

MASTER

Managing interdependencies in business ecosystems

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Eindhoven, January 2016

Managing interdependencies in business ecosystems

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requirements for the degree of

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in Innovation Management**

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Abstract

Background: Ongoing industry convergence is creating new types of interdependencies between telecom- and cable-operators and other players, forcing operators to adapt to new roles in continuously evolving business ecosystems. In order for operators to be able to make a grounded decision on which roles to pursue, they must be aware of the interdependencies that exist between the various roles in a business ecosystem and should know how they could manage the interdependencies.

Research objective and questions: The objective of this study was to see how interdependencies in business ecosystems might best be managed, embodied by the primary research question: *How can interdependencies in a business ecosystem be managed?* Two secondary research questions supported the primary research question. First, *what are the structures of the task relationships of interdependencies in a business ecosystem?* Second, *what are the control mechanisms used to coordinate interdependencies in a business ecosystem?*

Method: The research strategy was a single, embedded, and retrospective case study of the business ecosystem organized around the media- and entertainment-platform by a large, international cable-operator. Three data collection methods were used: documentary analysis, focus groups, and interviews. Subsequently, Qualitative Content Analysis (QCA) was the method used for analyzing the data from the interviews.

Results: The interdependencies in a business ecosystem have differently structured task relationships, and the interdependencies are coordinated with different control mechanisms, depending on the structure of interdependence. Moreover, a new way of reducing interdependencies is proposed that fundamentally enhances the opportunities to manage interdependencies; it involves changing the structure of the task relationship of interdependence to a structure with a lower task contingency. This radical way of managing interdependencies is recommended to be used in combination with control mechanisms in a sequential order.

Conclusion: The original theoretical contribution of this research is showing how interdependencies in business ecosystems differ in their structure, and suggesting how these interdependencies might be effectively managed.

Preface & Acknowledgements

In front of you lies the end product of what has been a memorable three years at the Eindhoven University of Technology (TU/e). This master thesis has been submitted in partial fulfillment of the requirements for the degree of Master of Science in Innovation Management at the Industrial Engineering & Innovation Sciences faculty of the TU/e. The research group to which it hopefully contributes is the Innovation, Technology, Entrepreneurship and Marketing (ITEM) group. I would like to thank some people that supported me throughout the process.

First of all, I would like to thank my mentor, Ksenia Podoyntsyna. In our first session we discussed my interests, motivations, and ambitions. At the end you concluded I was too broadly interested and had to find some focus. I appreciate you fulfilling the role of mentor in a broader sense than just academically. That especially has been of great help. You were patient with me and gave me the time to explore. Occasionally, when the horizon of this project seemed never-ending, you gave me motivation. Thank you. In addition I would like to thank my second assessor, Sjoerd Romme, for making the time to meet with me, assessing my work and providing valuable additional guidance for this research project.

Hereby, I would also like to thank Rogier de Wit for allowing me to do this thesis project at EY, and Claudia Hinten for assisting me during my time at EY. Similarly, credits go out to all interviewees who were willing to make some time available to talk to me. I have had some very interesting and pleasant conversations, often going beyond mere formalities and ending up to be a great career consult or friendly connection. If one day I am in a position that my knowledge or experience could be valuable input for a thesis or whatever educational project, I will go out of my way to schedule some time like you all did.

While I have learned a lot from this research, more questions than answers remain. The more I came to know, the more I realized how much there is I do not know. At some point, I could not see the wood for the trees. I was not the first to discover this paradox of gaining knowledge. The likes of Confucius, Socrates and Einstein all preceded me.

“The more I learn, the more I realize how much I don't know.”

— Albert Einstein (1879 – 1955)

This thesis provides some insights, but it will likely leave you with even more questions. I hope that will be a source of inspiration rather than a source of frustration.

Joep Heerings

Eindhoven, January 2016

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List of Abbreviations

API	Application programming interface
CEO	Chief Executive Officer
COSO	Committee of Sponsoring Organizations of the Treadway Commission
CPE	Customer-premises equipment
DRM	Digital rights management
ERM	Enterprise Risk Management
EY	Ernst & Young
IACC	Internal Audit, Control & Compliance
ICT	Information and communication technology
IP	Intellectual property
IPR	Intellectual property rights
IT	Information technology
LLC	Limited liability company
M&A	Mergers and acquisitions
NCC	Non-compete clause
NDA	Non-disclosure agreement
NOC	Network operations center
OTT	Over-the-top
QCA	Qualitative Content Analysis
RDK	Reference Design Kit
SLA	Service-level agreement
SMA	Service maintenance agreement
SMS	Short Message Service
SOC	Information security operations center
STB	Set-top box
TCE	Transaction cost economics
TMT	Technology, Media & Telecommunications
TV	Television
US	United States
VP	Vice President

1. Introduction

Today, Apple is considered to be the most valuable global brand, having an estimated brand value of over 128 billion US dollars (Finance, 2015). Apple is closely followed by Samsung, Google, and Microsoft. Furthermore, Verizon, AT&T, Amazon and China Mobile can also be found in the top 10 most valuable global brands. Meanwhile, Twitter, Baidu and Facebook are the top three brands with largest brand value growth from 2014 to 2015 in percentage. All of these firms operate in the Technology, Media & Telecommunications (TMT) sector, a new cross-industry segment created through the forces of industry convergence.

Through a process of digital convergence (Yoffie, 1997) the formerly distinct industries of telecommunications, information technology and media have been and are still rapidly merging. The process of digital convergence is the unification of functions – “the coming together of previously distinct products that employ digital technologies” (Yoffie, 1997, p. 2). Digital convergence is an example of technological convergence, which is the combination of previously distinct technologies into a common product (Basole et al., 2014). Technological convergence, in turn, can lead to industry convergence, which involves a collision of business models and gradual blurring or redefinition of industry boundaries (Basole et al., 2014). Converging industries can create a new cross-industry segment that widens markets, lowers barrier to entry and increases competition.

Due to the convergence of industries, many firms these days are not member of a single industry, but are rather part of a business ecosystem that crosses a variety of industries (Moore, 1993). Think of how Apple is the leader of a business ecosystem that crosses several traditional industries: personal computers, consumer electronics, information, and communications. Firms may also be involved in several business ecosystems at the same time (Pierce, 2009). Hence, “a traditional industry or market may contain numerous overlapping ecosystems” (Pierce, 2009, p. 325). A business ecosystem can be defined as a network of interconnected, co-evolving organizations, organized around a focal firm or a platform, which incorporates both production and use side participants, and focuses on the co-creation of new value through innovation (Thomas & Autio, 2013). The ecological metaphor of business ecosystems has been introduced to highlight interdependencies between organizations and to provide a fresh way to think about specialization, co-evolution, and co-creation of value (Thomas & Autio, 2012).

Business ecosystems have been successfully used as a form of organizing, particularly in sectors as smartphones, gaming, and commercial software (Wareham et al., 2014) and will only become more important in determining competitive success in the future (Williamson & De Meyer, 2012). Business ecosystems can be superior to both the classic integrated organization or to a streamlined supply network based on principal-agent relationships (Williamson & De Meyer, 2012). By leveraging a network of specialized partners, each with their own activities, assets and capabilities, a business ecosystem can offer flexibility in the

face of more complex and changing customer demands. Through the mobilization of diverse tacit knowledge in the ecosystem, customer service and innovation speed can be improved (Williamson & De Meyer, 2012), and subsequently a firm's sales (Ceccagnoli et al., 2012).

Along with opportunities, however, business ecosystems also present a new set of interdependencies that can brutally disrupt a firm's best efforts (Adner, 2006). Prior research has portrayed the organizations in a business ecosystem as being interdependent (Moore, 1993; Pierce, 2009; Kapoor & Lee, 2013) and found that interdependence is one of the key sources of risk in business ecosystems (Adner, 2006). Yet, while many studies refer to the interdependence between firms in business ecosystems, no study of influence has looked into the structure or nature of those interdependencies, let alone how to manage them. This study complements prior research on governance of business ecosystems (e.g. West (2003), Enkel et al. (2009), Tiwana et al. (2010), Eaton et al. (2011), Ghazawneh and Henfridsson (2013)) by focusing on managing interdependencies in business ecosystems. This study looks at coordination and control mechanisms, as they have been considered an effective way to coordinate interdependencies (Gulati & Harbir, 1998; Dekker, 2004), and coordination is even defined as the process of managing dependencies between activities (Malone & Crowston, 1994; Tiwana et al., 2010).

The new interdependencies in business ecosystems are particularly evident in the TMT-sector, between operators and other players, forcing operators to adapt to new roles in continuously evolving ecosystems. In order for operators to be able to make a grounded decision on potential partnerships in the ecosystem, they must first be aware of the interdependencies that exist between the various roles in a business ecosystem. Subsequently, they would have to know how to manage the interdependencies. Therefore the objective of this study was to see how interdependencies in business ecosystems might best be managed, embodied by the primary research question: *How can interdependencies in a business ecosystem be managed?* In order to answer this research question, a single case study was held, with semi-structured interviews as the key data collection method. The selected case study was the business ecosystem organized around the media- and entertainment-platform offered by a large cable-operator. It was selected for being a typical and representative case for business ecosystems around operators in the TMT-sector.

This thesis is structured as follows. First, as part of the introduction, the practical background demonstrates the practical need for this research. Second, the literature review provides the theoretical background on business ecosystems, interdependence, and control. Third, the research method will present and justify how the research questions were approached. Fourth, the empirical results of the study are reported. Fifth, the discussion considers the managerial implications, contributions to the literature, the limitations of this study, and opportunities for future research. Finally, the thesis will end with a conclusion.

1.1 Practical background

The context for this research is vital in identifying its practical relevance and potential significance. The research was performed at EY. EY (formerly Ernst & Young) is one of the world's largest professional services organizations with its key services traditionally being accountancy and tax services. In recent years, EY has also developed a consultancy-service aimed at performance improvement, assurance and risk and IT risk. The later sub-service is treated in the department of EY Risk Advisory – Internal Audit, Control & Compliance (IACC), the department at which this thesis was performed.

The types of clients common to EY are almost exclusively global firms, i.e. corporates. One of its key sectors of focus is the Telecommunications, Media & Technology (TMT) sector. In a report by EY, published in 2014 (EY, 2014), the EY risk radar, as shown in Figure 1 presents a snapshot of the top ten business risks for telecoms operators, divided into four quadrants of (1) compliance threats – originating in politics, law, regulation or corporate governance, (2) operational threats – impacting the processes, systems, people and overall value chain of a business, (3) strategic threats – related to customers, competitors and investors, and (4) financial threats – stemming from volatility in the markets and in the real economy.

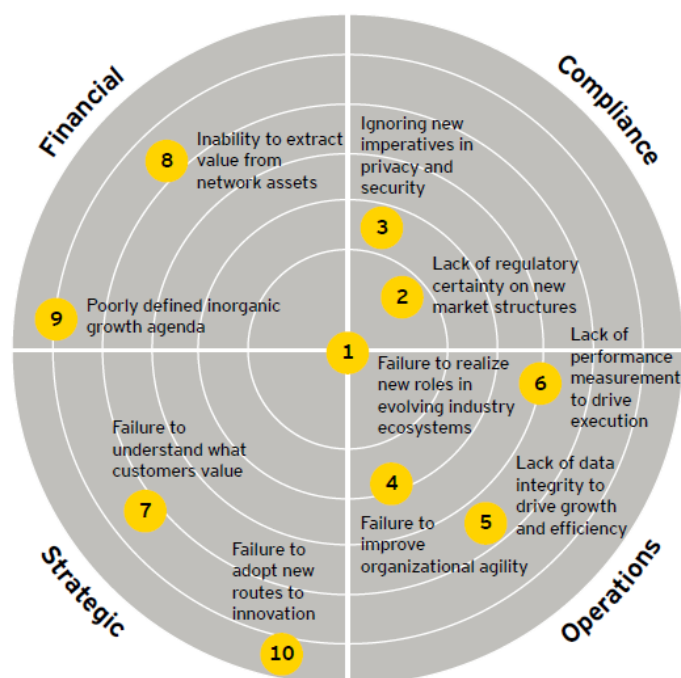


FIGURE 1 EY RISK RADAR 2014

SOURCE: REPRODUCED FROM EY (2014)

The first and most crucial risk identified in the report is the failure of firms to realize new roles in evolving industry ecosystems. As can be seen in Figure 1, this primary risk is positioned right in the middle of the radar, meaning the risk touches upon all aspects of business and encompasses compliance, operational, strategic and financial risks that can

endanger objectives from being accomplished. Some excerpts from the EY Report regarding the risk for operators of failing to realize new roles in evolving ecosystems illustrate the practical relevance and significance of this study into interdependencies in business ecosystems.

“As operators focus on pursuing the fresh vistas of growth opportunity now opening up, not only must they change their business models — a process that many have started — but they must also adapt to new roles across a growing number of industry value chains... The evolution of value chains also brings operators’ interrelationships with OTT (over-the-top) players to the fore” (EY, 2014, p. 11). OTT stands for over-the-top, which means that OTT players deliver their content, for example in the form of video’s, over mobile networks to the end-user (Chan et al., 2015), thereby skipping the telecom- or cable-operator in the delivery of the content. “In many cases, OTT providers have created more appealing alternatives to traditional offerings — for example, with mobile instant messaging services offering greater functionality compared to traditional SMS. The question for operators is whether they should try to emulate these OTT alternatives by developing cross-platform apps in-house or partnering proactively with these players to deliver a richer customer experience” (EY, 2014, p. 11).

“Operators can choose to occupy a range of positions within a single ecosystem in order to maximize the possibilities for value creation. There are already signs that different value chains themselves are combining to create new types of interdependencies ... As a result, operators must take a holistic view of new digital ecosystems, considering how they are likely to expand as customer needs change and complementary use cases arise” (EY, 2014, p. 12).

As can be concluded from the foregoing excerpts from the EY report, the greatest risk for firms operating in the TMT-sector is failing to evolve along with the evolving, business ecosystems of which it is part and not defining a clear role in it. In order for firms to be able to decide on ecosystem strategy and role, they have to be aware of the interdependencies in a business ecosystem, as interdependence is one of the key sources of risk in business ecosystems (Adner, 2006).

2. Literature review

The following literature review provides an overview of the current body of knowledge on business ecosystems, interdependencies and control of interdependence. The method used here was the systematic literature review, and is largely based on a guideline for the conduct of narrative synthesis in systematic reviews by Popay et al. (2006). The literature review is divided into three parts. In the first part, the concept of business ecosystems is discussed, including its advantages and the roles in an ecosystem. The second part then is a discussion on the literature on interdependence. Finally, the third part presents an abridgment of prior research on control of interdependencies.

2.1 Business ecosystems

Markets and hierarchies have dominated our thinking about economic organization for over seventy years (Moore, 2006). Either transactions would take place within hierarchically organized firms, or they would be organized by the market (Powell, 1990). A third form, the ecosystem organizational form, has become increasingly pervasive over the last years (Moore, 2006). The biological analogy of ecosystems in business was first introduced by Moore (1993). Moore suggested “that a firm be viewed not as a member of a single industry but as part of a business ecosystem that crosses a variety of industries” (Moore, 1993, p. 76). This section makes a start by defining what characterizes a business ecosystem.

2.1.1 Defining business ecosystems

Business ecosystems have been getting more attention recently, both in practice as well as in academic literature. However, it has not yet led to a coherent theoretical framework (Thomas & Autio, 2014). Although there is no widely accepted definition of what constitutes a business ecosystem, there seems to be a consensus on some core elements.

At heart, a business ecosystem is a complex and dynamic network of interconnected organizations (Peltoniemi & Vuori, 2004; Li, 2009; Clarysse et al., 2014; Thomas & Autio, 2014), in which symbiotic relationships between participants are formed (Basole, 2009). The relationships within an ecosystem are beyond a traditional value chain due to fluid boundaries between customers, suppliers, partners, information and goods (Li, 2009).

The ecological metaphor of business ecosystems has been introduced to highlight interdependencies between organizations and to provide a fresh way to think about specialization, co-evolution, and co-creation of value (Thomas & Autio, 2012). “In a business ecosystem, firms coevolve capabilities around a new innovation: they work cooperatively and competitively to support new products, satisfy customer needs, and eventually incorporate the next round of innovations” (Moore, 1993, p. 76). The process of co-evolution focuses attention on reciprocal cycles of adaptation among participants in a business ecosystem (Moore, 2006). These participants are often involved in a complex interplay between competitive and cooperative business strategies (Moore, 1993, p. 76). In the

literature, this is often referred to as co-opetition, when firms simultaneously cooperate and compete, as they have mutual interest in defending, developing, and growing the ecosystem (Adner & Kapoor, 2010; Basole et al., 2014). Williamson and De Meyer (2012, pp. 24-25), on the basis of Moore (1993) define a business ecosystem as “A network of organizations and individuals that co-evolve their capabilities and roles and align their investments as to create additional value and/or improve efficiency”. This definition underlines the co-evolution of organizations in a business ecosystem.

Peltoniemi and Vuori (2004) define a business ecosystem to be “a dynamic structure which consists of an interconnected population of organizations” (p. 13). This is still a fairly broad term. Basole’s (2009) definition of a business ecosystem acknowledges the networked character of a business ecosystem and the various interdependencies that exist within it. He defines a business ecosystem as “a complex networked system in which a variety of firms coexist and interdependent symbiotic relationships are formed” (Basole, 2009, p. 146). Thomas and Autio (2012) are in line with Basole and add to the definition that the network of interconnected organizations is “organized around a focal firm or platform” and incorporates both production and use side participants” (Thomas & Autio, 2012, p. 2). A platform can be defined as “products, services, or technologies that act as a foundation upon which external innovators, organized as an innovative business ecosystem, can develop their own complementary products, technologies, or services” (Gawer & Cusumano, 2013, p. 2). Discussing platforms is an entire research stream on its own, and is beyond the scope of this thesis. In later papers, Thomas and Autio (2013) added that the focus of a business ecosystem is on the co-creation of new value through innovation and reinforce this importance of collective value creation (2014), accounting explicitly for the role of complementary asset providers.

Clarysse et al. (2014) also acknowledge the process of collective value creation, in a non-linear fashion through combining of skills and assets, and add to this that the focus of the business ecosystem is on addressing the needs of the end-customer. This focus on integrating individual offerings into a coherent, customer-facing solution is also recognized by Adner (2006).

Synthesizing the different definitions of business ecosystems, the definition by Thomas and Autio (2013) is most comprehensive. On the basis of their definition, the conceptualization of the concept for this literature review is formulated. *A business ecosystem is a network of interconnected, co-evolving organizations, organized around a focal firm or a platform, which incorporates both production and use side participants, and focuses on the co-creation of new value through innovation* (Thomas & Autio, 2013, p. 4). This definition addresses the key characteristics of the business ecosystem as identified in the literature, that is: the value logic of the ecosystem (co-creation through innovation); the ecosystem being an interconnected network of both production and use-side participants (symbiosis); and the locus of coordination in the form of either a focal firm or platform. In case a business ecosystem is

organized a platform, it is often referred to in the literature as a platform ecosystem. Note that the original definition by Thomas and Autio was complemented by the term 'co-evolving' to address the co-evolution of organizations in an ecosystem. Appendix I contains an overview of the conceptualizations of key constructs used in this research.

2.1.2 Unlocking ecosystem advantages

Now that business ecosystems have been defined, a question that arises is: why are business ecosystems getting increasingly popular in practice and theory and what are the advantages of a business ecosystem?

Williamson and De Meyer (2012) distinguish four contextual factors that will drive the importance of business ecosystem strategies. First, many businesses face growing pressure to focus on fewer core activities and, second, many business activities are increasingly relying on knowledge content. Through participating in business ecosystems, firms can tap into knowledge across organizational boundaries, sometimes even beyond traditional industry boundaries (Selander et al., 2013). This allows them to focus on their core activities, while still profiting from specialized knowledge. Third, firms face growing uncertainty, which can be more effectively absorbed by flexible ecosystems. Fourth, advanced information and communication technology (ICT) is becoming more powerful and cost-effective, which enables business ecosystems to organize diverse resources and knowledge distributed across the globe more economically.

Business ecosystems can be superior to both the classic integrated organization or to a streamlined supply network based on principal-agent relationships (Williamson & De Meyer, 2012). By leveraging a network of specialized partners, each with their own activities, assets and capabilities, a business ecosystem can offer flexibility in the face of more complex and changing customer demands. Through the mobilization of diverse tacit knowledge in the ecosystem, customer service and innovation speed can be improved (Williamson & De Meyer, 2012). Through participating in business ecosystem, firms can tap into knowledge across organizational boundaries, sometimes even beyond traditional industry boundaries (Selander et al., 2013), and can subsequently increase their sales (Ceccagnoli et al., 2012).

Williamson and De Meyer (2012) identify the potential strengths of pursuing a business ecosystem as a strategy, from the point of view of the focal firm. First, a business ecosystem strategy allows the focal firm to mobilize a rich diversity of complementary assets, while keeping its own activities focused. In case the focal firm is able to build a platform around which to organize the ecosystem, it may also reap economies of scale with much lower capital investment than it could have achieved as a vertically integrated firm. Second, leaving the complementary assets in the hands of partners avoids the risks associated with M&A (mergers and acquisitions) deals of integration capabilities into one's own organization. Third, a business ecosystem allows a lot of flexibility in its configuration.

Finally, the focal firm will have access to a greater pool of knowledge (Williamson & De Meyer, 2012).

Table 1 shows six keys to unlocking ecosystem advantage from the point of view of the focal firm, as presented by Williamson and De Meyer (2012).

TABLE 1 KEYS TO UNLOCKING ECOSYSTEM ADVANTAGE

SOURCE: ADAPTED FROM WILLIAMSON AND DE MEYER (2012)

Key to unlock advantage	Criticality
Pinpointing the Added Value	Pre-requisite to cover inevitably higher costs than vertically integrated structures
Structuring Differentiated Partner Roles	Essential to achieving the benefits of specialization and focus for individual partners and promoting cooperation over competition
Stimulating Complementary Partner Investments	Enables the lead firm to amplify the impact of its investment and create potential for increasing returns to scale
Reducing Transaction Costs	Key to minimizing an important cost disadvantage relative to vertically integrated structures
Enabling Flexibility and Co-Learning	Flexibility and accelerated co-learning are important potential advantages relative to vertically integrated structures
Engineering Value Capture Mechanisms	Ecosystems have a risk of “free-rider” problems where the network architecture established by the lead firm creates value for participants but fails to capture value for itself

2.1.3 Defining roles in an ecosystem

As seen in the previous paragraph, structuring a business ecosystem with clearly differentiated partner roles is a key to unlock an ecosystem’s advantage (Koenig, 2012; Williamson & De Meyer, 2012). Organizations in a business ecosystem can play one or more roles (Williamson & De Meyer, 2012), and the roles in a business ecosystem are not static. Instead, firms co-evolve their capabilities and roles (Moore, 1993). The set of roles in the ecosystem should be complete and mutually exclusive. A complete set of roles is required to cover all of the necessary tasks to deliver value to the end customer (Williamson & De Meyer, 2012). The roles should be mutually exclusive, because overlapping contributions, and hence overlapping tasks, of firms are likely to lead to duplication, uncertainty and confusion (Williamson & De Meyer, 2012). Ultimately, this will be detrimental to the ecosystem’s performance.

Various studies have in some way attempted to create a role typology for organizations in business ecosystems, reflecting the different streams of research in which business ecosystems have been treated. Some papers have looked at roles in an ecosystem from a strategy perspective (e.g. Iansiti and Levien (2004) and Hagel et al. (2008)). Iyer et al. (2006)

instead have focused on the position of firms in the ecosystem and the number and nature of network-linkages it has.

Williamson and De Meyer (2012) distinguish between a lead firm and suppliers of components, competences or knowledge. The lead firm can actively stimulate and shape the business ecosystem around it, by using smart power. The lead firm does not have to be the largest or have the most resources in the ecosystem. Williamson and De Meyer advocate that the lead firm should aim to promote an ecosystem that combines a comprehensive and mutually exclusive set of specialist niches, each of which makes a different contribution to customer value and that create a positive spiral by generating new knowledge or additional demand as they interact. Competition within these niches may improve efficiency or innovative performance, while competition between niches because of overlapping contributions are likely to have an adverse effect on ecosystem’s performance (Williamson & De Meyer, 2012).

Adner and Kapoor (2010) consider only actors that are only one network link away from the focal firm or customer: suppliers, complementors, and customers, as shown in a generic scheme in Figure 2. Upstream suppliers deliver components that serve as inputs for the focal firm, which then serves a product to its customer. The customer, in turn, bundles complements of downstream complementors together with the focal firm’s product.

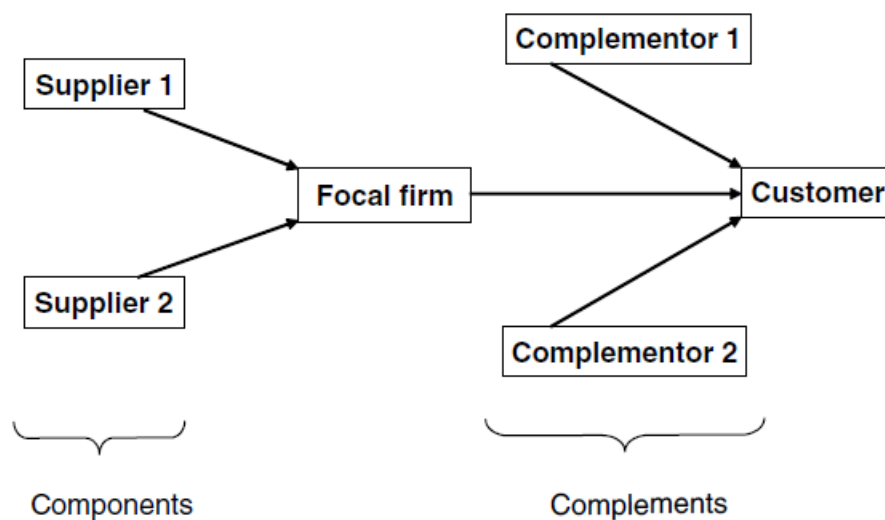


FIGURE 2 GENERIC SCHEME OF AN ECOSYSTEM

SOURCE: REPRODUCED FROM ADNER AND KAPOOR (2010)

Both Iansiti and Levien (2004) and Peltoniemi and Vuori (2004) take a wider perspective and argue that the organizations in a business ecosystem can be any party which influences the system, and can vary in size and purpose. In other words, the business ecosystem could include universities, research centers, public sector organizations, regulatory agencies, media outlets, and a firm’s competitors.

Eisenmann et al. (2008) look at platform ecosystems, and distinguish demand-side users, supply-side users, platform providers, and platform sponsors. “Platform providers mediate users’ transactions; they serve as users’ primary point of contact with the platform. They supply its components and adhere to its rules. Platform sponsors do not deal directly with users; rather, they hold rights to modify the platform’s technology. They design the components and rules, and determine who may participate in the network as platform providers and users. A platform’s sponsor and provider roles each may be filled by one firm or shared by multiple firms” (Eisenmann et al., 2008, p. 4). Eisenmann et al. (2008) argue that for a given platform, each of these roles may be open or closed. They advocate that speaking of “open” or “closed” platforms should always be done in relation to specific roles, rather than just referring to the platform as a whole.

Summarizing, various papers (e.g. Pierce (2009) and Adner and Kapoor (2010)) seem to align in their distinction of ecosystem roles being the focal or lead firm, complementors, suppliers, and customers. In case the business ecosystem is a platform ecosystem, the platform provider and platform sponsor role can be divided amongst different players or be fulfilled by one. The complementor, supplier and customer might be seen as a sub-categorization of the niche player. Figure 3, adopted from Pierce (2009), confirms this thinking. Pierce distinguishes between complementors, customers and suppliers, yet all labels these to be niche firms.

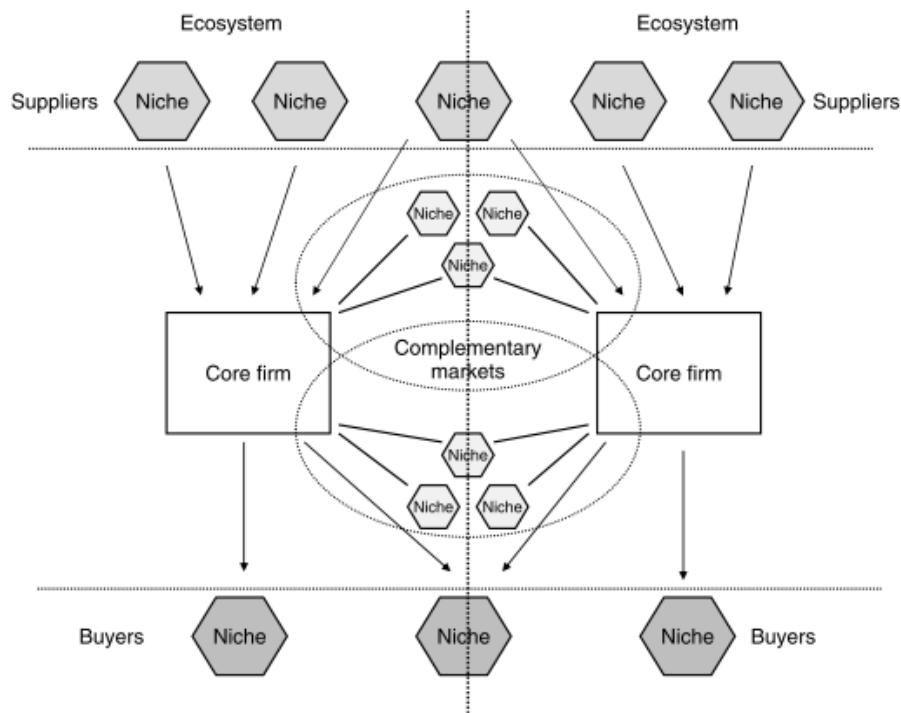


FIGURE 3 COMPETING DIFFERENTIATED ECOSYSTEMS

SOURCE: REPRODUCED FROM PIERCE (2009)

Differentiating between the roles in a business ecosystem can help to define an ecosystem's boundaries. Defining the boundaries of an ecosystem is complex, since business ecosystems are often considered open and accessible (Thomas & Autio, 2014). Iansiti and Levien (2004) state that it is impossible to draw the precise boundaries of an ecosystem. Therefore, their advice to firms is: "to systematically identify the organizations with which your future is most closely intertwined and determine the dependencies that are most critical to your business" (Iansiti & Levien, 2004, p. 2).

The context for this study is the Technology, Media & Telecommunications (TMT) sector, and in order to set the boundaries for the ecosystem under study, it would therefore be helpful to distinguish roles in this TMT-context. Basole (2009) studied the mobile industry, which has great overlap with the TMT sector as a whole, since products and services in this sector are increasingly mobile. Hence, the segments that Basole identifies can therefore be seen as a context-specific role typology. Therefore, Basole's classification will be used as a guideline for differentiating between the roles in this research. The roles he identifies are based on the product or service the role provides to the ecosystem. This is in line with the way Williamson and De Meyer (2012) distinguish between roles. Figure 4 shows the different roles as identified by Basole (2009) and used for this study.

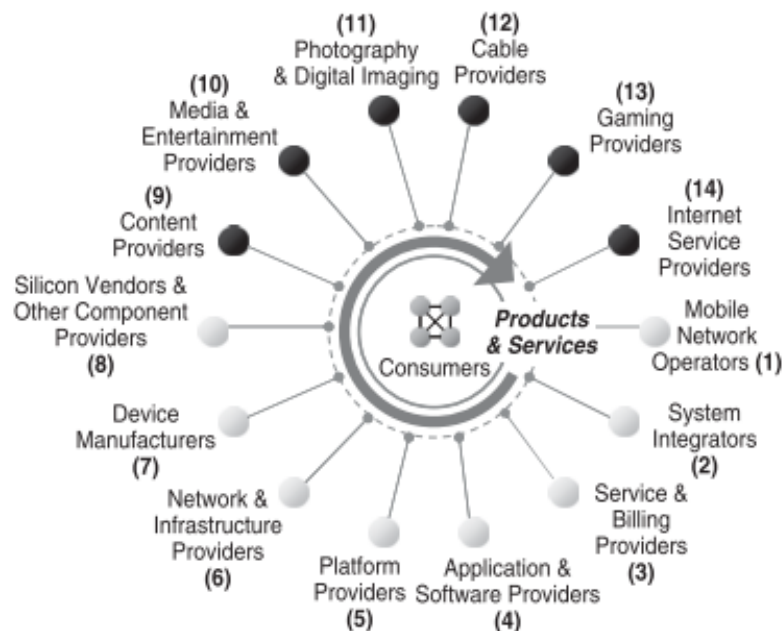


FIGURE 4 ROLES IN THE CONVERGING MOBILE INDUSTRY

SOURCE: REPRODUCED FROM BASOLE (2009)

2.2 Interdependencies

Prior research on business ecosystems has portrayed the organizations in a business ecosystem as being interdependent (Moore, 1993; Pierce, 2009; Kapoor & Lee, 2013) and found that interdependence is one of the key sources of risk in business ecosystems (Adner, 2006). Yet, while many studies refer to the complex interdependence between firms as being a defining characteristic of business ecosystems, no study of influence has looked into the structure or nature of those interdependencies, let alone how to manage them. This section will discuss the concept of interdependence in more detail.

2.2.1 Conceptualizing interdependence

Staudenmayer (1997) recognized that many scholars use a different conceptualization and operationalization of the concept of interdependence. She suggests that the literature on interdependence can roughly be divided into three main theoretical perspectives (information processing theories, resource-based theories, and sense-making theories), which vary along the following analytical dimensions: (1) the primary driver of interdependency (internal technology, internal firm environment, external firm environment), (2) the structure of task relationships (sequential, pooled, reciprocal), and (3) the nature or content of tasks (loose versus tight coupling). Figure 5 shows a framework for understanding interdependency along these dimensions.

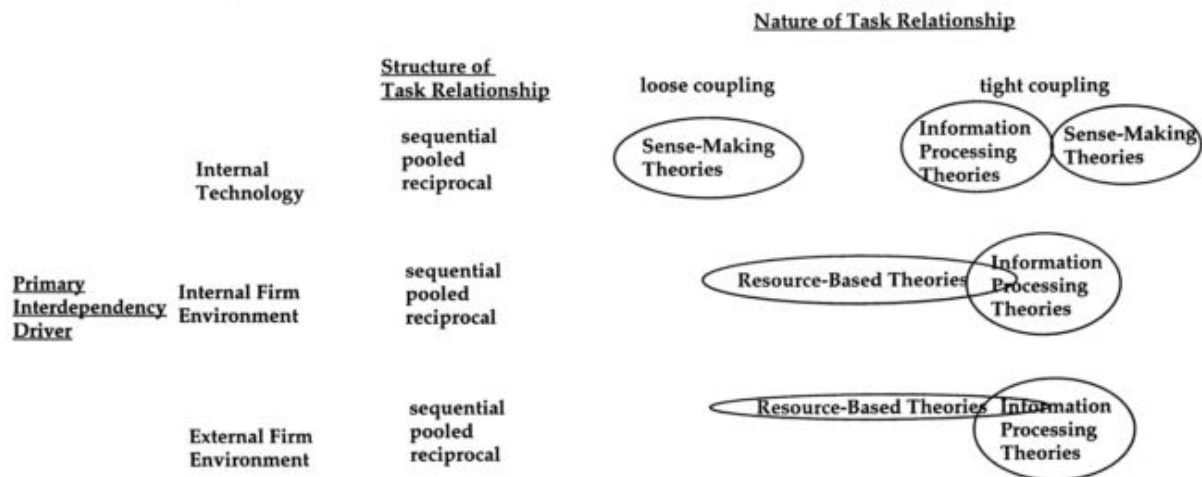


FIGURE 5 A FRAMEWORK FOR UNDERSTANDING INTERDEPENDENCE

SOURCE: REPRODUCED FROM STAUDENMAYER (1997)

Appendix II contains a tabular summary of the three theoretical perspectives along some key dimensions. For a detailed discussion on the three perspectives, please refer to Staudenmayer (1997). This study will be approached from the perspective of information-processing theories. The main motivation for this choice is that this perspective believes that matching coordination mechanisms to interdependencies results in higher performance, which matches the organizational paradigm of EY as the firm aims to create control frameworks for their clients in which they match specific control mechanisms to specific

types of risks. In this thesis, the approach is taken to match mechanisms to interdependencies instead, as these are believed to be a major source of risk (Adner, 2006). The perspective of information-processing theories will be discussed below.

2.2.2 Information-processing perspective

The information processing perspective on interdependence relies on the assumption that organizations are open systems that must process information (to accomplish internal tasks, coordinate diverse activities, and interpret an external environment) but have limited capacity to do so (Staudenmayer, 1997). Thus, prior research in this perspective focuses on interdependencies within the organization (as do most studies in the other two perspectives), with departments or units within the organization as the units of analysis between which interdependencies exist. In this study, however, the focus will be on business ecosystems being the open system, while the organizations operating in the ecosystem will be the units of analysis.

The strength of interdependence between tasks is believed to be a major influence on uncertainty, which is the difference between the amount of information required to perform the task and the amount of information already possessed (Staudenmayer, 1997). The need for information processing arises to minimize the uncertainty (Staudenmayer, 1997). Figure 6 shows the basic underlying model of interdependency according to the information processing perspective, as adopted from Staudenmayer (1997).

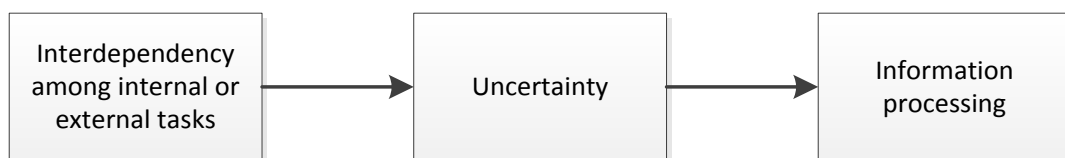


FIGURE 6 INFORMATION PROCESSING PERSPECTIVE: MODEL OF INTERDEPENDENCY

SOURCE: ADAPTED FROM STAUDENMAYER (1997)

Thompson (1967) is particularly influential in this research stream. Holding the environment of an organization constant, Thompson defined internal interdependence as *“the extent to which a task requires organizational units to engage in work flow exchanges of products, information, and/or resources and where actions in one unit affect the actions and work outcomes in another unit”* (Thompson, 1967, p. 54). Note that organizational units in ecosystems will be represented by organizations. Accordingly, Thompson theorizes that internal interdependence stems from the task requirements. In that way, he classified interdependencies according to the structure of task relationships, i.e. how two interdependent tasks of different units are structured, distinguishing between three forms of interdependence (Staudenmayer, 1997): pooled, sequential and reciprocal interdependence. In the order introduced, they are proposed to be increasingly difficult to coordinate, because they represent increasing degrees of contingency, i.e. the extent to which tasks are contingent on each other. *“With pooled interdependence, contingency is non-existent or minimal. Action in each position can*

proceed without regard to action in the other positions as long as the overall organization remains viable. With sequential interdependence, however, there is always an element of potential contingency since each task in the set must be readjusted if another departs from expectations. With reciprocal interdependence, such contingencies are not merely potential but actual” (Staudenmayer, 1997, p. 12). Accordingly, Thompson proposes a different type of coordination mechanism for each type of interdependence. Table 2 shows the types of interdependence proposed by Thompson.

In addition, Thompson suggested that the types of interdependencies form a Guttman-type scale, implying that all organizations have pooled interdependence, more complicated organizations have sequential as well as pooled interdependence, and the most complex organizations have all three types of interdependence.

TABLE 2 THOMPSON'S STRUCTURES OF INTERDEPENDENCE

SOURCE: ADAPTED FROM THOMPSON (1967)

Type of interdependence	Description
Pooled	Each part renders a discrete contribution to the whole and each is supported by the whole, although the parts do not interact in any direct way.
Sequential	The output of one part is the input to another.
Reciprocal	The outputs of each part become inputs for the others.

Summarizing, Thompson conceptualized interdependence as a dyad of tasks with a definite, visible and stable structure (Staudenmayer, 1997). Accordingly, he classified types of interdependence according to their structure. The information processing perspective is rooted in objectivism, tasks are assumed “to be” one of the types mentioned. The goal of the information processing perspective is to match information processing mechanisms with the level of contingency. The coordination mechanisms suggested by Thompson will be discussed in a later section on control and coordination of interdependencies.

2.2.3 Interdependence in business ecosystems

Prior research that considered interdependencies in business ecosystems particularly focused on the interdependencies between the focal firm and its suppliers or complementors. For example, in the first work on business ecosystems, Moore (1993) stated that business ecosystems are characterized by the process of co-evolution in which interdependent species evolve in an endless reciprocal cycle – in which changes in species A set the stage for the natural selection of changes in species B – and vice versa. Focusing on this description, one could infer that business ecosystems are dominated by the Thompsonian notion of reciprocal interdependence. This is in line with Powell (1990) who stated that network forms of organization, such as business ecosystems, are typified by

reciprocal patterns of communication and exchange. Another example comes from Pierce (2009) who discussed the dependence that complementors have on the focal firm. Kapoor and Lee (2013), in turn, compared different types of organizational forms in their use to manage interdependent activities with complementors. In yet another study, Adner (2006) found that interdependence is one of the key sources of risk in business ecosystems.

Koenig (2012) is the only one to have looked into the structure of interdependence in context of business ecosystems. He proposed that the mode of interdependence is a defining characteristic of the type of ecosystem. Koenig theorized that the structure of interdependence, focusing on reciprocal and pooled interdependence, conditions the mode of ecosystem development. According to his framework, platform ecosystems are characterized by pooled interdependence.

2.3 Control of interdependence

As tasks in a business ecosystem are interdependent, there needs to be some coordination of tasks being performed in order to enable a smooth operation (Thomas & Autio, 2014).

Control mechanisms have been suggested as an effective way to coordinate interdependencies (e.g. by Gulati and Harbir (1998) and Dekker (2004)) and therefore the focus of this study is on control mechanisms.

Prior research does not always make clear distinctions between the concepts of control, coordination and governance. One reason for this could be that the functions of management accounting, risk management and corporate governance are increasingly intertwining (Bhimani, 2009). In order to prevent confusion, a start is made by defining these concepts and seeing how they related to each other.

2.3.1 Defining governance, control and coordination

Governance can be broadly defined as *a mode of organizing transactions* (Heide, 1994). Research into governance structures has mainly been informed by transaction cost economics (TCE). Markets and hierarchies have traditionally been the two dominant governance structures (Moore, 2006). However, firms began to engage in forms of collaboration that were different from both the arm's length market contracting and the former ideal of a vertically integrated firm (Powell, 1990). In response to these changes, more recent research suggested hybrid governance structures to lie somewhere on the continuum between market and hierarchy and could take the form of, for example, joint ventures, buyer-supplier relationships, franchising and licensing agreements or inter-organizational networks (Powell, 1990; Dekker, 2004). Powell (1990) however argued that the continuum fails to capture the complex realities of exchange and misses the role that reciprocity and collaboration play as alternative governance mechanisms. In that light, he proposed that network forms of organization are the third governance structure (Powell, 1990). Moore (2006), later, claimed that business ecosystems are the third form of economic organization. As a business ecosystem is inherently a network, this study sees business ecosystems as a

subtype of networks and thus as an economic form of organization, i.e. governance structure, to organize transactions.

Subsequently, the issue of control directly relates to the choice of governance structure. (Dekker, 2004). Yet, while governance has received plenty attention in prior research, also in the context of business ecosystems (e.g. West (2003), Enkel et al. (2009), Tiwana et al. (2010), Eaton et al. (2011), and Ghazawneh and Henfridsson (2013)), research into the actual structuring, management and control of these inter-organizational relationships has received little attention (Dekker, 2004). The literature on control has mainly focused on the control of relationships within organizational boundaries, for examples attempting to align employees' interests with organizational interests (Kreutzer et al., 2015). Yet, there have also been papers that considered control of inter-organizational relationships (e.g. Provan and Skinner (1989), Heide (1994), Dekker (2004), and Vlaar et al. (2007)). Intra-organizational control and inter-organizational control has been a latent topic of great interest in business ecosystems, yet has not often been discussed using the term control.

Dekker (2004) distinguishes two purposes of inter-organizational control. First, the primary purpose of control is to create conditions that motivate partners to achieve desirable or predetermined outcomes (Dekker, 2004). In line with this, in the context of platform ecosystems, Tiwana et al. (2010) define control as "the formal and informal mechanisms implemented by a platform owner to encourage desirable behaviors by module developers, and vice versa" (p. 9). Notice how Dekker focuses on desirable outcome and Tiwana et al. on desirable behaviors; more on this in the next section on types of control. The second purpose of control in inter-organizational relationships is the coordination of interdependent tasks between partners (Dekker, 2004), where coordination can be defined as *the process of managing dependencies between activities* (Malone & Crowston, 1994). Tiwana et al. agree with Dekker in theorizing that the role of control mechanisms in platform ecosystems is more about coordinating than controlling agency problems, as traditionally assumed in control theory, because the relationship between platform owners and complementary partners is not necessarily a principal-agent relationship, characterized by conflicting interests. Instead, complementary partners often have interest in the success of the platform. Hence, coordination and control mechanisms are effectively interchangeable in this context, as coordination is a purpose of control.

Brenner and Ambos (2013) define control as any process (mechanism, instrument or strategy) applied by an organization to ensure the execution of organizational goals and plans. Cardinal (2001) also refers to objectives by stating that control is any process by which managers direct attention, motivate, and encourage organizational members to act in desired ways to meet the firm's objectives. When considering controls in a business ecosystem, the organizational members are the organizations in the ecosystem, and the firm's objectives might also objectives of the entire ecosystem in this study.

Table 3 shows the conceptualizations of governance, control, and coordination, as used in this study.

TABLE 3 CONCEPTUALIZATIONS OF GOVERNANCE, CONTROL AND COORDINATION

Concept	Conceptualization	Source
Governance	A mode of organizing transactions.	Heide (1994)
Control	Any mechanism implemented by an organization to create conditions that motivate the organization to achieve desirable or predetermined outcomes for the organization and to encourage desirable behavior.	Dekker (2004) and Tiwana et al. (2010)
Coordination	The process of managing dependencies between activities.	Malone and Crowston (1994)

2.3.2 Types of control

Cardinal et al. (2004) distinguish two attributes of control. The first attribute of control is control formality, which considers whether controls are formal or informal. The second attribute of control is control target, which refers to the attributes of a process that control mechanisms are intended to influence. Control targets can be divided into input, behavior and output control. Table 4 shows the attributes of control and their definition by Cardinal et al.

Prior research has been in disagreement on a typology of control, for example discussing whether input control should be considered a formal or informal control (Kreutzer et al., 2015). Ouchi (1977) included input control, though not labeled as such, to be applicable when few or no output measures are available or when knowledge of the transformation process is lacking. Input control is included in this research for these situations. More fundamentally, the distinction by Cardinal et al. (2004) between the two control attributes of control formality and control target removes the need to discuss whether input control is informal or formal, as it is presumed all control targets can be either formal or informal mechanisms.

TABLE 4 ATTRIBUTES OF CONTROL

SOURCE: ADAPTED FROM CARDINAL ET AL. (2004)

Control attribute	Type of control	Definition
Control formality	Formal	Officially sanctioned (usually codified) institutional mechanisms, such as written rules, standard operating systems, and procedural directives – visible, objective forms of control.
	Informal	Unwritten, unofficial values, norms, shared values, and beliefs that guide actions and behaviors – less objective, uncodified forms of control
Control target	Input	Mechanisms to manage resources acquired by the firm; it focuses on human, material and financial resources flowing into the firm.
	Behavior	Mechanisms to manage task activities of a firm that transform inputs into outputs.
	Output	Mechanisms to manage product and service outcomes and regulate results or outcomes of the firm.

2.3.3 Antecedent conditions of control and control strategies

Having identified possible types of control mechanisms, the next step is to identify under which conditions to apply a certain type of control. Ouchi (1977) created a framework based on two antecedent conditions: (1) knowledge of the transformation process, and (2) the availability of output measures or the measurability. The transformation is the process by which inputs are turned into outputs. In order to apply behavior control, knowledge on this process is required (Ouchi, 1977). In case of output control, a reliable and valid measure of the desired outputs must be available.

In case there are no reliable measures of outputs available and there is little knowledge of the transformation process, organizations are suggested to use 'ritualized control'. Ouchi (1977) describes this as a situation in which no learning can take place, because correct behaviors and outputs cannot be identified. He mentions that organizations in this situation tend to heavily rely on the selection process as their only means of effective control. This seems to perfectly fit the description of input control as stated before (mechanisms to manage resources acquired by the firm; it focuses on human, material and financial resources flowing into the firm (Cardinal et al., 2004)). Therefore, input control replaces the term 'ritualized control' in this quadrant of the framework.

Figure 7 shows the framework that assists in selecting appropriate control types, following from the antecedent conditions of control, where ritualized control has been replaced with the more common term of input control. Ouchi acknowledges that both conditions will in reality be continuous variables, rather than discrete as portrayed in the framework, and most organizations will use a mixture of behavior control and output control. The framework simplifies reality for the sake of exposition.

		Knowledge of Transformation Processes	
		Perfect	Imperfect
Availability of output measures	High	Behavior control or Output control	Output control
	Low	Behavior control	Input control

FIGURE 7 FRAMEWORK OF CONTROL TARGETS AND THEIR ANTECEDENT CONDITIONS

SOURCE: ADAPTED FROM OUCHI (1977)

2.3.4 Coordinating interdependencies

Thompson (1967) considered coordination mechanisms to be effective mechanisms to coordinate interdependencies. He suggested a different type of coordination for each type of interdependence. First, Thompson suggested standardization to coordinate pooled interdependence. “This involves the establishment of routines or rules which constrain action of each unit or position consistent with those taken by others in the interdependent relationship” (p. 56). In his synthesis of the research on organization design, Mintzberg (1980) distinguishes standardization of work processes, outputs and skills. Second, sequential interdependence was suggested to be coordinated by plan, which involves the establishment of schedules for the interdependent units by which their actions may then be governed (Thompson, 1967). Finally, Thompson suggested that reciprocal interdependence is coordinated by mutual adjustment, which involves the transmission of new information during the process of action.

2.3.5 Governance and control in business ecosystems

Many papers focus on the governance of platform ecosystems (e.g. Tiwana et al. (2010), Elaluf-Calderwood et al. (2011), Eaton et al. (2011), Wareham et al. (2014)) and discuss the *paradox of control and generativity* (also referred to as the Goldilocks Governance Problem (Tiwana et al., 2010)) that lies within platforms. The platform owner must retain sufficient control while allowing enough room for innovation on the platform by complementary partners (Tiwana et al., 2010). This is closely related to the *paradox of change*, which is the need for technology ecosystems to be stable and evolvable at the same time. Platform

ecosystems should be stable to assure complementors and customers that investments will yield returns, while evolvability is required to be able to adjust to changes in customer requirements, markets and technology.

Thus, governance of business ecosystems and platform ecosystems in particular, has received considerable attention in prior research. However, research on coordinating and controlling interdependencies in business ecosystems has to date been very scarce. A reason that this control-perspective has received little attention might be that most research on business ecosystems has come from a strategy perspective and looked at how value can be created, an intuitively positive outlook. Behavior control, however, has been predominantly viewed as a mechanism that stifles creativity, and hence a bias against control has formed as it would harm innovation (Cardinal, 2001). However, Cardinal (2001) found that certain types of control enhance innovation, both incremental and radical.

Despite the limited attention, there have been few papers that have considered control or coordination in business ecosystems. For example, Thomas and Autio (2014) consider task coordination to be part of the governance system of business ecosystems. “Depending on the size of the ecosystem community and the degree of stratification, coordination mechanisms can range from top-down, hierarchical direction through established lines of command to lateral and informal coordination, for example, through the communication of technological trends and the propagation of social roles and behavioral norms .. Coordination of tasks can be done through varying the degree of modularity of the product or service, the standardization of interfaces, or restricting access. Rules, roles and procedures can be embedded in case of a platform and need to be communicated to all ecosystem participants” (Thomas & Autio, 2014, p. 18). The coordination mechanisms Thomas and Autio suggest, standards and rules, are similar to standardization and planning as coordination mechanisms for respectively pooled and sequential interdependence as theorized by Thompson (1967).

Tiwana (2015) focuses on platform ecosystems and finds that input control is complementary to a modular design of third-party extensions, i.e. applications, on a platform. Modularization increases the autonomy for extension developers to experiment freely in revising an extension, and input control allows the platform owners to ensure an extension’s interoperability and quality before it enters the ecosystem (Tiwana, 2015).

2.4 Literature review summary

Prior research has portrayed the organizations in a business ecosystem as being interdependent (Moore, 1993; Adner, 2006; Pierce, 2009; Kapoor & Lee, 2013). Yet, no study of influence has looked into the structure of those interdependencies; let alone how to manage them. Control mechanisms have been suggested as an effective way to coordinate interdependencies (e.g. by Gulati and Harbir (1998) and Dekker (2004)), distinguishing between two attributes of control: control formality and control target (Cardinal et al., 2004).

3. Research method

Based on the foregoing theoretical background, a problem statement and research questions were derived, leading to a conceptual framework presented in this section. The way to approach the answering of these questions comes in the form of a research strategy and research design. The choices that were made regarding the research method are presented and justified in this chapter. First, let us start by defining the problem statement and the related research questions.

3.1 Problem statement and research questions

Following from the theoretical and practical background, the problem that inspired this thesis project is outlined, followed by the research questions that this study aimed to answer.

3.1.1 Problem statement

Ongoing digital and industry convergence is creating new types of interdependencies between (telecom) operators and other players, forcing operators to adapt to new roles in continuously evolving ecosystems. In order for operators to be able to make a grounded decision which role to pursue, they must first be aware of the interdependencies that exist between the various roles in a business ecosystem. Subsequently, they would have to know how they can manage these interdependencies. This knowledge is lacking. That is the problem tackled in this study.

3.1.2 Research questions

The problem statement leads us to the overarching primary research question that this study tried to answer:

Q1 *How can interdependencies in a business ecosystem be managed?*

In order to answer this primary research question, two secondary questions were crafted in support:

Q1.1 *What are the structures of the task relationships of interdependencies in a business ecosystem?*

The approach to this research question is deductive, following the categorization of Thompson (1967) of structures of task relationships into pooled, sequential and reciprocal. The second secondary research question considers control:

Q1.2 *What are the control mechanisms used to coordinate interdependencies in a business ecosystem?*

This question was also approached deductively, taking the control attributes of control formality and control target of Cardinal et al. (2004) as starting points.

3.1.3 Conceptual framework

The previous empirical and theoretical work provided a conceptual framework that directs the data analysis (Forman & Damschroder, 2007).

Figure 8 shows the conceptual framework. Essentially, the premise of the research is based on the underlying model of interdependency according to the information processing perspective, as shown in Figure 6. The strength of interdependence between tasks is regarded to have an influence on uncertainty (Staudenmayer, 1997), i.e. the higher the level of interdependence, the higher the uncertainty. The three types of interdependence considered by Thompson (pooled, sequential, and reciprocal) are increasingly difficult to coordinate because they contain increasing degrees of contingency (Thompson, 1967). Control mechanisms have been suggested as an effective way to coordinate interdependencies (e.g. by Gulati and Harbir (1998) and Dekker (2004)), thereby moderating the relationship between interdependence and uncertainty. Two attributes of control mechanisms, identified by Cardinal et al. (2004), are considered in this study: first, the control target (input, behavior, and output); second, the control formality (formal, informal). In the conceptual framework, control targets are shown. All three can be either formal or informal.

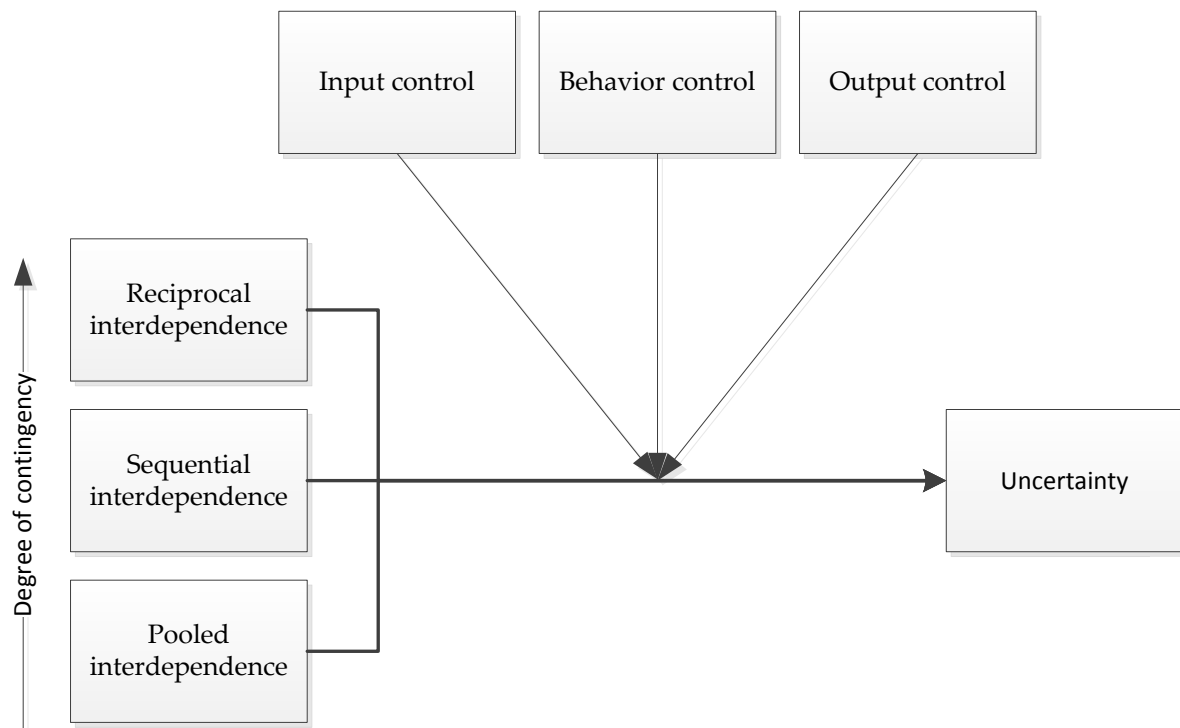


FIGURE 8 CONCEPTUAL FRAMEWORK

3.2 Research strategy and design

Based on the foregoing research questions, a research strategy was selected. A research strategy is a way to collect and analyze empirical evidence (Yin, 2002). The research strategy chosen for the thesis project is a case study. "A case study is an empirical enquiry that investigates a contemporary phenomenon within its real-life context, especially when the boundaries between phenomenon and context are not clearly evident" (Yin, 2002). This is very applicable to business ecosystems as it is impossible to draw the precise boundaries of an ecosystem (Iansiti & Levien, 2004). Furthermore, a case study provides a multi-dimensional, holistic perspective that is used to create a shared view of the situation being studied (Kohlbacher, 2006). This is essential, as this study aims to provide multi-perspective view on interdependence in business ecosystems, rather than studying interdependence from one perspective as prior research has mainly done (for example from the perspective of the focal firm, e.g. by Adner (2006) and Kapoor and Lee (2013), or the complementors, e.g. by Pierce (2009)).

More specifically, the case study strategy is a (1) single, (2) embedded, and (3) retrospective case study. Let us consider these three characteristics. First, a single case study was chosen, as opposed to a multiple case study, mostly after considering the limited time available to conduct the research. A multiple-case study would likely provide more externally generalizable results, but the time constraints did not allow a full multiple-case study. A commonly heard concern of single case studies is that they would provide little basis for scientific generalization (Yin, 2002). However, as Yin (2002) states, the goal of the case study as a research strategy is to expand and generalize theories (analytical generalization) and not to enumerate frequencies (statistical generalization). Furthermore, the rationale for selecting a single case study was also that the selected case study is a typical and representative case for the business ecosystems around operators, both telecom and cable, in the TMT-sector. Read more on the case study selection in the next section.

Second, the case study was an embedded case study, meaning that multiple units of analysis were chosen (Yin, 2002). The research questions are leading in defining the unit of analysis (Forman & Damschroder, 2007). As the research focuses on interdependencies between firms, firms were chosen to be the units of analysis. Multiple firms in the ecosystem were analyzed, and hence the case study is an embedded case study.

Third, the case study was a retrospective case study, which is a type of longitudinal case study design in which all data are collected post hoc (Street & Ward, 2010). It was chosen to be able to reconstruct a time line and observe possible changes in interdependencies over time. These changes were expected as firms co-evolve their capabilities and roles in business ecosystems (Moore, 1993). A purely cross-sectional study would not allow identifying any signs of co-evolution. A prospective case study, in which theory-based hypotheses are tested at a predetermined follow-up time, would be more appropriate in theory testing (Bitektine, 2008) rather than in theory building, which is the goal of this study.

3.2.1 Case study selection

The selected case study is the business ecosystem organized around the media- and entertainment-platform by a large, international cable-operator. The main motivation for selecting this case study is that it is a typical and representative case for business ecosystems around telecom-operators and, even more so, cable-operators in the TMT-sector.

One of the major risks for cable- and telecom-operators is that over-the-top (OTT) service providers make them a serving hatch, a 'dumb pipe'. If people for example watch series or movies through these OTT-services, the OTT- service-provider is able to gather data on who watches what and when. That is very valuable data to create targeted advertisements in specific time slots for specific people. The operator in that case only provides the underlying network, and does not have access to customer data insights, making their network a 'dumb pipe'. So the challenge for the cable-operator under study, and all cable- and telecom-operators alike, is to avoid becoming a 'dumb pipe'.

The cable-operator in the selected case study recognizes the need to innovate beyond and on top of their cable network. The value proposition of the cable-operator has always been to connect customers to the digital world through their vast network of cables. Yet, their value proposition is shifting more towards providing entertainment, rather than only connecting customers to the digital world, which becomes clear from their Annual Report in 2014. The operator is investing in content, entertainment and video-on-demand with strategic investments in media firms. The shifting value proposition, from network provider to entertainment provider, marks a key strategic path taken to avoid becoming a 'dumb pipe'. The media-and entertainment platform under study plays a central role in this strategy.

In 2012 the cable-operator introduced the platform, first in the Netherlands, offering access to live TV, videos from the web, apps, games, music and personal content on any device, by means of a set-top box (STB). Early 2015, it had over a million subscribers. The platform was developed in cooperation with a multitude of specialized partners such as device manufacturers and middle-ware providers, and the platform's value is complemented with the help of content, service, and application providers. These roles are interdependent in different ways. All these partners are organized as a business ecosystem: a network of interconnected organizations, organized around the platform, which incorporates both production and use side participants, and focuses on the co-creation of new value through innovation (Thomas & Autio, 2013).

3.3 Data collection

Having selected a representative and typical case study, data was collected to be able to empirically answer the research questions identified earlier. This section will first discuss the main data collection methods, second the sampling method used, and finally briefly present the data collection research procedure.

3.3.1 Methods

Multiple data collection methods were used in order to triangulate their findings, which is common in case study research (Saunders et al., 2007). Specifically, three different data collection methods were used: documentary analysis, focus groups, and interviews. Table 5 shows an overview of the data collection methods used. A brief rationale for choosing each method is given next.

TABLE 5 DATA COLLECTION METHODS USED

Data	Method	Details	Purpose
Secondary	Documentary analysis	- Websites	Serve as input for and triangulate focus groups and interviews
		- Academic journal and books, Professional publications/reports (e.g. by EY)	
Primary	Focus groups	- 1 focus group with four directors and partners from EY	Serve as input for interviews
		- 1 focus group session with two interviewees and one partner	Triangulate findings of interviews
	Semi-structured interviews	- 4 interviews at EY - 6 interviews at case-related firms - 4 interviews at firms related to other cases - 2 interviews with academics/experts in the field of business ecosystems	Serve as primary input for data analysis

3.3.1.1 Documentary analysis

Documentary analysis was selected primarily to provide contextual data for the case study and to be able to triangulate the findings from the interviews (Saunders et al., 2007). The documentary data mainly included websites informing about the selected case study and TMT-sector in general. Other sources were academic journals, books, and publications by EY and other consultancy firms.

3.3.1.2 Focus groups

In the explorative stages of the research, two focus group sessions were held; these are group interviews in which interactive discussion between participants is encouraged, with a clearly defined topic (Saunders et al., 2007). In the first focus group session, four directors and partners from EY were joined together, representing various departments and all having experience with the focal firm in the case study. Hence, they brought different

perspectives on the ecosystem to the table, allowing us to paint a rich picture of the context. Due to their higher, strategic positions in the firm and in their experience with the focal firm, the participants could provide a helicopter view on strategic issues surrounding the focal firm and its context. The main reason for choosing to start with a focus group session was that the interactions between participants can provide rich insights in the explorative phase, where the aim is to identify the key issues and frame the context. The participants in the first focus group session were not selected as interviewees, so that these interviews can function both as cross-check and in-depth exploration of the issues mentioned in the focus group.

The second focus group session took place right after the individual interviews with EY employees, with one partner and two of the interviewees. While the first group was meant to provide contextual data, the second focus group functioned as a triangulation of the individual interviewees. It was the synthesis of the first phase of the data collection, internally at EY.

3.3.1.3 Semi-structured interviews

Semi-structured interviews were selected as the main method of primary data collection. Interviews are an appropriate method of data collection in this research setting, and preferable over questionnaires, because the questions to be answered are partially open-ended, and the order and logic of questioning may need to be varied depending on the setting (Saunders et al., 2007). Furthermore, interviews best address the aim of the data collection is to discover not only the opinions of the interviewees, but also the reasoning behind those opinions. The interviews were non-standardized and semi-structured, to allow probing of answers, but at the same time not reduce reliability too much. Probing of answers is useful in situations “where you want your interviewees to explain, or build on, their responses. Interviewees may use words or ideas in a particular way, and the opportunity to probe these meanings will add significance and depth to the data you obtain. They may also lead the discussion into areas that you had not previously considered but which are significant for your understanding, and which help you to address your research question and objectives, or indeed help you formulate such a question. Interviews also afford each interviewee an opportunity to hear themselves ‘thinking aloud’ about things they may not have previously thought about. The result should be that you are able to collect a rich and detailed set of data” (Saunders et al., 2007, p. 324).

The interviews were almost all face-to-face, as this allows richer interaction and enabled the interviewee to express him or herself non-verbally as well. Three interviews were held through Skype, an internet-mediated software application for video calls, for sake of convenience. The transcription of the interviews was done using designated transcription software, namely Express Scribe Transcription Software.

3.3.2 Sampling

Sampling of interviewees for the semi-structured interviews was non-probabilistic and purposive, which is applicable since the research objective did not require statistical generalization (Forman & Damschroder, 2007; Saunders et al., 2007). Purposive sampling enabled the selection of firms and interviewees, on the basis of the researcher's judgment, that would best enable the researcher to answer the research questions (Saunders et al., 2007; Elo et al., 2014). This is a common form of sampling when working with very small samples such as in case study research (Saunders et al., 2007). Having said that, however, sampling was also influenced by matters of convenience, in terms of the limited time to collect and analyze the data from the interviews, and availability of interviewees and willingness to cooperate. Interviewees were selected from multiple firms in the ecosystem to get a holistic perspective on the case to create a shared view of the business ecosystem (Kohlbacher, 2006).

In addition some interviewees were not directly related to the case study. These were interviews with professional and academic experts on the topic of business ecosystems that were held in the earlier stadium of data collection to provide an in-depth insight into the ecosystem construct. In addition, several interviews were held with employees of firms in other related cases, i.e. in other ecosystems, that were eventually not included to form a multiple-case study due to time constraint in collecting sufficient data for these case studies. They are included in the figure, because they did help to draw the precise boundaries of the case study at hand. Figure 9 shows the distribution in the sample of respondents used for the semi-structured interviews.

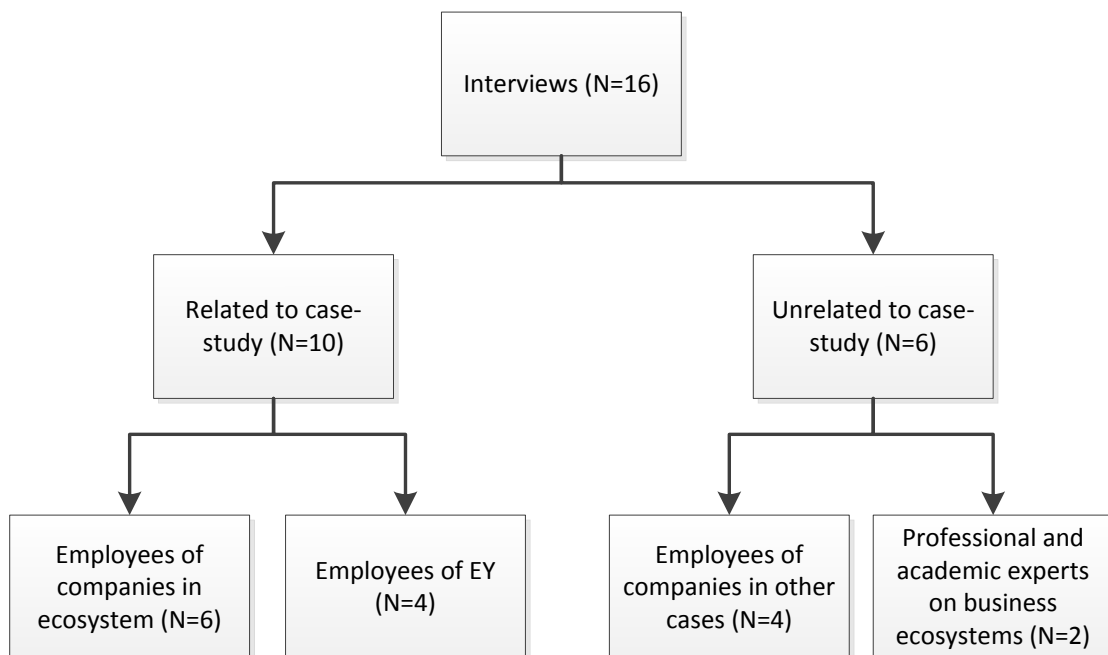


FIGURE 9 SAMPLE OF INTERVIEWEES

Table 6 provides an overview of the interviewees that were directly related to the case study as these interviews formed the primary data on which the results of this study are based. Three firms in the sample are middle-ware providers. They were numbered in the table, to show they are different firms. In the results they are not numbered, as the focus is on the role of the firm, not on the firm itself.

TABLE 6 CASE STUDY-RELATED INTERVIEWS

Interviewee details			Interview details		
#	Function	Firm/role	Date	Location/ medium	Duration (min.)
[1]	Senior Advisor	EY	17-06-2015	Amsterdam (NL)	81
[2]	Senior Manager	EY	18-06-2015	Amsterdam (NL)	93
[3]	Senior Advisor	EY	19-06-2015	Amsterdam (NL)	70
[4]	Senior Manager Business Development	EY	23-06-2015	Amsterdam (NL)	110
[5]	VP Business Development & Product Management	Middle-ware provider 1	10-07-2015	Eindhoven (NL)	60
[6]	Founder & CEO	Application platform provider	14-07-2015	Rotterdam (NL)	88
[7]	Launch Manager	Middle-ware provider 2	17-07-2015	Via Skype	79
[8]	Director/ Non- Executive Chairman	Platform provider's investment fund/ Application platform provider	22-07-2015	Amsterdam (NL)	59
[9]	Director	Middle-ware provider 3	23-07-2015	Hilversum (NL)	97
[10]	Product Director	Middle-ware provider 2	07-08-2015	Hoofddorp (NL)	64

3.3.3 Research procedure

The research procedure of the data collection involved three distinct, complementary phases, as shown in Figure 10. The first phase was an explorative phase in which documentary analysis and two interviews with experts on business ecosystems were used to explore the research context and case study. The two data sources were used to triangulate their findings and the findings based on the primary data collected through the interviews, as suggested by Saunders et al. (2007).

In the second phase of the research, four semi-structured interviews and two focus group sessions were held with EY employees experienced with the case study. The purpose of this stage was still more explorative, to get an insight into the interdependencies of the ecosystem, particularly from the point of view of the focal firm, as this is the client of EY. As mentioned, the first focus group session was meant to provide the context of the case study. This focus group session was complemented by the first round of interviews, in which four EY employees were interviewed who have experience working for the focal firm. The goal here was to validate and fine-tune the concepts and interview questions for the external interviews that were crafted on the basis of the focus group session and to get a rough insight into the interdependencies in the ecosystem. The second focus group concluded those phase, and functioned as a triangulation of the foregoing. This qualitative data provided the context for the research and input for the third stage.

In the third stage of the research, the main primary data was collected through six semi-structured interviews with employees from firms in the business ecosystem. Interviewees were sent an email requesting their cooperation for the interviewee with a short description of the aim of the research and purpose of the interview. In the interview, the interviewees were given a definition of business ecosystems, in order to get on the same page what constitutes a business ecosystem. They were not given a definition of interdependence, in order to initially work inductively, in order to attempt to understand interdependence as people experience it (Staudenmayer, 1997) rather than asking them to assign predefined labels. The main motivation for initially working inductively was the fear of missing out of surprising insights that had not been previously identified in the literature; more on deduction and induction later.

In the Appendix III the interview protocol can be found. As can be seen, the starting point for the interviews was a risk perspective, taking the interviewees through the main components of the Enterprise Risk Management (ERM) framework designed by the Committee of Sponsoring Organizations of the Treadway Commission (COSO) (2004), the most widely used risk management framework (Power, 2009). The main reason for taking a risk-perspective, rather than a more direct focus on interdependence is that prior research found that interdependence is one of the key sources of risk in business ecosystems (Adner, 2006). Hence, by asking interviewees about risk, the researcher could infer the interdependencies that underlie each risk. Furthermore, asking people about the level of

interdependency can miss or mislead us about key aspects of interdependence associated with newer, more complex work arrangements (Staudenmayer, 1997). For example, the tightly coupled interdependencies are more likely to be visible and experienced by respondents, such as interdependencies in which the organization has a direct relationship with another firm. The interdependencies that occur infrequently are less visible and might be missed (Staudenmayer, 1997).

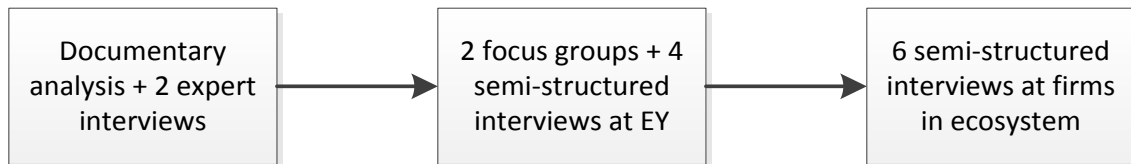


FIGURE 10 DATA COLLECTION PROCEDURE

3.4 Data analysis

Once the data had been collected, the data could be analyzed. This section will first discuss the main method used for data collection and thereafter briefly discuss the data analysis research procedure.

3.4.1 Methods

The key primary data came from the semi-structured interviews with employees of firms operating in the business ecosystem of the case study. The interviews were transcribed using smooth verbatim transcription, meaning the transcription was done word for word, but all utterances were left out to create a coherent text (Mayring, 2014) to enable complete analysis of the interviews. After transcribing all interviews, the method used for analyzing the data from the interviews was qualitative content analysis (QCA). QCA is method used for text analysis in social science and is a form of content analysis (Mayring, 2014), which is a family of systematic rule-guided techniques to analyze the informational contents of textual data (Forman & Damschroder, 2007). QCA is defined as an approach of empirical, methodological controlled analysis of texts within their context of communication, following content analytical rules and step by step models, without rash quantification (Kohlbacher, 2006). The strength of QCA lies in its systematic rule-bound procedure (Kohlbacher, 2006) and text is always interpreted in its context (Mayring, 2014).

Using qualitative content analysis is appropriate with unstructured or semi-structured data (Elo et al., 2014). It is also applicable in case study research, as it synthesizes openness and theory-guided analysis and text is always analyzed in relation to its context (Kohlbacher, 2006). “The central idea is that researchers constantly compare theory and data—iterating toward a theory which closely fits the data. Besides, an essential feature of theory building is comparison of the emergent concepts, theory or hypotheses with the extant literature because tying the emergent theory to existing literature enhances the internal validity, generalizability, and theoretical level of theory building from case study research” (Kohlbacher, 2006).

QCA involves coding of transcripts. Coding of textual data provides a classification system for the analysis of the qualitative data and used to reorganize the data into analytically meaningful categories that facilitates interpretation (Forman & Damschroder, 2007). Coding was done using an online tool called QCMap, an open access web application for systematic text analysis in scientific projects based on the techniques of QCA (Mayring, 2014).

The main problems related to QCA are the problems of inference, i.e. drawing conclusions about the whole text on the basis of a text sample and about the underlying theoretical constructs on the basis of the text, and the problems of reliability, relating to the trustworthiness of the coding (Kohlbacher, 2006). To enhance trustworthiness, a brief explanation was given on how the conceptualizations of key constructs came about (Elo et al., 2014).

3.4.2 Research procedure

Coding can either be done inductively or deductively. The conceptual framework and the nature of the research questions determined whether the coding categories were deductively assigned or inductively formed (Forman & Damschroder, 2007; Mayring, 2014). The key concepts in this study, i.e. structure of interdependence and control mechanisms, are based on existing theory. Hence, existing theory provided direction for the research questions, and as such the research can be considered primarily deductive in nature (Elo & Kyngäs, 2008), which can also be referred to as directed content analysis (Hsieh & Shannon, 2005). However, content analysts most often apply a combination of both deductive and inductively coding (Forman & Damschroder, 2007). The same was done in this thesis project. The initial coding was done inductively, focused on coding of (1) interdependencies, and (2) controls. Hereby, the type of interdependence or types of control were not yet taken into account to prevent missing out on new types of interdependence or controls, as mentioned earlier. Figure 11, as adapted from Mayring (2014), shows the process of inductive category formation. After the initial inductive coding, the coded excerpts of the interviews were assigned either a type of interdependence or controls that were derived from existing theory.

After the first round of coding, too many categories were identified, meaning the abstraction process was incomplete and categories overlapped and were not mutually exclusive (Elo et al., 2014). Therefore, overlapping categories were grouped together to identify similarities and differences between categories (Elo et al., 2014). The results were also presented to people familiar with the research topic and were asked to evaluate whether the results matched reality. This was done in order to establish a degree of face validity (Elo et al., 2014). Despite a systematic approach to the text analysis, there is always a degree of interpretation involved (Elo et al., 2014). To avoid over-interpretation, a focus was given on manifest content, while latent content (e.g. non-verbal clues) (Elo et al., 2014) were not included in the analysis. Moreover, an intra-coder and inter-coder agreement were

established to enhance reliability. Intra-coder agreement was established several times after coding finished entirely. Small adjustments to the coding categories were made, primarily to ensure consistency in the results. Inter-coder reliability is of particular significance for content analysis, with the main point to understand and interpret unreliabilities (Kohlbacher, 2006; Mayring, 2014), i.e. differences in the coding between two researchers. After inter-coder agreements, divergent opinions regarding the categorization were discussed, as suggested by Elo et al. (2014). This resulted in a couple of overlapping categories being grouped together and redundant coding being removed from the coding scheme.

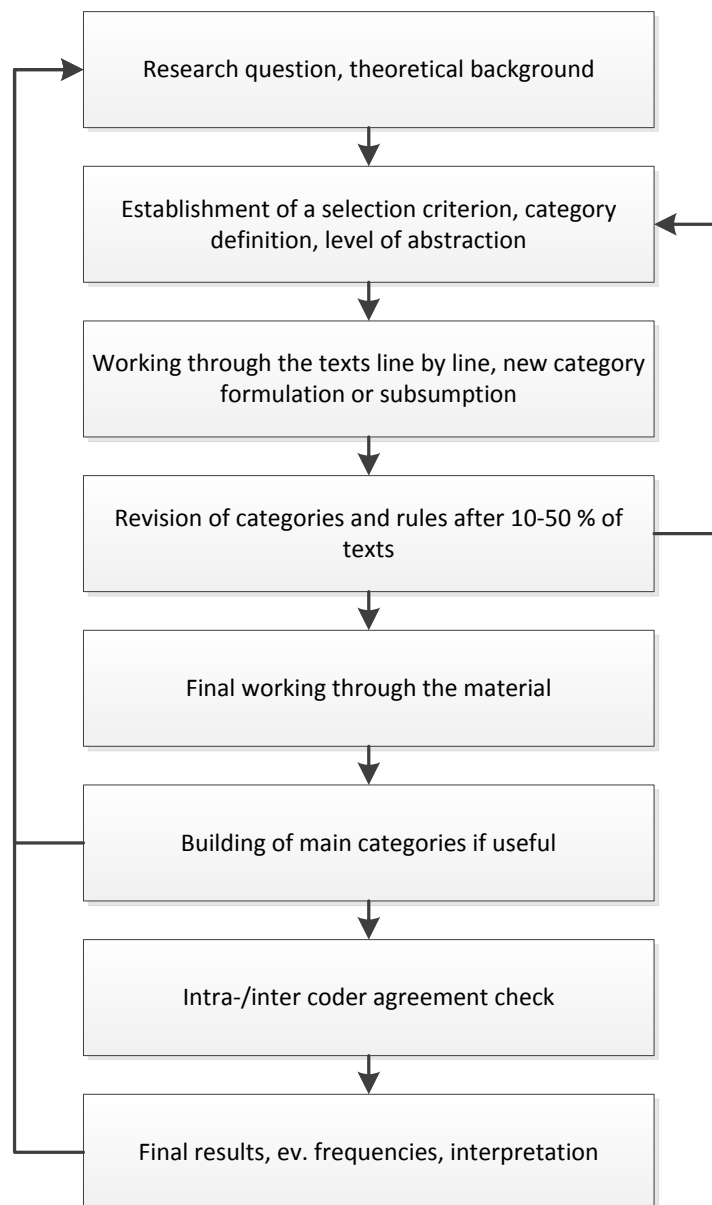


FIGURE 11 INDUCTIVE CATEGORY FORMATION

SOURCE: ADAPTED FROM MAYRING (2014)

3.5 Quality tests: validity and reliability

The quality of the research was judged with the help of four tests commonly used to establish the quality of empirical social research, of which case study is a form (Yin, 2002). These tests are: (1) construct validity, (2) internal validity, (3) external validity, and (4) reliability. Yin (2002) identified several tactics for dealing with these four tests when doing case studies. Table 7 shows the case study tactics for four design tests. These tests and tactics will briefly be discussed next.

TABLE 7 CASE STUDY TACTICS FOR FOUR DESIGN TESTS

SOURCE: ADAPTED FROM YIN (2002)

Test	Case study tactic	Phase of research in which tactic occurs
Construct validity	Use multiple sources of evidence	Data collection
	Establish chain of evidence	Data collection
	Have key informants review draft case study report	Composition
Internal validity	Do pattern-matching	Data analysis
	Do explanation-building	Data analysis
	Address rival explanations	Data analysis
	Use logic models	Data analysis
External validity	Use theory in single-case studies	Research design
	Use replication logic in multiple-case-studies	Research design
Reliability	Use case study protocol	Data collection
	Develop case study database	Data collection

3.5.1 Construct validity

Construct validity includes establishing correct operational measures for the concepts being studied (Yin, 2002). In data collection, using multiple sources of evidence in a manner encouraging convergent lines of inquiry is one tactic suggested by Yin (2002). Figure 12 shows how the principle of convergence of evidence was used in this study. In the case study, findings from the documentary analysis and the primary data from focus groups and interviews were converged to construct one set of findings, as opposed to non-convergence of evidence, in which the sources of evidence form separate sub-studies.

Another tactic was to establish a chain of evidence; both to increase construct validity as well as reliability. The principle of this tactic is to allow an external observer to follow the derivation of any evidence. In this study, the chain of evidence meant that references were made to specific secondary data, i.e. documents and academic literature, and to the primary data, i.e. specific interviews, to show on what evidence the argumentation is based. For example, representative quotations from the text were used to show a connection between the data and the results (Elo et al., 2014). Besides the tactics suggested by Yin (2002), a focus group was held after the initial interviews at EY, with two of the interviewees present, in

order to validate the interdependencies and controls mentioned in the interviews. Furthermore, an intra- and inter-coder agreement was established in order to make sure constructs were used correctly.

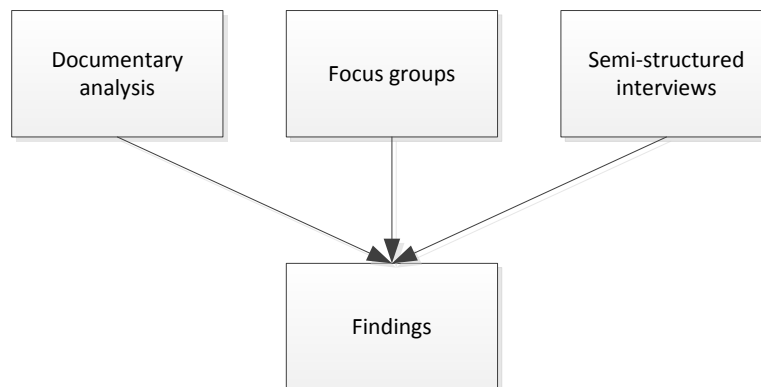


FIGURE 12 CONVERGENCE OF EVIDENCE

SOURCE: ADAPTED FROM YIN (2002)

3.5.2 Internal validity

Internal validity involves establishing a causal relationship, whereby certain conditions are shown to lead to other conditions. Internal validity is therefore only relevant for explanatory and causal studies (Yin, 2002). In a way, the case study at hand looks at the relationship between interdependencies and applicable controls. Though it is not so much a causal relationship, it is explanatory to a certain degree. To this end, pattern-matching was done, which involved comparing interdependencies identified in the interviews to the interdependencies identified in the literature, and similarly for and in relation to, control. More importantly, explanation building was used as an analytic technique, which is a special type of pattern matching that has the aim to analyze the case study data by building an explanation about the case (Yin, 2002). Rival explanations were addressed for unsure results, and can be found in the discussion.

3.5.3 External validity

External validity involves testing whether the findings of the case study are generalizable beyond the immediate case study (Yin, 2002). However, as mentioned earlier, the goal of the case study was to expand and generalize theories (analytical generalization) and not to enumerate frequencies (statistical generalization).

3.5.4 Reliability

The objective of the reliability test is to ensure that other researchers would arrive at the same findings when following the exact same research procedure (Yin, 2002). In order to enhance reliability, first, the research procedure was carefully documented. Second, a case study database was created online through Dropbox, a software application that enables file-sharing and storing in the cloud. This database contains the primary data, the coding schemes, and the final report.

3.6 Research design summary

The summary of the key choices for the research design are shown in Table 8.

TABLE 8 SUMMARY OF THE RESEARCH DESIGN

Research element	Choice for this study
Strategy	single case study
Method	mixed-method
Time horizon	longitudinal, retrospective
Techniques	
<i>Data Collection</i>	documentary analysis, focus groups, semi-structured interviews
<i>Data Analysis</i>	qualitative content analysis (QCA)

4. Results

In this chapter the empirical results from the case study are presented, following from the data analysis procedure as discussed in the previous chapter. The chapter is structured as follows. First, the flow of products and services in the ecosystem is illustrated, based on the documentary research and input from the interviews. Second, the findings from the secondary research questions are presented, looking at the structures of the task relationships of interdependencies in the ecosystem and subsequently at ways to reduce and control the interdependencies.

4.1 Flow of products and services

Before advancing to the interdependencies, this paragraph is meant to provide an impression of the business ecosystem, and how products and services flow between the roles in the ecosystem. This will facilitate the understanding of sections to come.

The business ecosystem organized around the media-and entertainment platform involves many different firms, which fulfill various roles. Figure 13 shows a diagram that shows the flow of products and services between the roles in the business ecosystem, based on information from the documentary research and empirical evidence from the interviews. The roles that were included in the figure are the roles that were directly interviewed or mentioned by the interviewees. The results are based on these roles. Roles that were identified in documentary research only, but not mentioned by the interviewees were not included in the analysis. The purpose of the figure is to give an insight into the flow of products and services, not of the workflows or interdependencies between the firms.

In essence, the flow of products and services goes from the left of the diagram, where predominantly the roles of suppliers to the platform are located, to the right of the diagram, where the end-consumer is located. In this case study, the end-consumer is a subscriber to one of cable-operator's brands. Firms in a business ecosystem can also play multiple roles (Williamson & De Meyer, 2012). In the middle of the diagram, the focal firm fulfills the roles of platform provider, network and infrastructure provider and system integrator by itself. The suppliers provide various types of 'components' to the focal firm to enable the functioning of the platform. In addition, there are several 'complementors' in the ecosystem. Application providers and Internet service providers deliver their own content or content provided by content providers to the end-consumer. Internet service providers can choose to deliver their service over the platform or skip the platform and deliver directly to the end-consumer over the Internet through another channel (e.g. on their own website). This way of delivering content is called Over-the-top (OTT). When firms choose to deliver their service exclusively OTT, in effect they exclude themselves from the business ecosystem around the platform. Yet, as many complementors deliver their service both OTT as well as through platforms such as the one in this case study, they are part of the ecosystem after all.

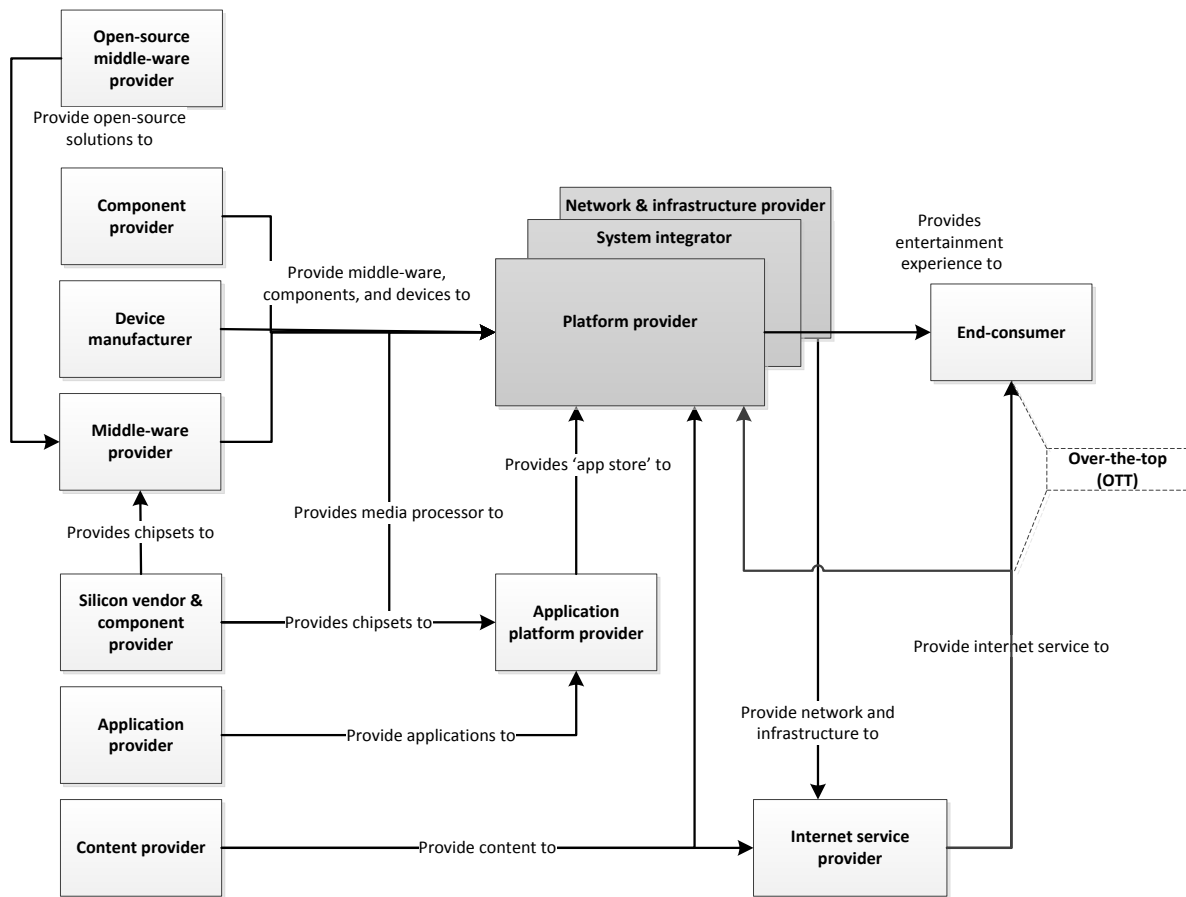


FIGURE 13 FLOW OF PRODUCTS AND SERVICES IN THE BUSINESS ECOSYSTEM

As said, Figure 13 provides an indicative schematic overview of the flow of products and services. The figure does not address the workflows between the firms that lead to the complex interdependencies that characterize a business ecosystem. These interdependencies will be discussed next.

4.2 Interdependencies

In this section, the first secondary research question is answered: *What are the structures of the task relationships of interdependencies in a business ecosystem?* Figure 14 shows the share of different interdependencies mentioned in the interviews. In Appendix IV the specific interdependencies between the various roles can be found, including the related control mechanisms mentioned in the interviews. Examples of the types of interdependence will be given shortly. Before delving into that, let us look two general observations that can be drawn from this graph.

First, there is a relatively small share of the pooled type of interdependence. Second, interdependencies are almost equally often characterized by a sequential or a reciprocal task relationship structure.

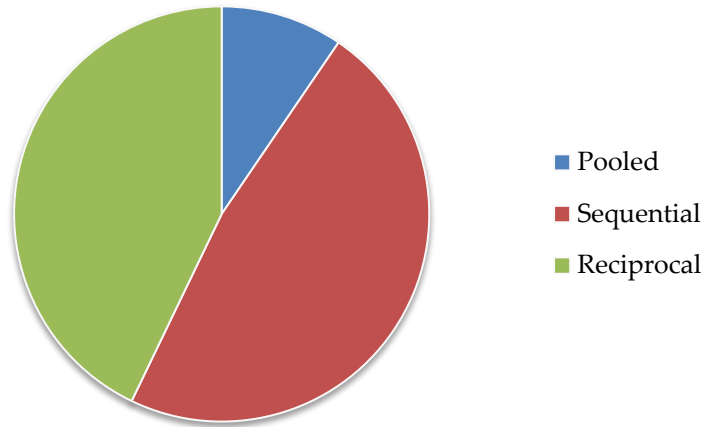


FIGURE 14 SHARE OF INTERDEPENDENCIES IDENTIFIED IN THE INTERVIEWS

Figure 15, Figure 16 and Figure 17 show respectively the pooled, sequential and reciprocal interdependencies identified in the interviews. Pooled interdependence was found to appear twice in the ecosystem, between middle-ware providers, and between application providers. As in both occasions, the interdependence occurred between firms holding similar roles, rather than between two different roles. Therefore in Figure 15, the pooled interdependencies have been shown by means of a zoomed frame, enclosed in a green dashed border. In the frame the structure of the interdependence is illustrated, as it is the same for both occasions.

When comparing Figure 15, Figure 16 and Figure 17, it becomes clear that the sequential interdependencies have a great overlap with the flow of products and services in the ecosystem. The reciprocal interdependencies, however, exist between roles that sometimes do not have a flow of products or services between them, and manifest themselves mostly on the supply-side of the ecosystem.

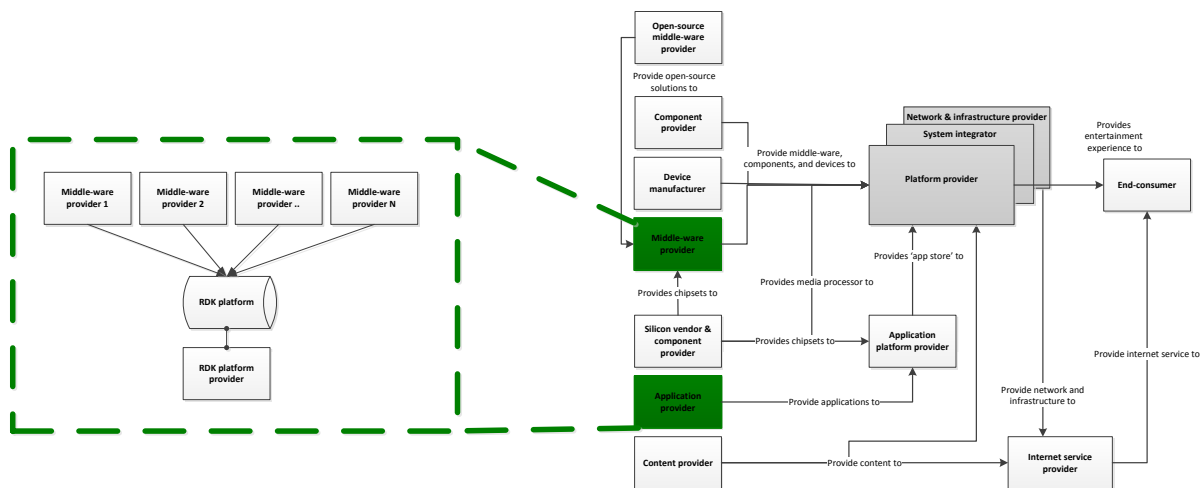


FIGURE 15 POOLED INTERDEPENDENCIES IDENTIFIED IN THE INTERVIEWS

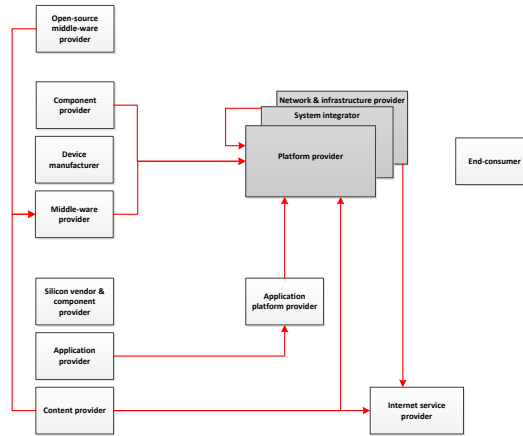


FIGURE 16 SEQUENTIAL INTERDEPENDENCIES IDENTIFIED IN THE INTERVIEWS

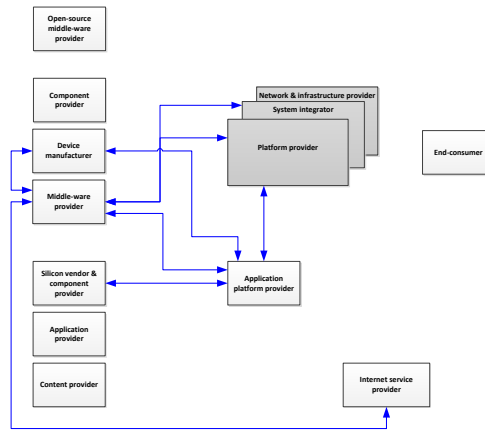


FIGURE 17 RECIPROCAL INTERDEPENDENCIES IDENTIFIED IN THE INTERVIEWS

Another observation is that the focal firm, fulfilling the roles of system integrator, network and infrastructure provider, and platform provider, has multiple interdependencies with different roles, depending on its own role. This is because interdependencies exist between tasks, and certain tasks relate to a certain role. For example, the firm has different interdependencies as a network and infrastructure provider than as a system integrator or platform provider, because these roles fulfill different tasks.

Additionally, when zooming in, some pairs of roles have more than one type of interdependence between them. These are the interdependencies between the platform provider and middle-ware provider; between the application platform provider and platform provider; and between the middle-ware providers themselves. Regarding the former interdependence, the platform provider was mentioned to take two approaches when integrating middle-ware providers into their solution. Sometimes, the platform provider wants a customized, first-of-a-kind solution, which requires intensive collaboration and iterative development, where the output of the platform provider’s design becomes the input for the middle-ware provider, and vice versa. In other words, a reciprocal interdependence exists. In other occasions, the platform provider knows exactly what

service or function they want to add to the platform, and then ask a middle-ware provider to deliver exactly that, which implies a sequential interdependence.

In the second double-type interdependence, between the application platform provider and platform provider, a different rationale exists for the two types of interdependence. The application platform provider has a reciprocal interdependence with the platform provider, as their application platform needs to be integrated with the larger platform, where the platform's design influences the application platform's design and vice versa. Additionally, the platform provider also needs the applications that run on the application platform, and is dependent on the applications as input for their platform. Here the application platform provider serves as intermediary, creating a sequential relationship.

The third interrelationship, amongst middle-ware providers, is a special occasion that will be discussed further on in the results. The foregoing two examples lead us to the following propositions regarding roles in business ecosystems. These propositions are concerned with defining the relationships between the concepts of tasks, roles and interdependencies. Since firms co-evolve their roles in a business ecosystem (Moore, 1993) and structuring differentiated partner roles is one of the keys to unlocking ecosystem advantage (Williamson & De Meyer, 2012), it is essential to clearly define roles and their tasks:

Proposition 1a: a role comprises multiple tasks

Proposition 1b: roles have multiple task interdependencies between them with a different structure of task relationship, which depends on the task.

4.2.1 Pooled interdependence

A *pooled interdependence* exists when each part renders a discrete contribution to the whole and each is supported by the whole, although the parts do not interact in any direct way (Thompson, 1967). Pooled interdependencies have been mentioned in the interviews to exist between middle-ware providers, and between application providers.

Figure 18 shows how application providers have a pooled interdependence between them. Application providers provide a discrete contribution to the 'app store', i.e. application platform, which is provided by the application platform provider and nested in the larger platform by the cable-operator. They are supported by the platform as a whole, since they need the platform to be successful in order to attract end-users to their platform. In turn, end-consumers are more likely to subscribe to the platform when the application platform has a lot of interesting 'apps' to offer. In that way, application providers depend on each other to make the platform successful, and hence make their own 'app' successful. In other words, complementors get attracted by complementors using the platform, creating a positive feedback loop that can grow at exponentially increasing rates as the number of complements rise. This positive feedback loop is referred to as direct, i.e. same-side network effects (Gawer & Cusumano, 2013).

The founder and CEO of the application platform provider mentioned that their platform has now reached a turning point, with a certain critical mass of application providers on their platform. Before that turning point, they had to put in a lot of effort to convince application providers to come to their platform. Now, the application providers come to them:

“Now we are actually seeing a bit of a turning point, we no longer have to try very hard to draw in the content.” (Founder & CEO, application platform provider)

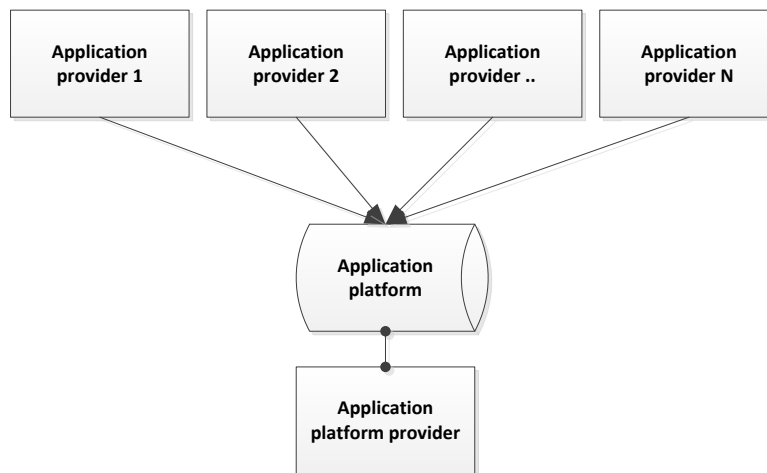


FIGURE 18 POOLED INTERDEPENDENCE BETWEEN APPLICATION PROVIDERS

Another example of pooled interdependence that was alluded to in the interviews is related to the Reference Design Kit (RDK). The RDK is “a pre-integrated software bundle that provides a common framework for powering customer-premises equipment (CPE) from TV service providers, including set-top boxes, gateways, and converged devices. The RDK was created to accelerate the deployment of next-gen video products and services. It enables TV service providers to standardize certain elements of these devices, but also to easily customize the applications and user experiences that ride on top” (RDK Management LLC, 2015). The RDK is by definition a platform, defined by Gawer and Cusumano (2013, p. 2) as “products, services, or technologies that act as a foundation upon which external innovators, organized as an innovative business ecosystem, can develop their own complementary products, technologies, or services”. The purpose of the RDK is that it standardizes the formerly unstandardized solutions of middle-ware providers and makes the complementary applications that ride on top of the platform more modular. Increasing modularity is a way to minimize interdependencies between subsystems (Tee, 2012; Tiwana, 2015).

“The operators have said: ‘we are so dependent on the [middle-ware providers] and all those middle-ware parties; we actually want one unified middle-ware which is managed by an independent association’. And that is called the RDK...(continued on next page)

... ‘Dear [middle-ware providers], could you put your technology in the RDK?’” (Founder & CEO, application platform provider)

“The RDK is an effort of the industry and the [three largest cable-operators] are now in the lead to develop a standard for the software in the box. And, thus, that is an effort to ensure that you can indeed plug-and-play all the vendors and technologies independently from each other” (Director, platform provider’s investment fund; Executive Chairman, application platform provider)

Middle-ware providers are thus asked to contribute their technology into the RDK that will become the industry standard. In return, they get license fees. Before the introduction of the RDK, these middle-ware providers had to integrate their solutions on different occasions at different clients. The outputs of each part were the inputs for the others, i.e. they had a reciprocal interdependence. The introduction of the RDK platform, however, changes their interdependence to a pooled form, in which each middle-ware provider renders a discrete contribution to the RDK platform and each is supported by the RDK platform, although the parts do not interact in any direct way. The middle-ware providers depend on each other, because if the other middle-ware providers decide not to contribute, the RDK platform might not become the industry standard and the individual middle-ware providers will not get many license fees. Figure 19 shows how the middle-ware providers have a pooled interdependence between them.

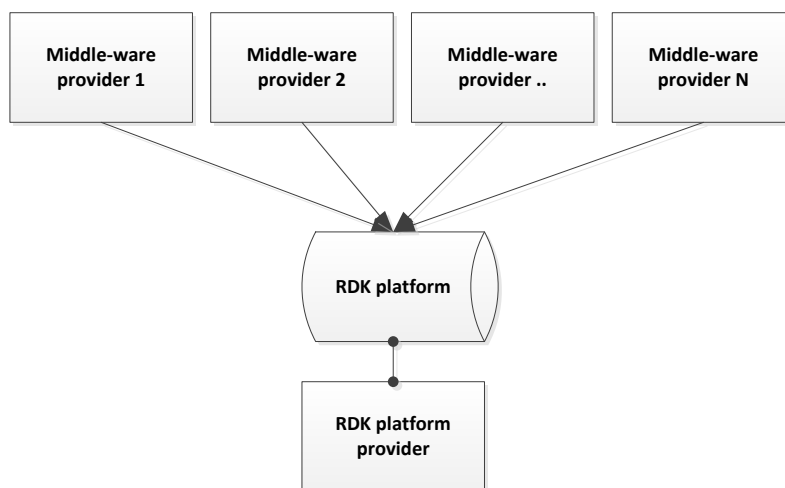


FIGURE 19 POOLED INTERDEPENDENCE BETWEEN MIDDLE-WARE PROVIDERS

In both foregoing examples, the pooled interdependence existed between complementors to a platform: for application providers, the platform was the ‘app store’, for the middle-ware providers, the platform was the RDK software-bundle. Based on these examples, it is proposed that pooled interdependence occurs between complementors to a platform.

Proposition 2a: pooled interdependence exists between complementors to a platform

4.2.2 Sequential interdependence

A *sequential interdependence* exists when the output of one part is the input to another (Thompson, 1967). Hence, two roles can be interdependent, while the flow of products or services, information, or resources is unidirectional. The receiving role depends on the providing role to provide, and the providing role depends on the receiving role to receive. Figure 20 shows the sequential interdependencies identified in the business ecosystem, as mentioned by the interviewees.

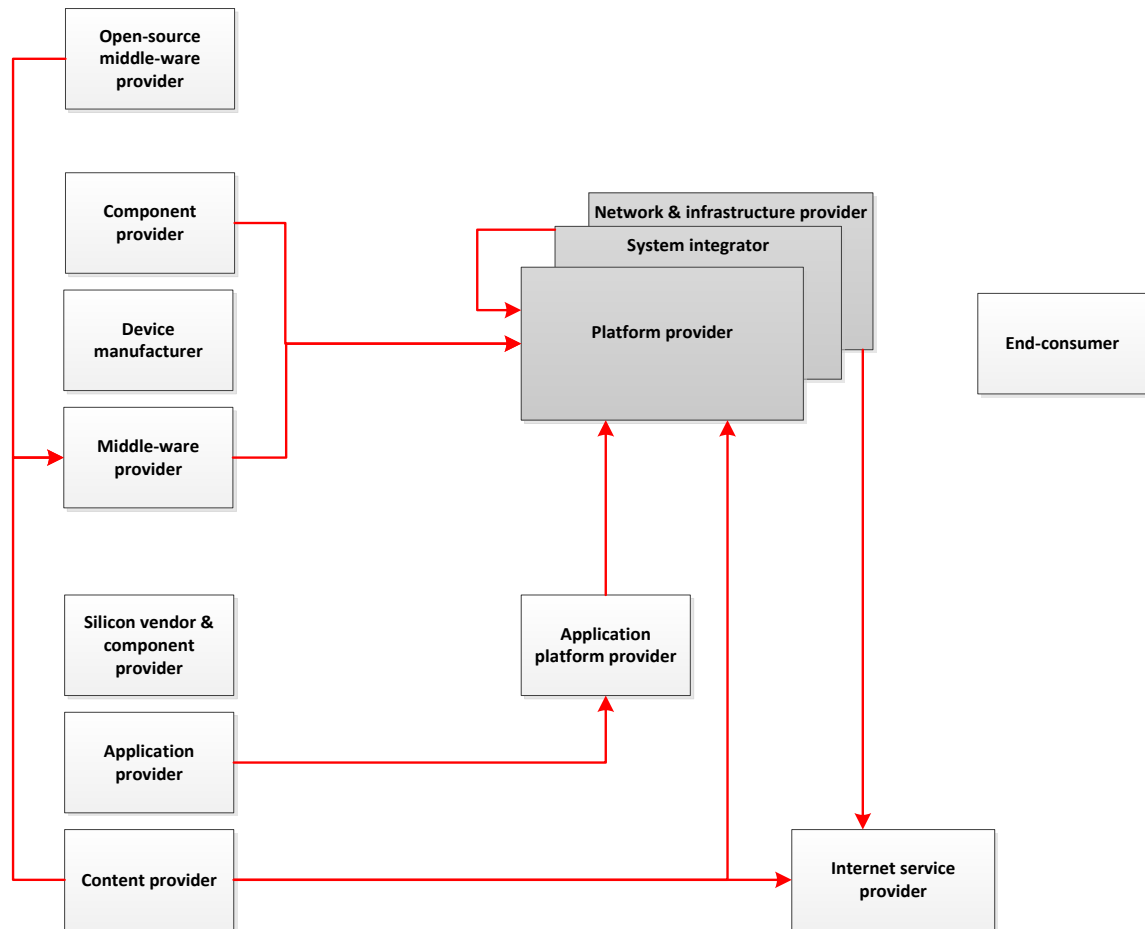


FIGURE 20 SEQUENTIAL INTERDEPENDENCIES

Many of the sequential interdependencies mentioned in the interviews are related to the delivery of the original content, 'apps', or internet services from the content provider to the end-consumer, passing through several roles. In essence, the various sequential interdependencies link up to form the core supply chain in the business ecosystem that creates the value for the end-consumer. It is best illustrated by the next quote:

"If you look at the definition of the industry, you start with the content creator. So typically that's the studios, [studio names], all these guys. They produce the films basically, they are in the upstream. Then you come to the delivery, so people like the operators they act just basically as a channel to distribute the content from the studios." (Launch Manager, middle-ware provider)

In short, it goes as follows. The content provider wants to provide the content to the end-consumer and can choose multiple channels for this. Before choosing a channel, the content first serves as the input to a middle-ware provider that encrypts the content, i.e. digital rights management. The content provider, for example broadcasting studios, then provides the content to either an internet service provider or a platform provider such as the one by the cable-operator. In contracts it is stipulated to which platforms the films and series are allowed to be distributed. In case the content is provided to the internet service provider, they may choose to deliver directly to the end-consumer over the internet, for example through their own website, (OTT) or offer their service, with the content, through the platform of the cable-operator. Though the latter option was not mentioned by interviews, documentary research shows that many internet service providers choose to deliver their service in both ways. If the service is provided OTT, the internet service becomes the input for the network and infrastructure provider who then transfers it over their broadband network to the end-consumer. This is also a sequential interdependence. Likewise, the application platform provider depends on the application providers to develop applications, as these 'apps' are the input to the 'app store' and to the task of the application platform provider to serve as a channel and deliver it to the cable-operator, who then deliver it to the end-consumer. As the application platform is nested in the larger platform, there is also a sequential interdependence between the platform provider and the application platform provider for delivering the applications to them. The foregoing tells us about the sequential interdependencies that exist in the supply chain from content provider to end-consumer.

In addition, four more sequential interdependencies were identified in the business ecosystem. First, it becomes clear from the interviews that the platform provider collaborates with middle-ware providers in two different ways. Either they work together with them to make a custom solution, meaning the integration of the middle-ware solution and platform solution are done reciprocally, more on that in the next paragraph, or the platform provider knows exactly what product or services they want to build into their platform and they just use it as input, making it a sequential interdependence.

"They have the engineering and design capabilities and they will engage directly which vendors that are able to provide the additional capabilities they are looking for. And then they just build it into their service."
(Product Director, middle-ware provider)

Second, similarly, the platform provider had a sequential interdependence with a component provider, where they used the component as input to the set-top-box. Third, many interviewees mentioned the role of the system integrator. In this ecosystem, the role of system integrator was fulfilled by the same firm as the platform provider. However, as we focus on roles, not on firms, a sequential interdependence exists between these roles, as the system integrator integrates all inputs into one pre-integrated solution or complete platform, and delivers it to the platform provider.

The final sequential interdependence is between middle-ware providers and open-source middle-ware providers.

"We are also partially dependent on open-source components. A part of our solution was not made by ourselves, these are things which are just freely available." (Director, middle-ware provider)

All of the above are examples of how sequential interdependence exists between roles that are linked by the supply chain in the ecosystem.

Proposition 2b: sequential interdependence exists between roles that are linked by a supply chain in the ecosystem.

4.2.3 Reciprocal interdependence

A *reciprocal interdependence* exists when the outputs of each part become inputs for the others (Thompson, 1967). This interdependence is characterized by reciprocity, as opposed to a unidirectional sequence in sequential interdependence. Figure 21 shows the reciprocal interdependencies identified in the business ecosystem, as mentioned by the interviewees.

The reciprocal interdependencies identified by interviewees all relate to roles that are 'upstream' suppliers to the platform. Either the interdependence exists between the platform provider and the supplier, or between suppliers themselves. The reciprocal interdependencies mostly arise because two technologies need to be integrated, asking for iterative adjustment. This closely matches an example of Malone et al. (1999), regarding their *fit* form of interdependence, where the interdependency between tasks results from the fact that, for example, different parts of a product need to fit together in the complete product.

Interviewees mention that often this reciprocal interdependence involves more than two roles, since the complete product involves different products and services, such as the hardware in the form of the actual device (the set-top-box), the operating system designed by the platform provider, and the middle-ware that connects the operating system of the platform provider with the applications or internet services that run on top of it. As one mentions, the focal firm needs to coordinate this complex interdependence to bring all these actors and their products and services together:

"To have the [platform name] box, you need a lot of suppliers, to get to the [platform name] box. I am not talking about the hardware only, but also the software and the information that is needed in order to create that. So it's bringing all of that together in order to create that [platform name] platform, which is the product that [brand name] or [brand name] or whatever other brand is selling to the client." (Senior Advisor, EY)

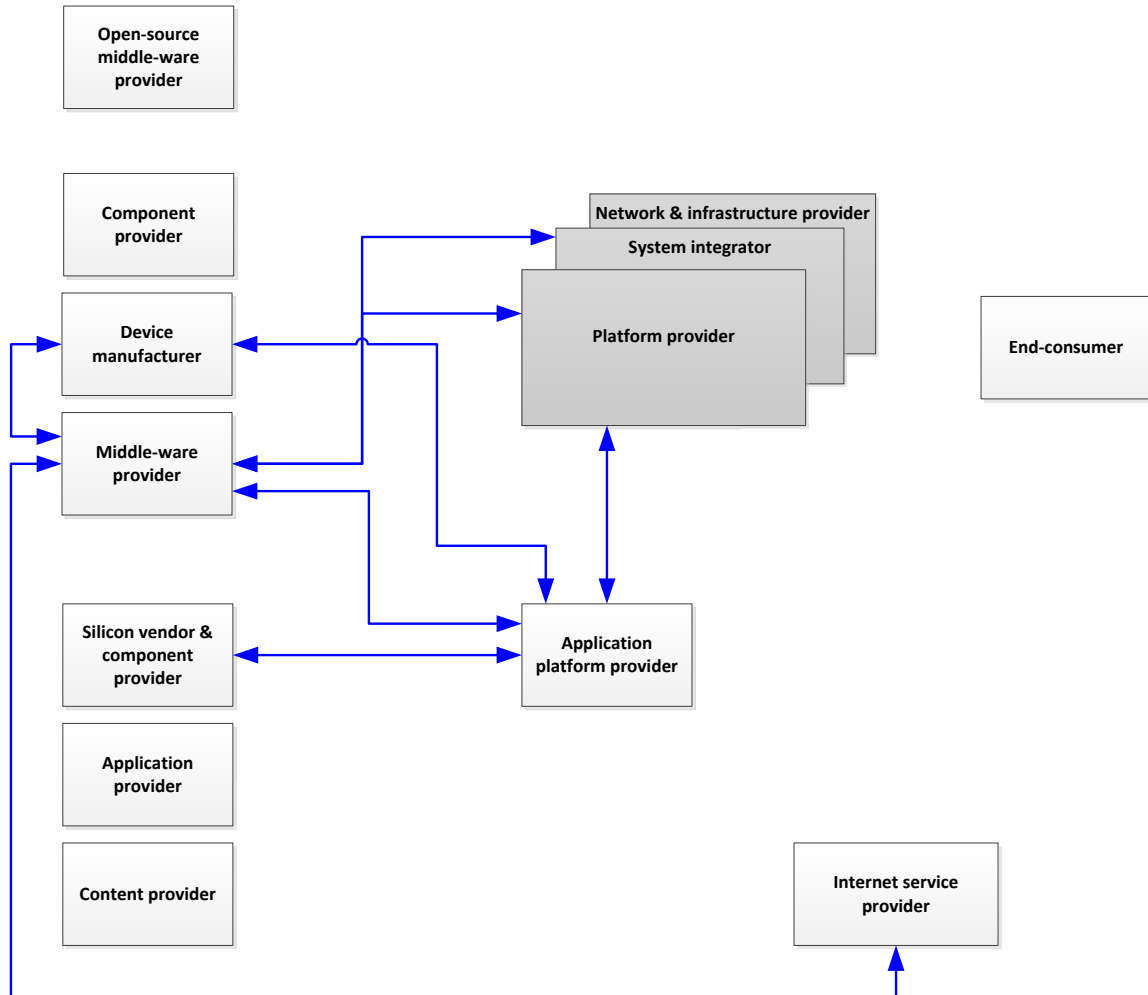


FIGURE 21 RECIPROCAL INTERDEPENDENCIES

The following quote illustrates how often multiple roles are involved, rather than only two:

"They [the platform provider] have a certain in-house project team, and also some vendors work on the premises for a long time together. So although you have very distinctive roles, in the end everyone works in one place as one team of people. It is not so much like a market; it is more like a team."
 (Launch Manager, middle-ware provider)

The vendors to which this interviewee refers were understood to be roles such as the middle-ware providers, component providers, and device manufacturers in similar supportive arguments made by the same and other interviewees.

Yet it is not only the suppliers of the technology involved in this form of team interdependence. An interviewee from a middle-ware provider gave an illustrative example, in which they worked together closely with two of the world's most popular internet services, on one hand, and middle-ware providers specialized in digital rights management (DRM) on the other hand, to collaboratively design a digital encryption solution for video files. This collaboration then continues beyond the instance:

"You're often in all kinds of triangles with such firms. What is allowed, what is possible, what is it technically feasible? What is affordable?"

(Director, middle-ware provider)

In addition to such complex 'triangles' of roles, with multiple firms reciprocally related to each other's and simultaneously working on producing one solution, there are also reciprocal interdependencies between two roles. For example, it was mentioned that sometimes, middle-ware providers choose to work ahead of concrete demand, and pre-integrate their solutions, in order to provide a more attractive, complete product to the customer, e.g. the platform provider.

"The point is, because we are quite a spider-in-the-web, often we are looked at to come with a total solution... That means we have 5/6 partners, plus our product, and we sell that as a whole to the client."

(VP Business Development & Product Management, middle-ware provider)

In this case, the solutions regularly also need to be interfaced with each other, making it necessary for middle-ware providers to inform each other about upgrades of their product. If one firm appends changes, their partner needs to do so as well, so that the integrated solution keeps working together.

Altogether, the reciprocal interdependencies seem to exist between roles with collaborative innovation activities, involving concurrent problem-solving and integration efforts. The reciprocal interdependencies were found to exist mostly on the supply-side of the ecosystem between suppliers to a focal firm, and between the focal firm and the suppliers, frequently roles that do not have a flow of products or services between them.

Proposition 2c: reciprocal interdependence exists between roles that collaborate in innovation activities and/or integrate their products and services.

4.3 Reducing interdependence

Having identified the interdependencies, the next step is to deal with the interdependencies. The second secondary research question therefore reads: *what are the control mechanisms used to coordinate interdependencies in a business ecosystem?* However, during the data analysis, a new way of managing interdependencies was discovered in the case, which has never been mentioned in prior research, and is radically different from the prior focus on implementing control mechanisms. Based on an example that came back multiple times throughout the interviews, it is proposed that, when firms want to reduce the level of interdependence, they would have to move from a task relationship structure with high contingency to a structure of the task relationship with lower contingency. The classic control approach and the new method, however, stand in relation to each other. Firstly, the new method is shown to reduce interdependencies. In the next section, the control mechanisms are then shown to coordinate interdependencies.

In the paragraph on pooled interdependence, the Reference Design Kit (RDK) was mentioned. The RDK is an effort of three of the world's largest cable-operators with the purpose to standardize the formerly unstandardized solutions of middle-ware providers and make the complementary applications that ride on top of the platform more modular. Increasing modularity is a known way to minimize interdependencies between subsystems (Tee, 2012; Tiwana, 2015) and coordination of tasks can be done through varying the degree of modularity of the product or service and through the standardization of interfaces (Thomas & Autio, 2014).

“So the RDK is a modular platform with which you can use both [middle-ware provider] as [middle-ware provider] as whoever. And the RDK made sure that the middle-ware is defined down and up. So all vendors can comply with that, which means they are truly interchangeable and then all components on top of it automatically work with the middle-ware as well, because they are both certified by the ‘air base’. So the modularity is the effort of the RDK. So the industry just says: “If you are not compatible with RDK then we are no longer going to work with you”. And that risk for them is enormous, because henceforth we can just switch. While now they still have the old business model of cankering as deep as possible into the organization, ‘then we are indispensable’, and the RDK thus tries to circumvent that problem by developing a certain standard (Director, platform provider’s investment fund; Executive Chairman, application platform provider).

Middle-ware providers are thus asked to contribute their technology into the RDK that will become the industry standard. In return, they get license fees. Before the introduction of the RDK, these middle-ware providers had to integrate their solutions on different occasions at different clients. The outputs of each middle-ware provider were the inputs for others, i.e.

they had a reciprocal interdependence with both platform providers and other middle-ware providers. The introduction of the RDK platform, however, changes their interdependence to a pooled form, in which each middle-ware provider renders a discrete contribution to the RDK platform and each is supported by the RDK platform, although the parts do not interact in any direct way. The middle-ware providers still depend on each other, because if the other middle-ware providers decide not to contribute, the RDK platform might not become the industry standard and the individual middle-ware providers will not get many license fees.

Figure 22 shows the situation as it was before the introduction of the RDK platform, with numerous reciprocal interdependencies between the platform providers and multiple middle-ware providers, and between middle-ware providers themselves.

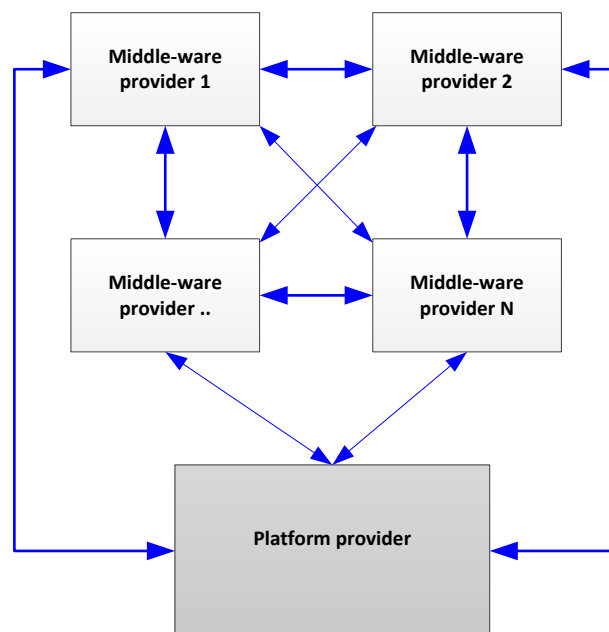


FIGURE 22 BEFORE RDK: RECIPROCAL INTERDEPENDENCE BETWEEN PLATFORM PROVIDER AND MIDDLE-WARE PROVIDERS.

Figure 23 shows the new situation, after the introduction of the RDK platform. The interdependence between the platform provider and middle-ware providers has been replaced with an interdependence between the platform provider and an intermediary role, namely the RDK platform provider. That role is fulfilled by RDK Management LLC, which is a joint-venture between the three largest cable-operators. This interdependence is characterized by a sequential structure of task relationships, as the platform provider can now simply use the RDK's standard output as input for their platform, instead of needing to coordinate multiple integration-efforts with different middle-ware providers.

This change of structure of the task relationship is advantageous for the platform providers, as they have lower coordination requirements. In other words, their interdependence level with middle-ware providers is 'lowered' to a 'level' of sequential interdependence. So for

the platform provider the coordination requirements are lowered. At the same time, the middle-ware providers now have a pooled interdependence between them. So for the middle-ware providers, the coordination requirements as well have been lowered. However, it is disadvantageous for the middle-ware providers, as they become replaceable and the platform provider no longer depends on them specifically. When asked why middle-ware providers would contribute to the RDK if it weakens their position relative to the platform provider, an interviewee mentioned:

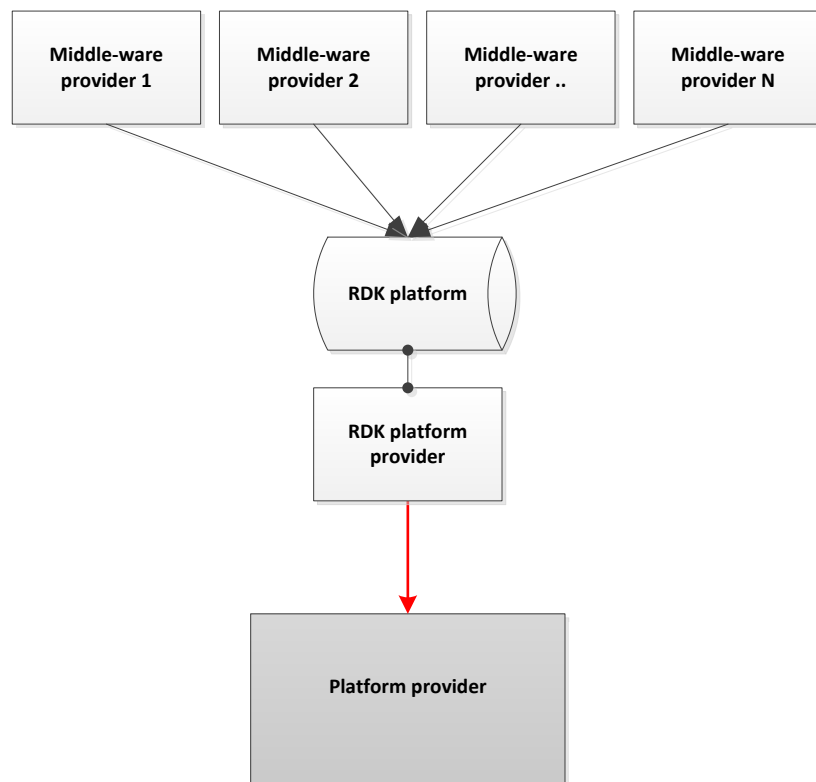


FIGURE 23 AFTER RDK: SEQUENTIAL INTERDEPENDENCE BETWEEN PLATFORM PROVIDER AND RDK PLATFORM PROVIDER

“You can keep it out for a long time, but if you know that it is coming, it might be better to embrace your enemy than trying to fight him, because you will not win it anyway” (Founder & CEO, application platform provider)

Hence, lower coordination requirements are not always desirable for everyone. That means that for some, having a higher form of interdependence is advantageous. For example, the middle-ware providers benefited from the reciprocal interdependence with the platform provider; and though the RDK lowers their coordination costs, their bargaining power with the platform provider lowers.

Nonetheless, whether a firm aims to reduce or increase its level of interdependence with another role, the RDK-example show it can be done by changing the structure of the task relationship of interdependence.

Proposition 3: the level of interdependence can be reduced by changing the structure of the task relationship of the interdependence to a structure that has lower task contingency.

4.4 Controlling interdependence

Now that a new way of reducing interdependencies has been introduced, this section looks at managing interdependence from the classic control- and coordination-perspective. The second secondary research question is central in this section: *what are the control mechanisms used to coordinate interdependencies in a business ecosystem?* First, we will discuss what types of control mechanisms were mentioned by interviewees in general, without looking at the type of interdependencies. Second, we take into account the type of interdependencies and see how controls differ in terms of control formality and control target per structure of interdependence. Third, we pay special attention to each of the three structures of interdependence by giving examples of control mechanisms mentioned by interviewees.

To begin with, let us take a general look at control mechanisms mentioned. In Appendix IV the specific interdependencies between the various roles can be found, including the related control mechanisms mentioned in the interviews. Divided into input, output, and behavior controls, Figure 24 shows an overview of the types of controls mentioned, for the moment not taking into account the type of interdependence they are meant to control.

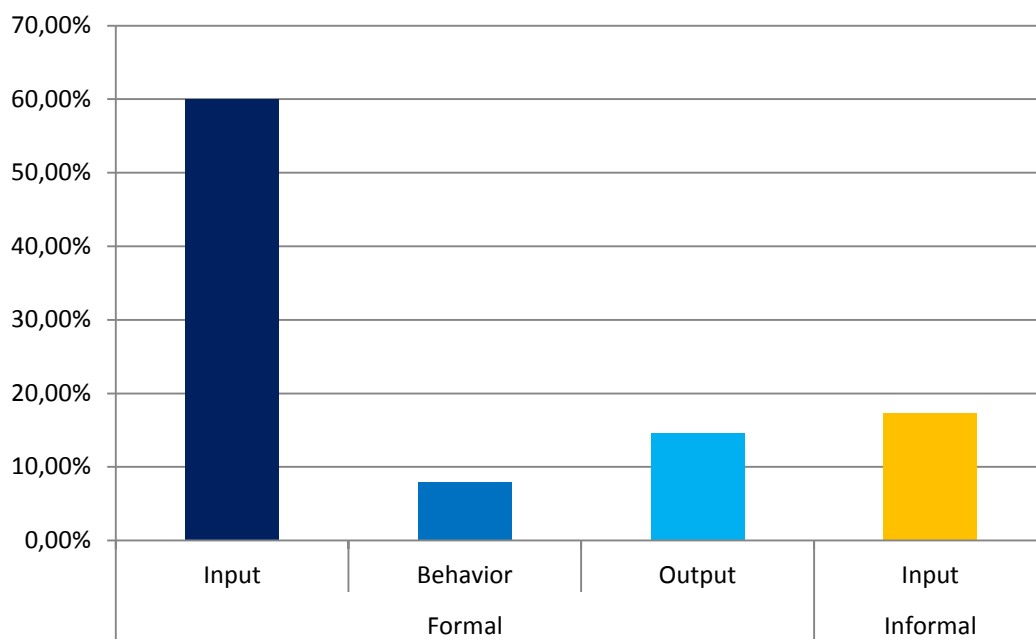


FIGURE 24 CONTROLS MENTIONED IN THE INTERVIEWS

First, interviewees mention formal controls considerably more often than informal controls. Second, input controls are by far the most mentioned control target. Third, all informal controls are input controls, however not all input controls are informal. Fourth, behavior and output controls were only found to be formal.

Proposition 4a: formal controls are used more often than informal controls to control interdependencies in a business ecosystem.

Proposition 4b: input controls are the most frequently used control target to control interdependencies in a business ecosystem, particularly formal input control. Behavior and output control are used relatively infrequently.

Proposition 4c: all informal controls used to control interdependencies in a business ecosystem are input controls, however not all input controls are informal.

Proposition 4d: behavior and output controls to control interdependencies in a business ecosystem are only formal.

Next, let us take into account the structure of interdependence. Figure 25 shows the controls being applied to specific types of interdependence, as mentioned in the interviews. The graph shows a couple of things.

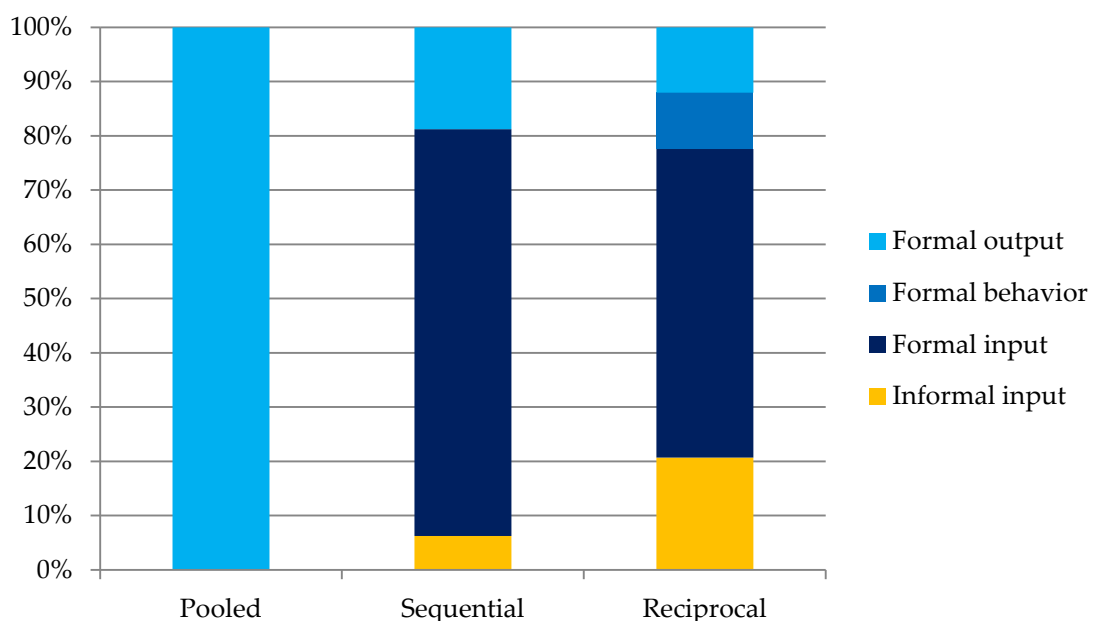


FIGURE 25 CONTROLS MENTIONED PER TYPE OF INTERDEPENDENCE

First, the most fundamental finding is that different control mechanisms, varying in control formality and control target, are used for different structures of interdependence. This might seem like an obvious finding, but prior research has not distinguished between types of

interdependence when researching control mechanisms, and hence lumped all structures of interdependence under the same umbrella. This leads to the following proposition:

Proposition 5a: control mechanisms used to coordinate interdependencies differ in terms of target and formality, depending on the structure of the task relationship of the interdependence.

For some interdependencies, interviewees mentioned multiple, different control mechanisms are used in combination. In the table in Appendix IV it can be seen that it concerns the interdependencies (1) amongst middle-ware providers; (2) between platform provider and middle-ware provider (3) between platform provider and system integrator, and (4) system integrator and middle-ware provider. The interdependencies are predominantly characterized by a reciprocal structure and some have a sequential structure of task relationship. There are no pooled interdependencies that are controlled by combinations of different controls. That leads us to the following proposition:

Proposition 5b: the higher the task contingency of interdependence, the more different types of controls are used in combination, both in terms of control formality and control target.

Now, let's zoom in to the two attributes of control distinguished by Cardinal et al. (Cardinal et al., 2004): control formality and control target. Starting with control formality, it can be seen in Figure 25 that formal controls are used considerably more often than informal controls, for all three structures of interdependence. However, the share of informal controls goes up along with an increasing level of task contingency. In other words, as the coordination requirements increase, increasing reliance is placed on informal controls.

Proposition 5c: the higher the task contingency of interdependence, the more reliance is placed on informal control in controlling interdependencies in business ecosystems.

Then turning to control target, several observations are striking. First, input control dominates sequential and reciprocal structure of interdependence and is constant between them, but is not implemented to control pooled interdependence. Second, output control is used as the only form of control for pooled interdependence. Third, output control is decreasingly used with higher levels of task contingency. Fourth, behavior control is only mentioned to be used to control reciprocal interdependencies, and is not used to control pooled or sequential interdependence, two types of interdependence with a lower contingency. Moving from sequential to reciprocal interdependence, the behavior control seems to seize some of the share of output control, as the share of input control is constant between the two types of interdependence.

- Proposition 5d:** input control dominates the sequential and reciprocal structure of interdependence and is constant between them, but is not implemented to control pooled interdependence.
- Proposition 5e:** pooled interdependence is controlled only by output control.
- Proposition 5f:** the higher the task contingency of interdependence, the less reliance is placed on output control.
- Proposition 5g:** behavior control is only used to control reciprocal interdependencies, and is not used to control pooled or sequential interdependence, two types of interdependence with a lower contingency.

4.4.1 Control of pooled interdependence

One formal output control mechanism was mentioned to control pooled interdependence, as shown in Figure 26. This was the introduction of the RDK, the industry-standard for middle-ware solutions implemented in the set-top-box. Though it is an initiative by the three largest cable-operators it is also seen as a control mechanism to coordinate the pooled interdependence between the middle-ware providers delivering their technology to the RDK software-bundle.

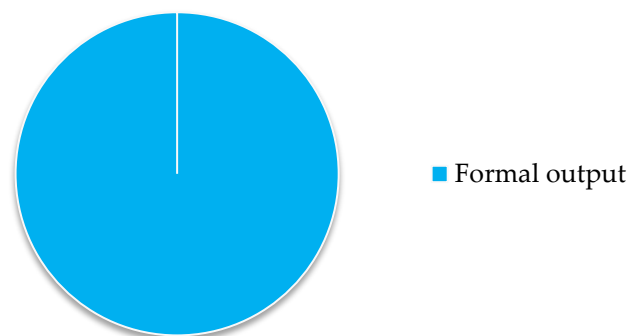


FIGURE 26 CONTROLS MENTIONED FOR POOLED INTERDEPENDENCE

An employee from one of the middle-ware providers mentioned that the RDK, as standardization in the industry, is also a means to control the pooled interdependence that came into existence through the RDK in the first place.

“Some standardization gives everyone a feeling of safety in the market. That is what it induces, that a certain agreement is found between competing suppliers” (Director, middle-ware provider)

4.4.2 Control of sequential interdependence

The results show that sequential interdependence is most often controlled through input controls, and particularly formal input controls, as can be seen in Figure 27.

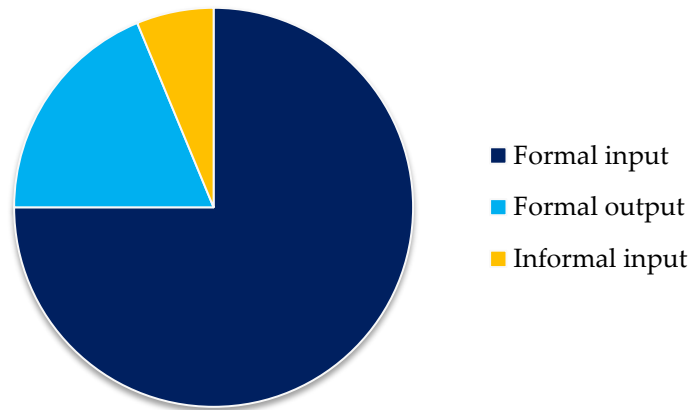


FIGURE 27 CONTROLS MENTIONED FOR SEQUENTIAL INTERDEPENDENCE

The application platform provider controls their sequential interdependence with application providers through several formal input controls. To enable application providers and facilitate the development of applications, the application platform provider created an open-source software development kit. The application provider also established a revenue-sharing structure. The application providers, as well as the platform provider, get a fixed percentage of the revenue generated by the sales of the apps in the app store. This is meant as an incentive system to align objectives and stimulate cooperation. Another measure to encourage output taken by the application provider was the organization of a Hackaton, an event in which many application developers are invited to develop new applications together. In order to retain sufficient control, some input controls were also implemented. For example, the application platform provider makes application providers sign a contract stating the application providers are the owner of the content or have the reselling-rights. Likewise, before publishing the apps the application platform providers does both the legal lifecycle management (i.e. regarding royalties, rights and fiscalities) and technological lifecycle management for applications, i.e. making sure apps are validated, functioning well and are virus-free.

Another way of controlling interdependence, and ensuring this desired continuity of partners, is to invest in them or acquire them completely. The platform provider made several strategic investments in the business ecosystems. Two of which were mentioned in the interviewee with the director of the platform provider's investment fund. First, the platform provider invested in a component provider to make sure the component provider could fund their roadmap and would not change their business model. They selected this component provider for their specific niche service offered. Before a merger or acquisition (M&A) of any firm (in the case study, an example was given of an acquisition of a middle-

ware provider), the platform provider perform a due diligence investigation to make sure the information that is shared with them is indeed the correct information, for example making sure there are no hidden law suits; that intellectual property rights (IPR) are really owned by the partner. Second, financial investments may also serve another purpose, rather than just ensuring future supply. The platform provider, in this case, invested in the application platform provider, at least partially, to make the application platform an industry standard and thereby ensure that enough application providers would be attracted to the platform. This was done through co-investment with other large cable-operators. At first sight, one may ask why the platform provider preferred to do co-investment, rather than be the sole owner of the application platform. The director of the investment fund owned by the cable-operator mentioned the following regarding co-investments:

"Well anyway we want to do co-investment. That's because our strategic interests are often the same as in case of [the application platform provider]. That is, to make sure that the firm is stable, that it has a large customer base." (Director, platform provider's investment fund; Executive Chairman, application platform provider)

Another example is that content providers establish clear functional and legal requirements that distribution partners, such as the platform provider, must meet. This is a formal input control. In particular, broadcasting studios require their video files to be encrypted. This demand for encryption, or digital rights management (DRM), is a legal and technical requirement that the content providers set as an input control to the platform provider. In turn, when partners of content providers are able to meet certain standards of safe deployment, they are awarded a certification by software providers specialized in DRM. This certification then allows these partners to distribute the content. This is a form of input control, as the partners' solutions are tested as a quality assurance.

A formal input control used by the network and infrastructure provider to control its interdependence on internet service providers, is to agree in contracts through which channels the service is allowed to be distributed over. The network and infrastructure provider wanted to negotiate certain exclusivity, because exclusive content draws end-consumers to your network. In the case study, contractual agreements prohibited a major internet service provider from providing certain content to other cable-operators, because cable-operators already had contracts with the underlying content providers themselves.

In addition to the formal input controls, one informal input control was mentioned to be used by platform providers to control their interdependence on the system integrator. The platform provider selects the system integrator on the basis of trust, established through a long-lasting joint-history and joint-customers.

Finally, some output controls were also mentioned to be implemented to control sequential interdependencies. The application platform provider, for example, ‘shrouded’ their source-code, which involves placing your source-code in a vault at a third-party, for example a bank, to protect it. Should the application platform provider then go bankrupt, then the platform provider gets their source-code. Another output control was used by content providers, providing a certification for middle-ware provider stating that they can roll-out there solution if they are able to make it through a certain test. In conclusion, the sequential interdependence of the platform provider on the system integrator is controlled by the system integrator by staying for 3 months after deployment monitoring the system and providing active support.

4.4.3 Control of reciprocal interdependence

The results show that reciprocal interdependence is coordinated by the largest variety of controls, varying in control formality and control target, as shown in Figure 28.

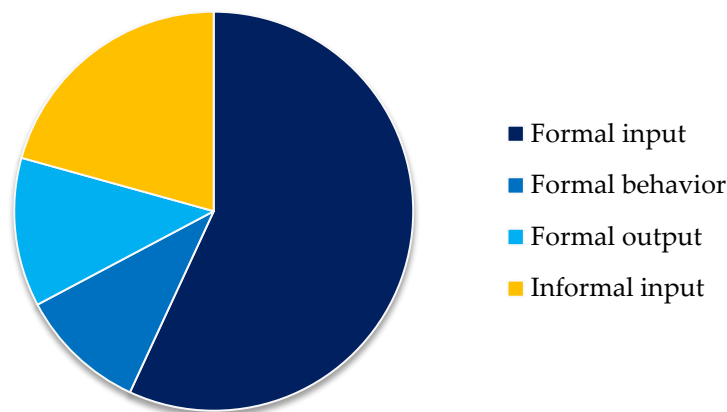


FIGURE 28 CONTROLS MENTIONED FOR RECIPROCAL INTERDEPENDENCE

First, the set of control mechanisms mentioned in the interviews is dominated by input controls, of which the majority is formal. In controlling reciprocal interdependencies between middle-ware providers, a lot of attention is paid to partner selection before starting any form of cooperation. Middle-ware providers perform background checks on potential partners in which they examine for example how the business of the partner is doing, as a sign of their strength. Once a careful background check has been made, a partner is selected on the basis of several criteria. First of all, a key criterion is the service provided by a partner. Many partners are selected on the basis of a specific service or niche capability. In addition, one interviewee mentioned that his firm always looks for partners with a complementary product portfolio to their own; to avoid conflicts of interest in the future, as a partner with overlapping capabilities or services might decide to offer more of its services to the platform provider, thereby deteriorating the position of the middle-ware provider. A more informal criterion that plays a key role in selecting a partner according to many interviewees is a long-lasting joint history with a certain partner. Having worked together

makes firms familiar with each other's services, stimulates learning between firms, and makes it easier to match customer requirements with the capabilities in order to minimize risks and make cost estimations more accurately. Furthermore, having joint-customers allows partners to work ahead of concrete demand. Other criteria used to select partners that were mentioned by interviewees are: industry reputation and proven management capability at current customers. The prospected continuity of the partner was mentioned several times as well. This continuity is crucial, since a bankrupt of a partner will affect the total solution. Prospected continuity is assessed on the basis of the partner's size, or looking at the investors backing the partners, such as an established mother firm. In order to minimize dependency on one specific middle-ware provider or other partner, the platform provider pursues a dual-vendor strategy. It aims to have at least two partners in each category. This dual-vendor strategy is mentioned by others more often to be a popular control.

The management of resource acquired by the firm does not end once the partner is selected. Middle-ware providers, between themselves, actively engage in relationship- or partner management. Relationship management is an informal input control and, according to interviewees, means keeping close ties with partners who you work well with. Partner management, instead is a formal control mechanism. In essence, the partner management function is performed a special team within a firm that contacts major partners on a regular basis and monitors contractual obligations and promises are being fulfilled. Sometimes, the platform provider visits the premises of the middle-ware provider to check how they work. For middle-ware providers to gain the trust of the platform providers, they have to build credibility through growing the relationship, keeping promises, and showing results in elaborate testing; an informal way of input control for the platform provider. More formally, prior to integrating a middle-ware solution, the platform provider performs a cycle of pre-launch testing on the service.

Another example mentioned are non-compete clauses (NCC) in contracts. Non-compete clauses are used to ensure that employees are not taken over by a competitor. Including penalty clauses in contracts for late deliveries, is an input control used by the platform provider. Middle-ware provider makes contractual penalty and liability-clauses in contracts when partners do not own the IPR to their product. Platform provider made contractual agreements with middle-ware provider on prices and royalties of the license model.

One middle-ware provider mentioned that the requirements phase is most key in defining the product that will form the input for the platform provider. The interviewee mentioned that this requires making clear agreements and write out use-cases with the operator to avoid ambiguity on what constitute the customer requirements.

A form of control used by a middle-ware provider is to clearly define their Application Programming Interfaces (API) and make their function modular. The movement towards increasing modular systems is reflected in the sector in general:

“You now see a very modular service landscape. It is not one monolithic system that you write everything together to fulfill a function. The trend is to separate; to make everyone vendors’ system, every vendors’ boundary clearer and clearer” (Launch Manager, middle-ware provider)

The increasingly modular landscape is evident according to another interviewee as well. Increasing modularity enhances the viability of an ecosystem strategy. He mentioned that large firms like the cable-operator in this study cannot innovate as well as smaller firms can, regarding price, throughput time, and development time.

“Those smaller firms can do that. With those smaller firms, the big firms can quickly activate and deactivate. The underlying technology, an operating system like SaaS [Software as a Service], enables easy application of plug-and-play” (Senior Manager Business Development, EY)

One middle-ware provider, for example, consults on a regular basis with partnering middle-ware providers or major internet service providers to collaboratively work on a problem. This is an informal control that entails shared decision making, problem solving and goal setting.

Dual-sourcing is a standard solution in reciprocal interdependencies as well. As sequential interdependencies were mentioned to be controlled through acquisitions or financial investments, so are reciprocal interdependencies. Firms invest in other firms to remove their dependency entirely by merger with their partner, or they invest to ensure the continuity of the partner. The platform provider makes sure, when doing a strategic investment, they have someone on the board (in observer-seat or full non-executive board member) or someone they have a close relationship with.

An often mentioned input control use by all middle-ware providers and the platform provider are service-level agreements (SLA) or service maintenance agreements (SMA) to determine the problem management procedure on how to deal with problems with the product or service. This includes assigning responsibilities, i.e. decentralized or centralized time frames to come up with a (temporary) solutions, and penalty clauses for exceeding limit of downtime. The degree of aggressiveness of the SLA that is agreed upon with a partner depends on the degree of aggressiveness that a firm has with its own client or partner to which it has to deliver, and it also depends on the maturity, confidence, experience, and credibility you have with them. The platform provider subsequently monitors the service and entire infrastructure and direct customer care issues through their information security operations center (SOC) and network operations center (NOC).

Secondly, apart from input controls, behavior controls are also extensively used to coordinate reciprocal interdependencies, as became clear from the interviews. All behavior controls mentioned were formal controls. Non-disclosure agreements (NDA) are a very common control mechanism. These are agreements signed by your own employees, or the employees of a partner, to prevent partners from sharing sensitive information with the competitor. Partnerships may also lead to new intellectual property (IP). An employee of the platform provider mentioned that their contracts include IP-clauses that specify the division of IP-rights (IPR) that result from the collaboration.

One of the middle-ware providers mentioned that the platform provider sometimes orchestrates an on-site workshop with multiple key vendors, in order to concurrently work together on some key issues. Also, as the system integrator and middle-ware firms depend on each other to integrate all their solutions, the system integrator is responsible for project management.. To that end, the system integrator creates a project plan, considering potential delivery delays, listing risks and possible mitigation measures. During the project, regular project meetings will be held during the course of the project, commonly organized by the system integrator, in which involved partners formalize problems, problem owners, and determine action points.

Third, reciprocal interdependencies are also coordinated through output controls. Before starting work, partners align delivery plans and deliverables with each other. Subsequently, both partners monitor these deliverables. Once the cooperation has started, one middle-ware provider mentioned to control the reciprocal interdependencies with other middle-ware providers by means of sharing product roadmaps with each other, to make sure that when one of the partners makes changes or upgrades to its product, the partner follows.

To protect their product outcomes, several middle-ware providers mentioned to either patent their core technology, or shroud their source code. Certifications are also a means of output control. When working together with the device manufacturers making the set-top-boxes, middle-ware providers mentioned that their integrated product, i.e. the output of the collective effort of middle-ware provider and device manufacturer, is required to be certified. In case it is not, the platform provider will not deploy it. Finally, an essential output control involves monitoring performance of your own service and, if necessary, triggering the incident management process.

5. Discussion

Having outlined the results, the next step is to interpret the results in light of prior research (Saunders et al., 2007; Evans et al., 2011). This research studied what types of interdependencies are present in business ecosystems and how these interdependencies can be managed. Prior research on business ecosystems has portrayed the organizations in a business ecosystem as being interdependent (Moore, 1993; Adner, 2006; Pierce, 2009; Kapoor & Lee, 2013) and found that interdependence is one of the key sources of risk in business ecosystems (Adner, 2006). Yet, while many studies refer to the interdependence between firms in business ecosystems, no study of influence has looked into the structure or nature of those interdependencies, let alone how to manage them. This study complements prior research on governance of business ecosystems (e.g. West (2003), Enkel et al. (2009), Tiwana et al. (2010), Eaton et al. (2011), Ghazawneh and Henfridsson (2013) and Wareham et al. (2014)) by focusing on managing interdependencies in business ecosystems, embodied by the primary research question: *How can interdependencies in a business ecosystem be managed?* In order to answer the primary research question, two secondary questions were asked: (1) *what are the structures of the task relationships of interdependencies in a business ecosystem*, and (2) *what are the control mechanisms used to coordinate interdependencies in a business ecosystem?*

Altogether, the results have led to several propositions. The empirical results, supported by theoretical arguments, indicate that the task interdependencies in business ecosystems have different structures, and that they are being controlled in different ways. Moreover, a way of reducing interdependencies is proposed that fundamentally enhances the opportunities to manage interdependencies. The discussion is structured as follows. The first part of the discussion presents the theoretical contributions and implications of the findings. The second part looks at the managerial recommendations on the basis of the findings. Finally, the third section will discuss the limitations of this research and identifies future research opportunities.

5.1 Theoretical contributions and implications

The findings from the research make theoretical contributions to the literature on interdependence and business ecosystems, and particularly the interface of these topics. The contributions and implications will be discussed on the basis of the two secondary research questions guiding this study: (1) *what are the structures of the task relationships of interdependencies in a business ecosystem*, and (2) *what are the control mechanisms used to coordinate interdependencies in a business ecosystem?*

5.1.1 Interdependence

In the process of identifying interdependencies and their structure it is important to identify the roles between which the interdependencies occur. Therefore, before looking at the structures of the interdependencies, first attention is drawn to the focus on roles in this study.

5.1.1.1 *Interdependence between roles*

In prior research, interdependencies have been described to exist between tasks or activities, individuals, departments and firms (Staudenmayer, 1997). The results of this study indicate that, while interdependencies indeed exist between tasks, one cannot speak about interdependence without referring to the roles that are involved in this interdependence. For example, saying that business ecosystems are characterized by reciprocal interdependence, as Moore (1993) does, is a hollow statement, since it does not mention between which roles in the ecosystem this type of interdependence is common. A role can comprise more than one task; hence roles can have multiple task interdependencies between them with a different structure, which depends on the task. For example, the application platform provider is both a supplier to the larger media- and entertainment platform in which it needs to be integrated, as well as an intermediary for delivering the applications to the platform provider. These different tasks relationships are the source of differently structured interdependencies between these roles, namely reciprocal and sequential respectively. The roles that firms fulfill can also be different for each ecosystem they operate in. For example, two middle-ware firms both mentioned that sometimes they fulfilled the role of system integrator in other ecosystems than the one under study.

Thinking in roles, as opposed to firms, contrasts the work of, for example, Iansiti and Levien (2004) who recommend firms to systematically identify the *firms* with which their future is most closely intertwined, in order to determine the critical interdependencies. This role-perspective is, however, consistent with other research, such as Williamson and De Meyer (2012), who stated that structuring differentiated partner roles is one of the keys to unlocking ecosystem advantage. The main reason for looking at roles instead of firms is to facilitate continuous monitoring and subsequent readjusting to evolving business ecosystems. For example, in this case study the focal firm fulfills the roles of platform provider, network and infrastructure provider and system integrator, which is consistent with the theorizing by Williamson and De Meyer that firms can play multiple roles. The focal firm was found to have different interdependencies with other roles, depending on its own role. Hence, looking at roles instead of firms provides a more fine-grained analysis of the interdependencies in a business ecosystem, as a firm knows which interdependencies it influences from a certain role it fulfills. Furthermore, when looking at firms instead of roles, a firm might fallaciously believe an interdependence has disappeared when a partner-firm leaves the ecosystem, while the interdependence with the role that the partner-firm fulfilled still exists; it just happens to be with a different firm having taken over that role. In other words, removing an interdependence is impossible if you cannot stop performing the underlying task entirely. You can select a different partner, but the interdependence with the role will stay, the role will just be filled by another firm. So by identifying your interdependencies with specific firms, you might miss interdependence once this firm leaves the ecosystem while the role is being fulfilled by another firm. Focusing on roles will therefore save effort in continuously scanning all players and entrants in the ecosystem.

5.1.1.2 *Interdependence in business ecosystems*

Koenig (2012) proposed that the structure of interdependence is a defining characteristic of the type of ecosystem. The findings of this study, however, indicate that a business ecosystem may contain several different structures of interdependence at the same time and, hence, that the structure of interdependence relates to an interrelationship between two or more roles rather than an entire type of ecosystem.

More particularly, the three structures of interdependence distinguished by Thompson (1967) were found to exist between different roles in a business ecosystem. First, a relatively small share of the pooled type of interdependence was found. Pooled interdependence was found to exist between complementors to a platform. This is, to a certain extent, consistent with Koenig (2012), who theorized that platform ecosystems are characterized by pooled interdependence. In a way, his thinking was right. However, Koenig did not refer to specific roles but to an entire type of ecosystem. As mentioned earlier, it is advocated that one cannot speak about a certain type of interdependence without referring to the roles that firms hold in a business ecosystem. The findings that pooled interdependence exists between complementors to a platform can be inferred from many previous studies on platforms and platform ecosystems (e.g. Gawer (2009), Wareham et al. (2014), Tiwana (2015)), though no study considers this explicitly. In addition, Thompson's definition of pooled interdependence seamlessly relates to the definition of an (external) platform by Gawer and Cusumano (2013, p. 2) as "products, services, or technologies that act as a foundation upon which external innovators, organized as an innovative business ecosystem, can develop their own complementary products, technologies, or services".

Second, interdependencies were found to be almost equally often characterized by a sequential or a reciprocal structure of the task relationship. This could be surprising at first sight, as prior research has characterized network forms of organization (Powell, 1990) and ecosystems in particular (e.g. by Moore (1993), Thomas and Autio (2012) and Williamson and De Meyer (2012)) by their reciprocal patterns of communication and exchange, and the reciprocal cycles of adaptation, i.e. co-evolution, between participants in a business ecosystem (Moore, 2006). Hence it might be surprising to find so many task interdependencies being characterized by sequential interdependence. This can be explained by the fact that, though the ecosystem is a complex network, there is still a core supply chain (or possibly multiple supply chains) underlying the network (Moore, 1993). This supply chain is commonly connected by sequential interdependencies. The sequential interdependencies, therefore, have a great overlap with the flow of products or services. The reciprocal interdependencies, instead, were found to be related more to collaborative innovation activities, involving concurrent problem-solving and integration efforts. Interestingly, these reciprocal interdependencies were mentioned predominantly between firms that do not have a flow of products or services between them.

5.1.2 Managing interdependencies

Having identified the interdependencies, the next step is to deal with the interdependencies. On the basis of prior research, which has focused on control and coordination of interdependence, the second secondary research question reads: *what are the control mechanisms used to coordinate interdependencies in a business ecosystem?* However, during the data analysis, a new way of reducing interdependencies was discovered in the case, which has never been mentioned in prior research, and is radically different from the prior focus on implementing control mechanisms. The classic control approach and the new method, however, stand in relation to each other. Firstly, the new method is shown to reduce interdependencies, while secondly, thereafter the control mechanisms are shown to coordinate interdependencies.

5.1.2.1 Reducing interdependencies

The majority of prior research has come from the information processing perspective on interdependence, as used in this study (Staudenmayer, 1997). Accordingly, the goal of the majority of prior research has been to match control mechanisms to the 'level' of contingency, as these mechanisms have been considered an effective way to coordinate interdependencies (e.g. by Gulati and Harbir (1998) and Dekker (2004)) and coordination is suggested to be a purpose of control (Malone & Crowston, 1994; Tiwana et al., 2010). However, this information processing perspective on interdependence, which has heavily influenced the current knowledge on interdependence, is stooled on the fundamental conceptualization of interdependence as a dyad of tasks with a definite, visible and stable structure (Staudenmayer, 1997). In other words, tasks are assumed "to be" one of the types mentioned. However, by taking the structure of the task relationship of interdependence as fixed, the current literature has looked for opportunities to manage the interdependencies with a blinkered view of the matter. Thereby, it has overlooked a more radical way to manage interdependencies, which involves changing the structure of the task relationships.

To see how this takes shape, first consider the following. The 'strength' or 'level' of interdependence between tasks is regarded to have an influence on uncertainty (Staudenmayer, 1997), i.e. the higher the level of interdependence, the higher the uncertainty. Yet, prior research has not given a conceptualization or operationalization of the 'strength' or 'level' of interdependence'. In this study, the three types of interdependence (pooled, sequential, and reciprocal) are suggested to be indicators of the 'level' or 'strength' of interdependence as the coordination requirements are higher as you move from one type of interdependence to the next, due to an increasing degree of task contingency (Thompson, 1967). Then, considering the structure of the task relationship as 'levels' of interdependence implies that this level can be reduced or minimized by changing the task relationship structure of the interdependence to a structure with a lower level of contingency.

In this case study, the introduction of the RDK platform is an example of how the level of interdependence might be reduced by changing the structure of interdependence. The

purpose of the RDK is that it standardizes the formerly unstandardized solutions of middle-ware providers and makes the complementary applications that ride on top of the platform more modular. Increasing modularity is a known way to minimize interdependencies between subsystems (Tee, 2012; Tiwana, 2015), which is why Thompson (1967) suggested coordinating pooled interdependence through standardization. The establishment of the RDK platform changed the level of interdependence between the middle-ware providers from reciprocal to pooled interdependence, and reduced the level of interdependence between the middle-ware providers and the platform provider from reciprocal to sequential. Therefore, effectively, increasing modularity indeed minimizes the interdependencies between subsystems, doing so by changing the structure of task relationship of interdependence. More importantly, the standardization in this case was primarily a means to change the reciprocal interdependence between middle-ware providers and the platform provider to a sequential interdependence, thereby lowering the coordination requirements for the platform provider and thus reducing their dependence on middle-ware providers. The introduction of the RDK-standard thereby weakened the position of middle-ware providers towards the platform provider. Note, therefore, that a firm might not always want to reduce its level of interdependence. Instead, a firm might want to increase their level of interdependence with another firm, in order to increase their bargaining power. This is the case for the middle-ware providers, who lost power when their interdependence with platform providers decreased through the introduction of the RDK-standard.

Figure 29 is the conceptual framework based on prior research, augmented with the original contribution of this study in dashed lines. While control mechanisms have been considered as an effective way to coordinate interdependencies by moderating the relationship between interdependence and uncertainty (e.g. by Gulati and Harbir (1998) and Dekker (2004)), changing the structure of interdependence actually reduces the level of task contingency, and thereby reduces the 'level' of interdependence. Thus, rather than trying to keep the adverse effects of interdependence on uncertainty under control by means of control mechanisms, a firm might actually lower the level of interdependence itself. This possibility has been overlooked by prior research which has primarily considered tasks and interdependencies "to be" as they are (Staudenmayer, 1997).

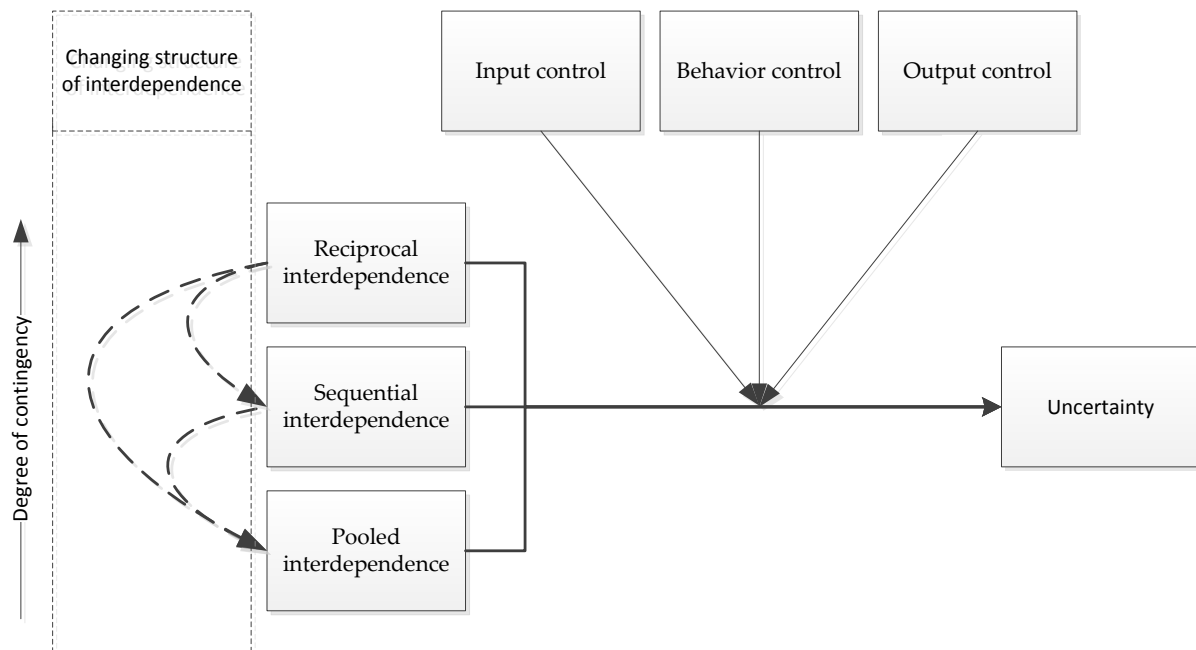


FIGURE 29 ORIGINAL CONTRIBUTION OF THIS STUDY: REDUCING INTERDEPENDENCE THROUGH CHANGING ITS STRUCTURE

This new way of managing interdependence is much more radical than prior research has suggested and marks a paradigm-change in the literature on managing interdependencies, as the prior research has been preoccupied with controlling and coordinating interdependence, rather than effectively reducing interdependencies. This radical way of managing interdependencies is, however, not mutually exclusive with the more classic and static view on interdependence and its management. Instead, reducing interdependence and controlling interdependence are hereby suggested to be complementary, as reducing interdependence does not remove the need to control the interdependence thereafter. First, a firm can see if it can change the structure of the task relationship of interdependence and do this if it is possible. Second, whether the structure of the task relationship has been changed or not, the firm can implement control mechanisms to control the interdependence. The section on managerial recommendations will discuss how firms can implement this.

5.1.2.2 *Coordinating interdependencies*

Having identified a way to reduce interdependence does not remove the need to subsequently coordinate the interdependencies. Regarding control mechanisms, some general observations stood out. First, formal controls are used considerably more often than informal controls to control interdependencies in a business ecosystem. This might be explained by the fact that formal controls are by definition more codified and visible than informal controls (Cardinal et al., 2004), and hence interviewees might not be aware of informal controls. Second, input controls are the most frequently used control target to control interdependencies in a business ecosystem, particularly formal input control. Behavior and output control are used relatively infrequently. Following Ouchi's (1977) line

of reasoning of antecedent conditions of control, a reason for this could be that there are no reliable measures of outputs available and there is little knowledge of the transformation process. Hence, firms choose to implement input controls to coordinate the interdependent tasks and thereby heavily rely on the selection process as Ouchi suggested. Many of the input controls mentioned indeed relate to partner selection. It is plausible that there are no reliable output controls available in business ecosystems, as the success of a firm's offering hinges on development and deployment of all other solution components by partner-firms (Adner, 2006). The relatively small share of behavior controls might be explained by the fact that behavior control has been predominantly viewed as a mechanism that stifles creativity (Cardinal, 2001). Organizational creativity, subsequently, is considered a subset of the broader domain of innovation (Woodman et al., 1993). As business ecosystems create new value through innovation (Thomas & Autio, 2013), this view of behavior control as a creativity-stifling mechanism might explain why behavior controls are used relatively infrequently in business ecosystems.

Third, all informal controls used to control interdependencies were found to be input controls, however not all input controls are informal. Prior research has been in disagreement on whether input control should be considered a formal control (Kreutzer et al., 2015). These results indicate that input control can be both informal and formal. Fourth, behavior and output controls were only found to be formal. This is in line with the classic belief that output and behavior control are formal controls (Kreutzer et al., 2015).

Looking at controls in relation to the structure of interdependencies shows us more detailed findings. First, the most fundamental finding is that different control mechanisms used to coordinate interdependencies differ in terms of control target and control formality, depending on the structure of the task relationship of the interdependence. Prior research has not considered differences in interdependencies when applying control mechanisms, though it had been suggested by Dekker (2004). This implies that future research should consider the structure of task relationships of interdependence when trying to coordinate the interdependence. Second, the higher the task contingency of interdependence, the more different types of controls are used in combination, both in terms of control formality and control target. Kreutzer et al. (2015) had already argued that behavior and output control should be used together. They suggested that the advantages of this complementary use might be higher in a context with high levels of organizational politics or opportunistic behavior by individuals at the expense of a larger organization. Basole et al. (2014) found that the risk of opportunistic behavior is larger in cooperative relations, characterized by both competition and cooperation between firms, and found that this type of relationships are prevalent in what he defines as the ICT ecosystem. Altogether, this might suggest that combining different types of controls, both in terms of control formality and control target, might be effective in business ecosystems, and in particular for interdependencies with a high task contingency.

The results show several things for both attributes of control: control formality and control target. First, the higher the task contingency of interdependence, the more reliance is placed on informal control in controlling interdependencies in business ecosystems. As several of these informal controls related to the relationship building and trust, an explanation for this finding could be that trust is an alternative uncertainty absorption mechanism to increased information (Tomkins, 2001). "A person or organization seeking to exercise mastery over some affairs will require information on only those matters that it has been decided not to take on trust. This decision will be the function of the perceived uncertainty attached to the functioning of a person or thing plus the consequences of that on-functioning" (Tomkins, 2001, p. 165). Given that the uncertainty, and hence the need for information, goes up with a higher task contingency (Thompson, 1967; Staudenmayer, 1997), a firm will want to increase its level of trust as task contingency goes up to decrease the need for information and thus the need to install uncertainty absorption mechanisms such as control mechanisms. The foregoing could explain the increasing share of informal control with higher levels of task contingency.

Second, turning to control target, the results of this study showed that input control dominates the sequential and reciprocal structure of interdependence and is constant between them, but is not implemented to control pooled interdependence. For sequential interdependence, this is in contrast with Thompson (1967), who suggested that sequential interdependence is best coordinated by plan, involving the establishment of schedules, which is more a behavior or possibly output control. However, as sequential interdependence only involves a unidirectional flow of a partner's outputs into a firm's transformation process as input, input control seems the logically preferred form of control. For reciprocal interdependencies, the large share of input controls might be explained by the lack of available output measures.

Third, pooled interdependence is controlled only by output control. As roles involved in a pooled interdependence have discrete contributions and do not interact directly, the way to control and coordinate each their interdependence is best done by output control. The formal output control mechanism mentioned to control pooled interdependence, was the introduction of the RDK, the industry-standard for middle-ware solutions implemented in the set-top-box. This is in accordance with Thompson (1967), who proposed that pooled interdependence is best coordinated through standardization. Fourth, the higher the task contingency of interdependence, the less reliance is placed on output control, while fifth, behavior control is only used to control reciprocal interdependencies, and is not used to control pooled or sequential interdependence, two types of interdependence with a lower contingency. An explanation for the latter could be that roles involved in a reciprocal interdependence through their reciprocal exchange of inputs and outputs are forced to gain more knowledge on each other's transformation process and are subsequently more likely to implement behavior controls using this knowledge, following Ouchi's (1977) reasoning.

Ouchi claims that no learning can take place if correct behaviors and outputs cannot be identified. In other words, learning can only take place if correct behaviors can be identified by having knowledge of the transformation process. A product director of one of the middle-ware providers mentioned that this learning between partner middle-ware providers is of great importance; perhaps not only to increase confidence, but also to learn about each other's transformation processes. Subsequently, once they have this knowledge, roles in reciprocal interdependencies would be more likely to implement behavior controls than roles in pooled or sequential interdependencies. This might explain the use of behavior controls exclusively in reciprocal interdependence.

The focus of this study was on the attributes of control, not on specific examples of control. Nonetheless, some specific examples are highlighted here to show how they related to prior research. The application platform provider was found to only use input controls in its sequential interdependence with the application providers. This result is in accordance with previous findings, as Tiwana (2015) found input control to be complementary to a modular design of third-party extensions, i.e. applications, on a platform. Modularization increases the autonomy for application developers to experiment freely in revising an application, and input control allows the platform provider to ensure an application's interoperability and quality before it enters the ecosystem (Tiwana, 2015). Another specific example of controlling interdependence mentioned by interviewees is to invest in partners or acquire them completely. Mergers (Pfeffer, 1972) and vertical integration (Sutcliffe & Zaheer, 1998) have long been recognized as a strategy to manage interdependencies. This study confirms the finding by Sutcliffe and Zaheer (1998) that supplier uncertainty, uncertainty about the behaviors and possible opportunism of the vertical partner in a transaction, is positively associated with decisions to vertically integrate. Several interviewees mentioned occasions in which acquisitions of firms were motivated by the need to ensure supply of a certain component. More specifically, the director of the investment fund owned by the platform provider mentioned that the platform provider prefers to do co-investments when investing in suppliers or partners. This is in accordance with Williamson and De Meyer (2012) who found that stimulating co-investments is especially relevant in business characterized by network effects. "By stimulating partners to co-invest, a lead firm can also create a multiplier effect, thereby enabling exponential growth in the ecosystem for each incremental investment of its own resources" (Williamson & De Meyer, 2012, p. 36).

Also, one interviewee mentioned that his company always looks for partners with a complementary product portfolio to their own; to avoid conflicts of interest in the future, as a partner with overlapping capabilities or services might decide to offer more of its services to the platform provider, thereby deteriorating the position of the middle-ware provider. Basole et al. (2014) also suggest firms to take into account the potential for such forms of opportunistic behavior in evaluating potential partners. Overlapping contributions also lead to duplication of efforts, uncertainty and confusion, which is ultimately detrimental to the

ecosystem's performance (Williamson & De Meyer, 2012). Furthermore, having joint-customers allows partners to work ahead of concrete demand. This is a form of risk taking that helps to build trust between partners (Dekker, 2004). A more informal criterion that plays a key role in selecting a partner according to many interviewees is a long-lasting joint history with a certain partner, which Dekker (2004) found as well.

A form of control used by one of the middle-ware providers is to clearly define their Application Programming Interfaces (API) and make their function modular. Controlling complementary assets by means of creating and evolving API's is a common form of control for platform owners (West, 2003; Ghazawneh & Henfridsson, 2013). The purpose of modularity is in fact to minimize interdependences between subsystems (Tiwana, 2015). Finally, once the cooperation has started, one middle-ware provider mentioned to control the reciprocal interdependencies with other middle-ware providers by means of sharing product roadmaps with each other, to make sure that when one of the partners makes changes or upgrades to its product, the partner follows. This is in line with Thompson's (1967) suggestion that reciprocal interdependence is best coordinated by mutual adjustment between two firms.

In conclusion, this study suggests that all three structures of task relationships of interdependence are present in business ecosystems and these structures are controlled through different controls, varying both in control formality and control target, and are also used in combination.

5.2 Managerial recommendations

Ongoing industry convergence is creating new types of interdependencies between telecom- and cable-operators and other players, forcing operators to adapt to new roles in continuously evolving ecosystems. In order for operators to be able to make a grounded decision on which roles to pursue, they must be aware of the interdependencies that exist between the various roles in a business ecosystem and should know how they could manage the interdependencies. Based on the findings from this study, the managerial recommendations are provided in the form of a roadmap, as shown in Figure 30. The roadmap is designed to assist firms in identifying and managing interdependencies. The roadmap is designed in and for a business ecosystem-context; but is likely to be useful for firms operating in other forms of business networks.

The first step in the roadmap is to identify the roles with which your future is most closely intertwined and determine the interdependencies that are most critical to your business. Once the critical interdependencies have been identified, the second step is then to determine the type of structure of the task relationship underlying the interdependencies (pooled, sequential or reciprocal). A role will likely have multiple different interdependencies, perhaps even with the same partner.

Having identified the critical interdependencies and their task relationship structure, the next step is to manage the interdependencies. In order to do so, the question that should be asked is whether is feasible and desirable to change the underlying structure of the task relationship, and do so if the answer is yes. In this decision, some factors have to be taken into account, such as the cost to change the structure and the impact it would have on the strategic position and business operations of the firm.

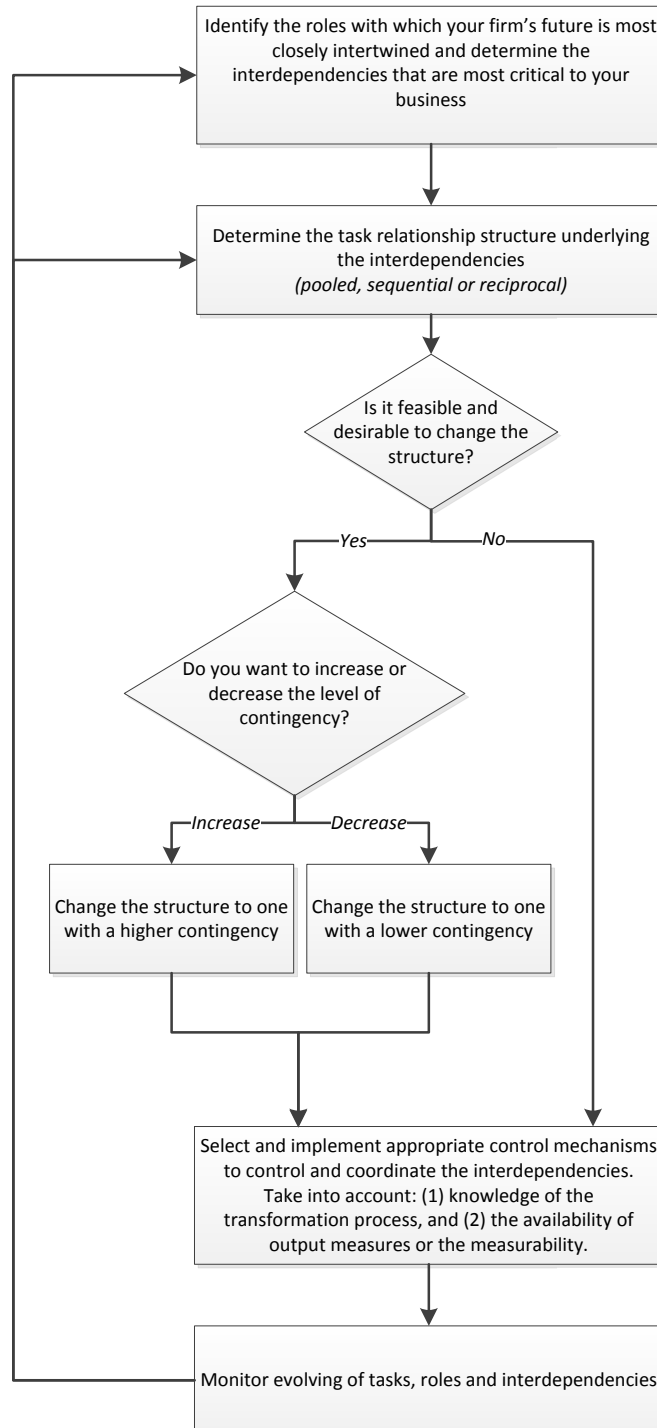


FIGURE 30 ROADMAP TO ASSIST IN IDENTIFYING AND MANAGING INTERDEPENDENCIES IN A BUSINESS ECOSYSTEM

Note that a firm might sometimes want to increase its interdependence with another role, depending on its strategic position and relation with that other role.

Thereafter, whether the structure of the task relationship has been changed or not, the firm should select and implement control mechanisms to control the interdependencies. In selecting control mechanisms, it is advised to take into account the two antecedent conditions by Ouchi (1977): (1) knowledge of the transformation process, and (2) the availability of output measures or the measurability. Other factors influencing the selection of control mechanisms could be the likely impact of the controls on innovation efforts or business operations.

The final step in the roadmap is continuous monitoring of tasks, roles and interdependencies, as all are subject to change and affect each other. If tasks, roles or interdependencies change, go back to the first or second step in the roadmap and reconsider the criticality or structure of the task relationship of your interdependencies, and accordingly adjust your control technique. The two feedback loops in the roadmap accommodate this iterative approach.

5.3 Limitations and future research

The original research design included an additional validation-phase, which was unfortunately not viable due to time-constraints. The idea was to administer a questionnaire to employees operating in the business ecosystem under study, most likely the former interviewees, with the objective to triangulate the findings from the interviews. In addition, a cross-validation with two other cases to enhance external validity was not feasible. However, some interviews were held initially, and in these interviews different roles came forward, such as the value-added reseller. New roles mean new interdependencies. In addition, the roles that firms fulfill can also be different for each ecosystem they operate in. For example, two middle-ware firms both mentioned that sometimes they fulfilled the role of system integrator in other ecosystems than the one under study. Future research could aim to perform a multiple case-study and compare the findings of this study to enhance to expand and generalize theories (analytical generalization). In addition, further research could investigate how multiple roles interact or conflict within a firm and how this affects their interdependencies with other roles.

A limitation of this interview is 'selection bias', a bias in interpretation of the researcher. This is fundamental to all (qualitative) research. The interviews were coded and results interpreted with the researcher's paradigm. Though measures have been taken to enhance both validity and reliability, another researcher might still reach slightly different findings on the basis of his or her interpretation.

Interviewees each brought a different perspective to the table; for example: a product manager looked more at the research matter from a project management perspective, whilst

the CEO takes a broader outlook. The multi-perspective view on the case gives a broad overview, yet to draw valid conclusions on specific interdependencies, multiple interviewees from one specific perspective might prove to be more valuable in future research. Likewise, a limitation in this research was that the first round of interviews and focus groups were only employees from EY, which only knew about the focal firm's perspective. Hence, early theorizing and conceptualization in this research is likely to be influenced by this perspective. Moreover, all these interviewees had similar experience with the ecosystem as they had discussed this case in their work a lot before. So their perspectives are likely to have converged through previous interaction. Hence, the fundament they laid for this research is not as rich, as their answers are not entirely independent.

From the literature review it became clear that more coherent frameworks are needed for interdependence, control and business ecosystems. Prior research has not reached consensus on these concepts. For control and business ecosystems the concept should be more clearly distinguished from related concepts. As long as conceptualizations and operationalization differ, external validity is limited and all research becomes ideographic. Looking at the research on interdependence, for example, the concepts of dependence and interdependence seem to be used interchangeably in prior research. This causes confusion, but it should not, as the interchangeability is theoretically justifiable. For example, a sequential interdependence might appear as a one-way dependence for the receiving firm. Yet, the providing firm just as much depends on the receiving firm, as it needs a customer for its product or service. Hence, though the underlying structure of the task relationship is only unidirectional, this does not exclude the existence of an interdependence as opposed to a one-way dependence.

The radical way to reduce interdependencies by changing the structure of their task relationship is stooled on one example from the case study. In this case study, the introduction of the RDK platform is an example of how the structure of interdependence might be changed. Future research should investigate, validate and design more ways to change the structure of interdependence.

A limitation of this research is the limited view on interdependence as the focus has been on distinguishing interdependence along the underlying structure of the task relationship (i.e. pooled, sequential, reciprocal, team) and has disregarded the nature of the task relationship (i.e. loose versus tight coupling). Ouchi (1979) theorized that conventional rational control mechanisms (by which he means output and behavior control) are less viable in loosely coupled organizational structures (Tiwana, 2015). Tiwana (2015) finds certain evidence of this in prior research, yet future research could consider the nature of interdependence as well, rather than just its structure, in order to find appropriate control mechanisms.

Staudenmayer (1997) calls for a more integrated model of interdependency and emphasizes the need to better integrate knowledge about interdependencies with theories of

organizational design and structure, and she refers to the classic debates in design theory over concepts of design and evolution. "Design refers to a process conducted by an outsider or representative of the system, as in information processing or resource-based solutions. In evolution, the search for design is conducted by the system itself in terms of itself via a series of local adaptations" (Staudenmayer, 1997). As business ecosystems are characterized by co-evolution (Moore, 1993), a business ecosystem is likely to design itself, yet many studies still advocate the focal firm leading the design of the ecosystem. Design, in turn, is related to governance (Tiwana et al., 2010). Future research on business ecosystem should therefore integrate knowledge about interdependencies with theories of organizational design and structure.

A limitation of this research is that it has only looked at the concept of interdependence from one theoretical perspective, namely the information processing perspective, largely influenced by Thompson (Staudenmayer, 1997). The implicit assumption of this perspective is that tasks are pre-identifiable and that patterns are clearly visible and recognizable. This assumption seems to have a natural bias towards a tightly coupled nature of task relationships, as these tend to be more visible and experienced by respondents (Staudenmayer, 1997). Closely related is the focus on single dyadic relationships, which is common in interdependency research (Staudenmayer, 1997). However, in reality firms must perform many tasks at the same time, which would suggest coordination conflicts and coordination costs and overload, yet such problems are largely ignored. As interdependencies become more abundant, complex and intertwined, as in business ecosystems, the required coordination mechanism applied in single dyadic relationships might no longer be relevant or adequate. Moreover, many interviewees mentioned that interdependencies are often not dyadic. Instead, often multiple roles are involved, rather than only two. The sensemaking perspective on interdependence challenges the most basic and simplifying assumptions (i.e. that organizations are rational with static and uniform tasks) (Staudenmayer, 1997). Tasks are becoming increasingly abstract, continuous, and flexible, and as such become less analyzable via traditional (rational) means such as inference or problems solving (Staudenmayer, 1997). Future research could use sense-making theory to study interdependence in its rich context of business ecosystems. In this light, it is interesting to note that Strode and Huff (2012), mistakenly, stated that Thompson had distinguished four types of interdependence, thereby adding *team interdependence* to the widely acknowledged pooled, sequential and reciprocal forms. Strode and Huff defined this form of interdependence as an interdependence in which work enters the unit and actors diagnose, problem-solve, and collaborate as a group, working concurrently to deal with the work (2012). Perhaps the representations of structure of the task relationship (pooled, sequential, and reciprocal) used in this study are not adequate enough to reflect the complexity that exists in business ecosystems. An inductive and ideographic approach might be more suitable to discover new arrangements.

This study operationalized the strength of interdependence as being represented by the structure of interdependence. However, there might be factors moderating the relationship between control and interdependence. Some factors, such as the size of the firm, brand importance, etc., were mentioned by the interviewees that could affect the strength of interdependence. Future research should relate the structure of interdependence to such factors, and to power distribution in the ecosystem, which has previously been considered primarily from a resource-based view (Staudenmayer, 1997).

This study found that many firms originally just depend on the focal firm in its role of this network and infrastructure provider, i.e. as 'dumb pipe'. In order to change this, the focal firm created the media- and entertainment platform, thereby creating dependencies of other firms on them as platform provider. Looking at the business strategies defined by Iansiti and Levien (2004), this can be marked as a strategic move from commodity to keystone player as keystones are effective at both creating and sharing value across the ecosystem through platforms (Basole, 2009). The focal firm also made some strategic investments in some of its suppliers and complementors; hence the next step could be to become physical dominator. Future research could try to see how roles and strategies in business ecosystems relate to each other, and how they complement each other, and thereafter see how business strategies relate to interdependence. In addition, Eisenmann et al. (2008) suggested that the roles in a platform ecosystem can be open or closed. Future research could investigate whether this openness per role affects the interdependencies these roles have.

Learning between partners in an ecosystem was mentioned to be important by several others in the ecosystem, in terms of capabilities. This could be a fertile soil for research. How do firms in a business ecosystem learn from each other, and does this learning affect interdependencies, e.g. their level or structure, and subsequent control? Future research could also look more closely at the incentives for firms to join an ecosystem, in relation to future interdependencies. Do firms want to tap other firms' capabilities, assets or resources? That will direct attention to which view (e.g. resource-based, information-processing) on interdependencies might be more appropriate to consider. For example, if the main motivation for firms to join an ecosystem is to tap into resources across the firm's boundaries, the resource-based view on interdependencies is likely to be best, whereas firms hoping to collaboratively work on new products or services, this might involve task interdependencies.

Finally, this research, as most other interdependence research, has conceptualized organizations as starting with a clean state of interdependent tasks waiting to be structured and coordinated (Staudenmayer, 1997). However, in business ecosystems firms co-evolve their capabilities and roles (Moore, 1993), which suggests that their tasks and hence their task interdependencies co-evolve along. This case study was retrospective to be able to reconstruct a time line and observe possible changes in interdependencies over time. Yet, the time period over which data was collected was still relatively limited. Therefore, in order to

better map the process of co-evolution in business ecosystems and its presumable effect on interdependencies, future research should gather data over a longer period of time. Once a clear theory has been established a prospective case study might be more appropriate to test theory-based hypotheses (Bitektine, 2008).

More extensive longitudinal research could provide insights into conceptions of interdependence, and how they change over time. Furthermore, future research should see how co-evolution truly occurs, and especially on what levels firms evoke change in each other. Perhaps the interdependencies are shaped or constrained by their past form (Staudenmayer, 1997). In this study, interviewees mentioned learning from each other in terms of capabilities, and that partners affected them and vice versa, but they mostly touched upon collective and iterative research and development efforts of products and service. Interviewees did not mention any deeper co-evolution, in terms of changes in organisational structure or nature of the firm. Research should see in what forms and at what levels this co-evolution takes place.

In conclusion, it is suggested that future research on interdependencies in business ecosystems is longitudinal and inductive in nature, conducted from a sensemaking perspective. This perspective might better address the rich context of business ecosystems.

6. Conclusion

The objective of this study was to see how interdependencies in business ecosystems might best be managed, embodied by the primary research question: *How can interdependencies in a business ecosystem be managed?* Two secondary research questions supported the primary research question. First, *what are the structures of the task relationships of interdependencies in a business ecosystem?* Second, *what are the control mechanisms used to coordinate interdependencies in a business ecosystem?* The findings indicate that the interdependencies in a business ecosystem have different structures of task relationships, and that the interdependencies are coordinated with different control mechanisms accordingly. Moreover, a way of reducing interdependencies is suggested that fundamentally enhances the opportunities to manage interdependencies; a way that involves changing the structure of the task relationship of interdependence to a structure with a lower contingency. This way of reducing interdependencies is recommended to be used in combination with control mechanisms in a sequential order. First, a firm should consider changing the structure of the task relationship of interdependence. Second, irrespective of whether the structure of the task relationship has been changed or not, the firm should implement control mechanisms to coordinate the interdependence, thereby taking the structure of the task relationship of the interdependence into account. Based on the findings from this study, a roadmap was designed to assist firms in identifying and managing interdependencies.

The original theoretical contribution of this research is showing how interdependencies in business ecosystems differ in their structure, and suggesting how these interdependencies might be effectively managed. The findings have some implications for existing theory. It is advocated that one cannot speak about a certain type of interdependence without referring to the roles that firms hold in a business ecosystem. Furthermore, future research should consider the structure of task relationships when talking about interdependence in business ecosystems, as this structure affects the type of control mechanisms that will likely be most effective in coordinating the interdependence.

This study has enriched the knowledge on interdependence in business ecosystems by looking at the structure of interdependencies, yet has still taken a limited view on interdependence. Future research should also consider the primary driver of interdependency (internal technology, internal firm environment, external firm environment), and the nature or content of tasks (loose versus tight coupling). In addition, it is suggested that future research on interdependencies in business ecosystems should be longitudinal and inductive in nature, conducted from a sensemaking perspective to better address the rich context of business ecosystems.

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Appendix I

TABLE 9 CONCEPTUALIZATIONS OF KEY CONSTRUCTS

Concept	Conceptualization	Reference
Business ecosystem	A network of interconnected, co-evolving organizations, organized around a focal firm or a platform, which incorporates both production and use side participants, and focuses on the co-creation of new value through innovation	Thomas and Autio (2013)
(Internal) interdependence	The extent to which a task requires organizational units to engage in work flow exchanges of products, information, and/or resources and where actions in one unit affect the actions and work outcomes in another unit.	Thompson (1967)
Uncertainty	The difference between the amount of information required to perform the task and the amount of information already possessed.	Staudenmayer (1997)
Pooled interdependence	Each part renders a discrete contribution to the whole and each is supported by the whole, although the parts do not interact in any direct way.	Thompson (1967)
Sequential interdependence	The output of one part is the input to another.	Thompson (1967)
Reciprocal interdependence	The outputs of each part become inputs for the others.	Thompson (1967)
Governance Control	A mode of organizing transactions. Any mechanism implemented by an organization to create conditions that motivate the organization to achieve desirable or predetermined outcomes for the organization and to encourage desirable behavior.	Heide (1994) Dekker (2004) and Tiwana et al. (2010)
Coordination	The process of managing dependencies between activities.	Malone and Crowston (1994)
Formal control	Officially sanctioned (usually codified) institutional mechanisms, such as written rules, standard operating systems, and procedural directives – visible, objective forms of control.	Cardinal et al. (2004)
Informal control	Unwritten, unofficial values, norms, shared values, and beliefs that guide actions and behaviors – less objective, uncoded forms of control	Cardinal et al. (2004)
Input control	Mechanisms to manage resources acquired by the firm; it focuses on human, material and financial resources flowing into the firm.	Cardinal et al. (2004)
Behavior control	Mechanisms to manage task activities of a firm that transform inputs into outputs.	Cardinal et al. (2004)
Output control	Mechanisms to manage product and service outcomes and regulate results or outcomes of the firm.	Cardinal et al. (2004)

Appendix II

TABLE 10 OVERVIEW OF THEORETICAL PERSPECTIVES ON INTERDEPENDENCE

SOURCE: ADAPTED FROM STAUDENMAYER (1997)

	Information processing theories	Resource-based theories	Sense-making theories
Representative research	Thompson (1967); Nadler & Tushman (1983); Tushman & Nadler (1996)	Salancik & Pfeffer (1974); Malone & Crowston (1994); Roth (1995)	Granovetter (1973); Schelling (1978); Weick (1976, 1990)
Theoretical structure	Realism, positivism, deterministic, nomothetic	Realism, positivism, deterministic, nomothetic	Nominalism, antipositivism, voluntaristic, ideographic
Concept of interdependency	Interdependency as a (bilateral) pattern of tasks	Interdependency as a pattern of relationships within a given context	Interdependency as equivocal systems of relationships
Unit of analysis	Tasks performed by work units, departments or individuals	Tasks performed by departments	Tasks performed by "things"
Antecedents of interdependency	Inherent in the information requirements of internal or external tasks	Uncertainty with respect to the task or environment and limited (shared) resources	Abstract nature of work; dynamic patterns of action
Consequences of interdependency	Uncertainty and information processing	Differences in power; conflict	Seemingly random and surprising events; An inability to comprehend and reason about work structure
Factors affecting the difficulty of achieving integration	Degree of contingency between tasks as represented by pattern of relationship	Criticality, value and availability of resource	Degree of coupling, timing and visibility
Implicit assumptions	Pre-identifiable and stable tasks; clearly visible and recognizable patterns	Mutual agreement about what resources are most critical	Interdependencies are subjectively defined
Predictions derived from theory	Tight couplings are most difficult to coordinate; matching	Interdependency determines power relations and	Loose couplings are most difficult to coordinate

	coordination mechanisms to interdependency results in higher performance	competitive advantage of firm	
Recommendations for management	Adopt appropriate information processing mechanisms and structures	Control decisions about resource allocations or avoid interdependencies	Impossible to design an ideal organization structure a prior; Individuals must act heedfully with respect to interdependency

Appendix III

TABLE 11 INTERVIEW PROTOCOL

Topic	Objective	Primary question	Secondary question
Introduction of interviewer	<ul style="list-style-type: none"> - Introduce interviewer - Explain purpose of project and interview - Remind interviewee of projected duration and topics to be discussed. - Obtain verbal or written consent for recording (consent form) 		
Introduction of interviewee	<ul style="list-style-type: none"> - Gain an understanding of the interviewee's background 	<p>Your position in firm X is Y. Could you describe this position and the related activities and responsibilities?</p>	<ul style="list-style-type: none"> - Could you describe to what extent your job involves identifying, managing and monitoring risks? Are you directly responsible for these risks or indirectly?
Introduction of topic and concepts	<ul style="list-style-type: none"> -Introduce concept of business ecosystems -Establish agreement/clarification on definitions of terminology 	<p>Have you heard about business ecosystems, risk management, and risk management in business ecosystems?</p>	<ul style="list-style-type: none"> - Have you heard about business ecosystems? - What do you understand by risk management? - And in a business ecosystem? - Do you understand/agree with these definitions? If no: why not; what would you want to change, remove or add to the definition?

Defining role in business ecosystem	-Determine the role that the firm fulfills in the business ecosystem	How would you describe the role that your firm fulfills in the business ecosystem?	<ul style="list-style-type: none"> -How would you describe the level of turbulence and innovation in your business ecosystem? (high/low) -How would you rate the level of complexity of relations in your ecosystem? Does your firm leverage a complex network of external assets? - Does your firm focus on a narrowly define segment (niche)? - Could you name firms in the ecosystem that fulfill other roles? How does your firm relate to other ecosystem players? - Can you mention a firm in the business ecosystem and describe their role? Why do they fulfill this role? - How dynamic are these roles do you think? Do you think the industry will change towards being more or less turbulent? - Do you think your firm will become more or less dependent on other organizations in the future?
Objective setting	-Determine the objectives your firm has in the business ecosystem	- Which strategic objectives does your firm have?	
Event identification	-Determine the events that could affect the achievement of objectives	- Which internal and external events affect the achievement of your firm's objectives?	- Which events have affected or could have affected the achievement of these aforementioned objectives?

Risk Assessment	-Identify the risks that the firm encounters '- Make a preliminary assessment of likelihood and impact of these risks	Which strategic risks do you identify in your business ecosystem, and how would you assess them, considering likelihood and impact?	- Can you tell me about the risks encountered related to the aforementioned events OR which risks affect your work? - In your experience, which risks affect the organization the most? OR In your opinion, what are the most worrisome risks in your area? (likelihood/impact) - Which risks occurred? Which risks have you actively tried to mitigate? How? - Have these risks changed over time? - - Do you think there are chain effects in risks from your innovation partners to you and vice versa? - Does your firm depend on other firms? - What are the risks of these dependencies? - Which risks occurred in the cooperation in the ecosystem/with that specific partner?
Risk Response	- Determine risk responses to previously identified ecosystem risks	Which risk responses do you find most applicable to each of the risks identified before, choosing from avoiding, accepting, reducing or sharing risk?	- Which risk responses do you find most applicable to the previously identified risks? Choosing from avoiding risk, accepting risk, reducing risk, or sharing risk? --> Closed question - How did your firm respond to the risks?
Control activities	Explore possible control activities to the previously identified ecosystem risks	Which policies and procedures are or could be established and implemented to help ensure the	- Which policies and procedures did you implement to mitigate the risks?

Concluding the Interview	Closing interview and explore references to other informants	<p>risk responses are effectively carried out?</p> <p>Do you have any remaining questions or suggestions for the continuation of my research?</p>	<p>- Are there any other risks that we have not discussed and that you find worrisome?</p> <p>OR - Do you want to add anything on risks or the business ecosystem?</p>
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Appendix IV

TABLE 12 INTERDEPENDENCIES AND CONTROL MECHANISMS MENTIONED IN THE INTERVIEWS

Interdependence	Structure	Control formality	Control target	Mentioned by who
Application platform provider - Application provider	Sequential	Formal	Input	[6]
Content provider - Middle-ware provider	Sequential	Formal	Output	[9]
Content provider - Platform provider	Sequential	Formal	Input	[7][10]
Middle-ware provider - Device manufacturer	Reciprocal	Formal	Output	[9]
Middle-ware provider - Middle-ware provider	Pooled	Formal	Output	[9]
			Input	[5][7][10]
	Reciprocal	Formal	Behavior	[5]
			Output	[5][9]
	Informal	Input	[5][7][10]	
Middle-ware provider - Middle-ware provider/Internet Service Providers	Reciprocal	Informal	Input	[9]
Network & Infrastructure provider - Internet service provider	Sequential	Formal	Input	[9]
Platform provider - Application platform provider	Sequential	Formal	Input	[8]
			Output	[6]
Platform provider - Component provider	Sequential	Formal	Input	[8]
Platform provider - Device manufacturer	Reciprocal	Formal	Output	[7]
Platform provider - Middle-ware provider	Sequential	Formal	Input	[9]
			Input	[5][7][8][9][10]
	Reciprocal	Formal	Behavior	[5][8][9]
			Output	[9][10]
	Informal	Input	[5][7][9]	
Platform provider - System integrator	Sequential	Formal	Output	[7]
		Informal	Input	[7]
System integrator - Middle-ware provider	Reciprocal	Formal	Input	[5][7][10]
			Behavior	[7]
			Output	[10]