how it fits with their requirements and interests. The assumption of a priori understanding and interest is perhaps not surprising given the popularity of platforms such as Apples iPhone – a platform for which complementors created software and "apps" before it was permitted by the platform owner (Ghazawneh & Henfridsson, 2013). Another example used by Gawer (2009; 2014) is the example of IBM's system 360 technology platform which was gradually wrestled away from IBM as complementors started selling IBM-compatible components. Although both cases are

perhaps extreme in the sense that the platform owner was essentially pre-empted, they are symptomatic of the idea that the value and utility of platforms are assumed to be readily visible.

The research presented in this thesis offers a different perspective. If one assumes (as we have) a relational perspective on digital platforms, it follows that one views the *platform core as a relational structure* that is subject to diverging perspectives. From a strictly functional perspective, the core of the digital platform featured in the appended research papers is to provide a robust, secure link for communication between two points. While solving this issue is a feat of design and engineering, its business potential is far from apparent. Nor can it be assumed that prospective stakeholders understand the problems that one has to overcome in order to devise the underlying technology. In that situation, no amount of clearly defined technical interfaces or boundary resources will serve to aid the aspiring platform owner. Instead, results show that the process of *technical* coring was complemented with what can be considered *information* coring as well as *social* coring. The information core relates to management of the different streams of data and translation between different syntaxes that intersect as the platform integrates different complements into different contexts. The perception of the platform is largely determined by the digital components (i.e. the service and contents layers from figure 2). Like any other information system, only the visual interface of a digital platform may be discernible to users (Venkatesh & Ramesh, 2006). Although it is only the tip of the proverbial iceberg, this small portion of the overall platform architecture is what users understand and appreciate. Hence, the idea of information coring essentially involves boiling down a sea of data and contingencies into a simple, contextually viable delivery system for information. The social core manifested in distinct ways for respective stakeholder types. As complementors were concerned with their complements being co-opted or customer relationships interrupted, the platform owner took a proverbial step back and refrained from dominating their complementors (cf. Bergvall-Kåreborn & Howcroft, 2014). While users were less concerned with who delivers what, they were all the more keen to preserve a simple supplier-customer relationship rather than face a web of suppliers of digital services. The platform owner responded by complementing their integrated technical solution with a commensurate organisational structure by assuming first-line support for all technical difficulties. Hence, based on the findings presented in this thesis, I suggest that the core of a digital platform should be considered from a technical sense as well as an informational and social sense, and that there needs to be a clear alignment between the three.

6.4 Implications

Based on the findings which have been presented in chapter 5 and discussed in chapters 6.1-6.3, this thesis offers a number of implications for research and practice.

6.4.1 Implications for Research

The line of reasoning pursued in chapter 6.2 invites the idea of *combining* a relational perspective with the idea of conceiving digital platforms as information systems artefacts. Rather than draw exclusively upon the ontology of digital technology (as exemplified via the layered modular architecture, Yoo et al., 2010), we see platforms as constituted of technology artefacts, information artefacts and social artefacts. Each of these artefacts can have a different relationship with each type of stakeholder – and thus offer different affordances. A research design based upon this relational, multifaceted view could offer new insights into several avenues of research in relation to digital platforms. For instance, platform *generativity* describes the ability of a platform or technology to spawn new and unexpected additions and innovations from a diverse base of users and complementors. This ability is typically associated with willingness of stakeholders to actively engage with a platform based on properties such as accessibility, usefulness, and adaptability (Zittrain, 2006). Recent research on generativity has highlighted that attainment of generativity is a balancing act of control and change that is not solely enacted via technology, but rather a mesh of social- and technical factors (Tilson et al., 2013) where user agency is a central component (Eaton et al., 2015). This contingent, stakeholder-dependent view of platform change and control appears amenable to the relational, multifaceted view of digital platforms suggested in the previous section. A more granular view of digital platforms may offer opportunities to elaborate on the mechanisms that fuel generativity rather than reduce it to a few general properties or strategic levers (Tilson et al., 2010).

However, while an expanded, more complex view of digital platforms provides opportunities for studying this phenomenon, it also invites serious questions regarding *platforms* as an area of research in information systems research. The range of empirical phenomena conceived as platforms is undoubtedly diverse, including industrial manufacturing, e-commerce, computer components and mobile telephones (Gawer, 2014; Gawer & Cusumano, 2014). The range of applications for platform research is reflected in the increasing abstraction of platforms as a concept e.g. tangible components that are persistent across multiple products or product varieties (Wheelwright & Clark, 1992), an evolving technological system (Gawer &

Henderson, 2007), a technology, product or service that solves problems for multiple actors (Gawer, 2009) or a multi-sided marketplace that connects different types of actors (Hagiu, 2014). Given the sheer diversity of empirical phenomena and theoretical framings, whatever commonality there is to be found in platform research takes the form of exceedingly high levels of abstraction, such as the notion of *leverage logics* presented by Thomas et al. (2015). Based on the findings presented in this thesis, I suggest that platforms are essentially relational constructs and that our understanding of a digital platform core could benefit from disentangling into three distinct subsystems. While I stand by the assertion that such an approach could provide new insights, it also serves to further dilute the already diverse notion of platforms and the vague properties of a platform core. In our own field of information systems research, recent years have seen research focus more on issues that are peripheral to platforms, such as boundary resources (Ghazawneh & Henfridsson, 2013), the dynamics of platform-based ecosystems (Tiwana et al., 2010) and the influence of ecosystem participation on firm roles and identities (Lindgren et al., 2015). The platform itself seems to be left out of scope – and perhaps with good reason. How far can we push the platform metaphor and still utilise it to derive useful, *accurate* insights into complex phenomena? At what point do we accept that digital (or digitised) platforms are more aptly described as a set of standards, systems, actors, contingencies and goals? Yes, we can utilise "digital platform" as an *analytical delineation* that toes the line between infusing a socio-technical phenomenon with an *a priori* identity, and dissecting it into infinite layers of social structures (Grint & Woolgar, 1991). However, reifying digital platforms (or platforms in general) as actual objects is ultimately likely to do more harm than good.

6.4.2. Implications for Practice

Academic misgivings notwithstanding, a deeper understanding of digital platforms is arguably more relevant than ever from a practice point of view. Digital components are increasingly incorporated into existing products e.g. vehicles and wearables, which enable their transformation into platforms for product–based services (Porter & Heppelmann, 2014). This development is part of the overall digitisation of both business and society, whereby physical goods and items are combined with digital technology to extend their functionality as well our ability to leverage them for personal or professional needs (Yoo et al., 2010). Hence, a digitised product not only offers avenues for new features, but also offers several additional advantages. First, digitisation offers the prospect of complementing a physical product with digital modules which exhibit the low cost and high flexibility of all forms of digitised data (Henfridsson et al., 2014; Yoo et al., 2010). Second, digital

technology enables loose couplings between (hardware) form and (software) function (Yoo et al., 2012), meaning that a digitised product can be modified after leaving the factory by updating its software with new instructions. Hence, digital modules that complement or enhance a product can be developed and sold long after the product has been delivered and put into use. Third, rather than going it alone or within a select group of partners, digitised products offer significant opportunities to invite external competence – either in planned, formal networks, or on a more emergent, ad-hoc basis (Lyytinen et al., 2016). Openness is of course not endemic to digitisation, but the advantage of leveraging external skills is a sufficiently powerful incentive to push even conservative industries towards a more inclusive mind-set (Svahn et al., 2017).

The relational approach pursued in this thesis can provide insights into how innovating in an increasingly digitised and distributed world affects existing social and cultural expectations. For instance, a manufacturer may choose to reposition an established physical product as a (digital) platform for services that somehow adds value and/or functionality. However, digitising a product and complementing the existing architecture with digital components may not be all that easy. Existing research has already demonstrated the practical difficulties of combining physical and digital materials in product development (Svahn, 2012). Moreover, the results presented in this thesis suggest that in addition to purely technical considerations, the issue of product versus platform *identity* may be equally daunting. The distinction between digitised product and digital platform is largely a matter of perspective. In both cases, you have a fixed physical architecture that can accommodate variation in the digital medium. There is no guarantee that users will get automatically accept the "new" platform identity – especially if they are accustomed to the "old" product. Moreover, the mere availability of technical interfaces that permit complements does not automatically mean that third-party providers will be eager to engange with a new market or industry. Rather, the (prospective) platform provider needs to create support for the platform identity and consider what functionality might drive adoption, and how that is communicated for different stakeholders. In other words, the idea of *platform* coring needs to be expanded to a wider sense of *ecosystem* coring in which technology is only one of several indispesible components. It is possible (or even likely) that as the product is repositioned as a platform, the sponsoring organisation will need to enhance its scope and cultivate additional capabilities.

6.5. Limitations and Future Research

As with all research, the results presented in this thesis offer neither an absolute truth nor is it without flaws. This section will present the limitations in the research design as well as offer some suggestions for subsequent research.

The first limitation is related to limitations in the empirical data. The results presented in this thesis are based on a single-case study which offers the opportunity for generalisation to theory (Mason, 2002; Yin, 2011). However, their results are restricted by the theories and analytical frameworks applied in data analysis (Walsham 1995; Klein & Myers 1999). Any singular analytical approach serves to cast a spotlight on a specific aspect of a phenomenon, but also leaves other aspects buried in the shadows. I have sought to address these limitations in two ways. First, I have gathered data on the case across two separate projects that have each provided different empirical contexts. Whereas project #1 provided data on relatively mature stakeholder relationships, project #2 offered insight into the very early phase of an inter-organisational collaboration. Moreover, the different projects also entailed different preconsitionas and goals which affected the role into which the "platform" was cast. Second, I have theorised digital platforms using several different theoretical frameworks: options theory (paper 1), entrepreneurial alertness (paper 2), organisational boundaries (paper 3) and a service-oriented perspective (paper 4). While I have sought to mitigate the risk of overlooking relevant factors by applying multiple, diverging analytical frameworks, it is nonetheless an inescapable fact that the results presented here do not cover every conceivable theoretical standpoint. Hence, the application of other ontological, epistemological or theoretical perspectives could very well reveal additional insights that complement the findings of this thesis.

Second, and related to the previous point, the use of a single case implies that while we can provide analytical generalisation, we cannot claim *statistical generalisation* or gauge to what extent the characteristics of the phenomenon featured in the appended papers is representative for other instances. We cannot be certain if the properties of the digital platform featured here is representative of digital platforms *in general*. For instance, the results presented in this thesis are bounded by the scope of the platform (i.e. an industry platform) as well as the inclusive view of digital platforms as comprised of both physical and digital components. While the logical limitations of statistical generalisation have been described by Lee and Baskerville (2003), additional empirical research into digital platforms is

necessary in order to furnish us with a more comprehensive understanding of how digital platforms can manifest in practice.

Third, the appended research papers each apply an interpretive approach, meaning that the results are the result of a "double hermeneutic" (Walsham, 1995). The empirical phenomenon has been directly experienced and interpreted by the informants who then share their experiences and understanding with the researcher. Hence, the researcher is one step removed from the phenomenon, and is essentially re-interpreting the informant's original interpretation of the empirical phenomenon. As this cover paper applies a "new" framework through which the results of the appended papers are integrated and re-examined, the results presented in this thesis may be said to represent a *triple* hermeneutic. In other words, I have re-interpreted the findings of the four appended papers via an affordance perspective. As the results described here represent a rather high level of abstraction, future applications of an affordance perspective on digital platforms should be designed "from the ground up" to provide a tighter coupling between research aim, theory, and methodology (Robey, 1996).

Fourth (and last), while much of the interest in affordance theory in relation to information systems and information technology started with Zammuto et al. (2007) outlining how IT can provide affordances for organisational strategies, it is equally viable (and pertinent) to consider the (technical) structures that need to be in place for affordances to emerge. This perspective may be considered a reversal of the causality presented by Markus and Silver (2008) and marks a road that is thus far less travelled in information systems research. Rather than begin with a *technical object* and study how it may be applied in an organisation, one identifies sought *affordances* relative to goals and stakeholders prior to selecting or designing the corresponding technology. Examples of this approach have been presented by Seidel et al. (2013) and Cousins and Robey (2015). Seidel et al. (2013) conduct a study of environmentally sustainable work practices in which they outline four functional affordances that need to be enabled by judicious use of IT: reflective disclosure, information democratisation, output management, and delocalisation. Based on a study of work-life balance, Cousins and Robey (2015) outline five affordances for mobile technologies that affect the management of work-life boundaries: mobility, connectedness, interoperability, identifiability, and personalisation. As the affordances outlined by Seidel et al. and Cousins and Robey are persistent over time, future research could investigate *functional affordances* as a means to evaluate (or plan) information technology investments.

7. Conclusions

The constituent papers of this thesis have addressed the topic of digital platforms from various perspectives – some of them admittedly more tenuous than others. Looking at their combined results, this dissertation has addressed the issue of digital platform stability in relation to stakeholders. The relative significance of the latter part of the research question is reflected in the adoption of affordance theory as a theoretical framework through which to view, consider and integrate findings from the respective papers into a coherent thesis. While extant platform literature has explored issues pertaining to governance, ecosystem management, market dynamics, platform establishment et cetera in a fair amount of detail, the issue of stability has thus far not received much attention. Based on the findings presented in chapters 5 and discussed in chapter 6, this thesis offers two main contributions.

First, the idea of platform stability as derived from low-variety components that are persistent over time is difficult to apply in relation to digital platforms. The rate at which digital technology evolves via incremental improvements as well as radical improvements makes change the norm rather than an intermittent occurrence. Furthermore, change happens at all levels of digital platforms, meaning that the only source of *technical* persistence to be found is the general standards used to maintain basic interoperability in diverse network infrastructures (such as the Internet). Hence, limiting our understanding of stability to technical or structural features is insufficient in relation to digital platforms. Rather, we need to approach stability as a composite property, based on the ability of the platform to satisfy technical, informational, and social expectations. These expectations are always in flux – both individually and in relation to one another. Hence, stability should not be considered as a fixed or absolute property, but rather a moving target. A tentative definition of stability in relation to digital platforms may therefore be expressed as *the ability to leverage digital technology to attain goal-oriented outcomes despite variant circumstances*.

Second, extant research described platform establishment in terms of a "coring" strategy in which the prospective provider identifies and develops an element or technology that has market potential. In relation to industry platforms, the core takes the form of technical foundation upon which third-party actors can provide complements that serve to foster innovation and/or value creation for the aggregate platform ecosystem. Relationships are typically limited to technical interfaces provided by the platform owner that

explicate permissible actions in relation to the platform. An unspoken assumption in this conception of a coring strategy is that the mere availability of an appealing technology or technical foundation is sufficient to attract external interest. The technical applicability and business relevance of the platform is assumed to be immediately recognisable to potential platform adopters. This thesis suggests that the existing notion of (technical) coring needs to be complemented with *information* coring and *social* coring when applied to digital platforms. The proposed concept of information coring expresses the ability to simplify a vast complexity of data streams and algorithms into information presented to the user in a comprehensible manner. Social coring refers to the idea of complementing the technical architecture of a platform with corresponding organisational structures where needed i.e. to mirror technical integration and social integration in a platform.

A relational perspective applied to digital platforms offers a possible avenue for theorising digital platforms as *information systems artefacts* rather than the dichotomous relationship between platform-as-architecture and platform-as-marketplace found in extant literature. However, the results, theories, and perspectives presented in this thesis are based on a single case. More empirical studies of digital platforms are needed to validate – and expand upon – the findings presented here.

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